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# *The Impact of Changes in Kindergarten Entrance Age Policies on Children's Academic Achievement and the Child Care Needs of Families*

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## Abstract

The past two decades have seen a rising trend in the minimum entrance age for kindergarten in the U.S. This trend has been motivated by findings from cross-sectional studies that find that older entrants perform better than younger entrants on a wide range of outcomes in school. However, these studies fail to account for the selection bias in kindergarten entrance age resulting from parental choice, thereby leading to biased estimates of the entrance age effect. In addition, a little-noticed but potentially large consequence of raising the minimum entrance age is that it imposes an additional economic burden in the form of childcare and time costs on families whose children are forced to stay out of school for an additional year.

This dissertation provides new evidence on the causal effect of delaying kindergarten entrance on children's academic achievement in elementary school using exogenous variation in birth dates and kindergarten entrance age policies. Both initial level differences and subsequent growth in test scores are examined. I find that a one-year delay in kindergarten entrance has a positive and significant effect on children's test scores when they begin school, which persists at the end of two years in school. The effect sizes associated with these estimates are large (0.62-0.85 standard deviation units) compared to effect sizes of other educational interventions. I also examine whether the entrance age effect is different for at-risk children, such as poor, children with a disability, and boys. I find that among poor and disabled children, the initial entrance age effect is smaller compared to that for non-poor and non-disabled children. However, delaying entrance has a sizeable effect on the gains in test scores over time for poor and

disabled children but has a negligible effect on gain scores for non-poor and non-disabled children.

This dissertation also develops an economic model for parents' kindergarten entrance age decisions and examines the effect of socio-economic factors on these decisions using a nationally representative dataset on kindergartners in the U.S. The estimates from this model are used to simulate the impact of changes in kindergarten entrance age policies on (a) the number of children affected by the policy change, (b) the socio-demographic composition of the affected children, and (c) the estimated additional childcare cost burden from the policy change. The results indicate that higher childcare prices and maternal wages significantly lower the age at which parents desire to send their child to kindergarten. Girls, non-whites, children from less educated and poor families are more likely to be affected by changes in entrance age policies. The additional childcare cost burden from a movement of all December/January cutoff dates to September, which reflects the current policy trends, is estimated to be close to $147 million per year for the families of close to 92,000 children who will be affected by this policy change.

# CHAPTER 1 – Introduction

This dissertation examines an important policy issue in the U.S. that has received much attention in recent years, namely, what is the age at which children should be allowed to enter kindergarten? The age at which children start formal schooling is an important issue because of its likely impact on a number of aspects of children's lives. Kindergarten entrance age may affect the amount of time children spend with their mother in early childhood, the development of academic and social skills during school years and could potentially affect labor market outcomes by affecting the age at which they enter the labor force. In addition, these decisions may in turn affect the behavior of other members of the child's family, such as the mother's labor force participation.

Central to this policy issue is the notion of "school readiness" and the question as to what characteristics define children's readiness for school and how they can be measured. Starting in the early 1990s there were efforts to identify some broad dimensions describing school readiness based on scientific research, including the National Education Goals Panel's (NEGP) definitions of school readiness. While these efforts highlighted broad categories, there were no standard measures to capture these constructs. In the absence of any standard measures for determining children's school readiness, states have traditionally used chronological age as the standard for judging children's readiness for school.

The use of chronological age has been surrounded by much controversy in the research community mainly because using age as the criterion fails to account for the developmental differences that exist even among children of the same chronological age that may be critical for their future success. Despite that, states have been raising the minimum entrance age for kindergarten under the belief that older entrants are more mature compared to younger entrants to cope with the kindergarten curriculum and are therefore likely to perform better in school. However, the consequences of changes in entrance age policies are not fully understood. There is no clear evidence regarding the effects of entrance age on school performance. Moreover, a little-noticed, but potentially large, consequence of raising the minimum entrance age is that it imposes additional childcare costs for families whose children are forced to stay out of school for an additional year. Some families may be left without access to quality childcare alternatives while others will have to bear an extra year of costs in terms of the time and/or monetary costs of childcare.

**Objectives**

The objectives of this dissertation study are as follows:

1. To examine whether entering kindergarten at an older age improves children's academic achievement in school?

1.1. Are there initial differences in the academic achievement of younger and older kindergarten entrants?

1.2. Do initial differences between older and younger entrants decrease or increase during the first two years in school?

1.3. Does the effect of entrance age on academic achievement differ by gender, disability, and poverty status?

2. To develop an economic model of families' entrance age decisions that will help examine the following issues:

2.1. Examine how economic factors, such as wages and cost of child care affect the decision to enter kindergarten.

2.2. Examine how changes in kindergarten entrance age policies affect parents' decisions regarding timing of entrance age.

2.3. Simulate the impact of alternate changes in kindergarten entrance age policies on:

2.3.1. How many children will be forced to stay out of kindergarten for an additional year due to a policy change?

2.3.2. What types of families will be most affected by a rise in the minimum entrance age?

2.3.3. What is the expected additional childcare cost burden on families from the additional year out of school?

## Policy Relevance and Contribution to Knowledge

This study makes a number of contributions. First, this research fills a major gap in the early childhood education literature by generating more accurate estimates of the effect of entrance age on school performance with an improved methodology and a richer dataset. It also shows that the entrance age effect on school performance varies for different types of children, such as children from poor families and disabled children. These estimates will inform the policy debate about whether raising the entrance age will improve children's performance in school and which children it is most likely to affect. Second, this research is the first to develop a behavioral model of families' entrance age decisions that helps to understand what factors influence these decisions. Third, the findings of this study will be useful for policymakers as it provides estimates of the number of children that will be forced to stay out of school for an additional year due to various changes in entrance age policies. Fourth, it identifies which families are most likely to be affected by entrance age policies. For example, it is possible that low-income families would send their child to school at an earlier age because schooling is free compared to expensive childcare, and therefore their children may be more likely to be forced to stay out of school for an additional year. These estimates will play a critical role in helping policymakers design policies that will better meet the needs of children.

## CHAPTER 2 – Effect of Kindergarten Entrance Age Policies on Children's Academic Achievement

### 1. INTRODUCTION

There is considerable debate in the research community about when children are ready to enter school. In the absence of any consensus on a better measure, states have traditionally used chronological age as the standard for judging children's readiness for school. In recent years, there has been a trend toward raising the minimum entrance age for kindergarten. A recent study reported that more than a third of the reporting school districts had raised their minimum entrance age by 3 to 4 months over the period 1974-1997 (De Cos, 1997). Furthermore, a number of states are currently considering raising the minimum entrance age in their state. For example, California is debating whether to raise the minimum entrance age for kindergarten by 3 months. If approved, entering kindergartners will be required to complete five years of age by September 1st instead of December 2nd of the school year. Hawaii, Vermont and Maryland are other states with December or January cutoff dates that are also considering raising the minimum entrance age.

Other approaches to delaying kindergarten entrance, such as creating transitional kindergarten classes or grade retention to give younger children an additional year to catch up, are also being widely practiced in schools across the nation (Boettger, 1994; Gredler, 1984; Leinhardt, 1980; Wang & Johnstone, 1997). In addition, parents of young children are also encouraged to hold their child out of school for an additional year (Bracey, 1989; Elkind, 1987).

Such actions have been motivated by numerous studies that have suggested a positive correlation between entrance age and school performance (Langer et al. 1984, Uphoff & Gilmore 1985, Dipasquale et al. 1980, Diamond 1983, Maddux 1980, Bisanz et al. 1995, Davis et al. 1980, Breznitz & Teltsch 1989). State policy makers have interpreted this positive correlation as a causal link between entrance age and school performance and are seeking to raise children's achievement by raising the age at which they enter kindergarten. With the current emphasis on school accountability, entrance age policies may seem like a politically attractive strategy to state policymakers by which gains in test scores may be achieved without any corresponding educational investments (Stipek, 2002). That is, a state can expect to boost its test scores, at least for students in the first few years of school, by increasing its minimum entrance age.

However, there exist numerous other studies that either find no effect of entrance age on school performance or find small initial differences that disappear in subsequent grades (Morrison et al. 1997, DeMeis & Stearns 1992, Kinard & Reinherz 1986, Langer et al. 1984, Shepard & Smith 1986, Breznitz & Teltsch 1989). In addition to the ambiguity in findings, the entrance age literature also suffers from methodological weaknesses, most importantly, its failure to account for the endogeneity of kindergarten entrance age. Parents choose the age at which they want to send their child to school based on a number of observable and unobservable factors that may also affect the outcomes of interest. Failure to account for such selection would result in biased estimates of the entrance age effect. Other weaknesses include the use of small and unrepresentative samples to estimate the entrance age effect.

It is not clear, therefore, what these changes in state policies are achieving. If there is no real entrance age effect on cognitive skills then the recent rise in minimum age requirements across states may have deprived many children that are "ready" from entering school without any offsetting benefits to them or their families. Age of entry could make a particularly large difference for disadvantaged children, who, if not enrolled in school, may not be able to attend a high quality pre-school or day care instead. In addition, postponing school can place an economic burden on parents.

In this chapter, I use a nationally representative sample of kindergartners from the Early Childhood Longitudinal Study—Kindergarten Class (ECLS-K) to estimate the causal effect of kindergarten entrance age on children's academic achievement. Specifically, the paper addresses the following questions—(1) Do older entrants achieve higher test scores compared to younger entrants at the beginning of kindergarten? (2) Do older entrants gain more or less over time from schooling than younger entrants? and, (3) Do boys and at-risk children, such as poor and disabled, benefit more than others from delaying entry into kindergarten?

I present instrumental variable (IV) estimates of the effect of entrance age on test scores in kindergarten and first grade. With valid instruments, IV estimates are consistent and may be interpreted as causal estimates of the entrance age effect. The instruments for kindergarten entrance age are derived from two sources of potentially exogenous variation—variation in birthdays within a year, and variation in kindergarten entrance age policies, both across states and across schools within a state. Three instruments for entrance age are used—(i) number of days between child's 5th birthday and school's cutoff date, (ii) minimum entrance age required on the first day of school, and (iii) state's upper age limit by which children must be in kindergarten.

The findings from this study can be summarized as follows. Both OLS and IV estimates suggest a positive and significant relationship between kindergarten entrance age and children's academic achievement. However, OLS estimates are downwardly biased suggesting that previous studies that failed to account for selection bias may have underestimated the true entrance age effect. The IV estimates show that a one-year delay in kindergarten entrance leads to a 6-8 point increase in the test scores at the beginning of kindergarten. This initial achievement gap stays till the end of grade 1 for math, increases by just over a point for reading, and reduces by a quarter for general knowledge. Among at-risk children, such as children living in poverty or children with a disability, the entrance age effect is smaller in kindergarten compared to not-at-risk children. However, delaying entrance has a sizeable effect on the gains in test scores over time for poor and disabled children but has a negligible effect on gain scores for non-poor and non-disabled children.

This chapter proceeds as follows. Section II discusses the background for the kindergarten entrance age debate and the related literature. Section III describes the ECLS data, and the specific sample and variables used in the analysis. Section IV describes the analytic strategy, including the instruments for kindergarten entrance age. Section V reports the OLS and IV results. Section VI summarizes the findings from this chapter and their implications for policy.

## 2. BACKGROUND AND LITERATURE REVIEW

There are two dominant viewpoints in the early childhood literature surrounding the entrance age debate. Supporters of delayed entry into kindergarten believe that children need the "gift of time" and general out-of-school experience to be able to perform better in school. Those who oppose delaying entry into school believe that school can provide the nurturing environment that helps to promote children's learning and development.

The empirical literature has tried to identify separately the influence of age and schooling on children's learning. Two types of approaches have been used in previous studies. The first approach uses the observed variation in entrance age to estimate the entrance age effect. These studies compared children within a class that had delayed entry to those who entered when they first became eligible. The findings of these studies were inconsistent. Some studies reported that children who delayed entry by a year were more likely to receive special education services and had significantly more behavior problems (Graue & DiPerna, 2000; Byrd et al., 1997; May et al., 1995) while others found that children who delayed entry were less likely to be retained in grades than children who did not delay entry (May et al., 1995; Langer, Kalk & Searls, 1984). Studies that compared academic performance of delayed-entrants to others found no significant differences in the achievement of the two groups (Cameron & Wilson, 1990; Kundert et al., 1995; Graue & DiPerna, 2000). A more troubling issue with these studies is that their results suffer from biases resulting from selection. Children who delay entry may differ from children who entered on time on other unobserved outcome-related measures such as ability or maturity. For example, low ability children may be more likely to both delay entry and perform worse in school, in which case studies would find children who delayed entry to be performing worse than other children. Moreover, comparing the retention rates among children who delay entry and those who do not is potentially problematic because it is possible that teachers are more reluctant to retain children who are already relatively older than their classmates (Stipek, 2002).

The second approach used in the literature uses variation in birth dates of children within a class to estimate the age effect. It is argued that, given a school cutoff date, the randomness in birth dates generates exogenous variation in age. Children born in months just before the cutoff date would be younger than children born in months just after the cutoff date. Studies typically divided children from a class into age groups based on their month of birth and compared the academic outcomes across these age groups. The findings of these studies are also mixed. Most studies report that older children had higher academic achievement than their younger classmates, in the early elementary grades (Cahan & Davis, 1987; Crosser, 1991; Cameron & Wilson, 1990; McClelland et al., 2000; Stipek & Byler, 2001; Sweetland & De Simone, 1987; Jones & Mandeville, 1990; Crone & Whitehurst, 1999; Morrison et al., 1997). Studies that examined the age effect in later grades found that there were small or insignificant differences between older and younger children in a class (Jones & Mandeville, 1990; Langer, Kalk & Searls, 1984; Sweetland & De Simone, 1987; Bickel et al., 1991; McClelland et al., 2000; Stipek & Byler, 2001). However, two studies found no difference in achievement even in kindergarten (Dietz & Wilson, 1985; Kinard & Reinherz, 1986) while others reported differences that persisted in the later elementary grades (Breznitz & Telsch, 1989; Cameron & Wilson, 1990; Crosser, 1991).

It is often argued that "interpretation of findings of studies examining naturally occurring variations are less problematic than for the delayed-entry studies because birth dates are presumably randomly distributed" (Stipek, 2002). It is true that variation in birth dates is random. If all children entered school when they first became eligible, then there would be an exact one-to-one mapping between birth month and entrance age, leaving variation in entrance age random. However, many times parents choose to either hold their child out of school for additional time or even manage to send their child to school before she is eligible when schools allow exemptions from the cutoff date policy.[1] Despite prevalence of such behavior, many studies have assumed that there is a one-to-one match between birth month and entrance age in order to estimate the age effects. Some studies simply do not take delayed entry into account and treat the variation in age as exogenous even with delayed entrants in the sample. As mentioned earlier, delayed entrants may constitute a selected sample of children, as a result of which studies may find smaller or insignificant differences in the achievement of older and younger children even in the presence of true age effects. Other studies have tended to ignore children who delayed entry and estimated the age effect using children who entered school on time. These studies are likely to underestimate the true entrance age effect because the sample of younger children is selected and may consist of high-ability children whose parents chose not to delay entry. Finally, there are some studies that dropped all children who were born in months just before (youngest) or just after the cutoff (oldest) since the youngest children are likely to be of higher than average ability and the oldest children are likely to be of lower than average ability. For example, Cahan and Davis (1987) estimated the within-grade regression slopes of

[1] A study by the National Center for Education Statistics (NCES) reported that close to 9 percent of first and second graders had experienced delayed kindergarten entrance in 1993 and 1995 (NCES 1997).

achievement on age on the basis of the middle 10 months of birth only i.e. excluding the months before and after the cutoff date. While it is reasonable to assume that selection is most likely to occur in the months just around the cutoff, it is possible that parents of children born in months away from the cutoff may also choose to delay their child's entrance. For example, parents that are very involved in their children's education may want to delay their child's entry in order to give their child an edge over her classmates. These parents may also be more likely to make other investments in their child that improves her academic performance (e.g. getting a tutor or reading to children). Therefore, using the variation in age generated by the months of birth away from the cutoff date may in this case overestimate the entrance age effect. The above examples illustrate that even though variation in birth dates is random, the variation in entrance age generated may not be exogenous when delayed or early entrants are removed from the sample.

In addition, findings from previous studies sometimes failed to consider grade retention or early promotion. Stipek (2002) in her review of the entrance age literature concludes that the advantage of being older than classmates diminishes over time, which suggests a narrowing in the achievement gap between younger and older entrants over time. Studies on which these conclusions are based need to be interpreted carefully. They are primarily cross-sectional studies that estimate the entrance age effect using data from higher grades. The sample used in these studies only includes children that progressed through grades at a "normal" rate or at grade-level i.e. they were neither retained nor skipped a grade. It is not surprising, therefore, that these studies find that the entrance age effect diminishes or disappears in later grades. Children who perform either very well or very poorly are selected out of a cohort over time through retention or grade acceleration and as a result the sample of children in higher grades is likely to comprise of children with similar ability. Some "retrospective" studies use scores from previous grades obtained from school records in order to examine whether the entrance age effect changes over time (Cameron & Wilson, 1990; Bickel et al., 1991). But, these studies also restrict their sample to grade-level children. These studies would not only find no entrance age effect in later grades but would also tend to find small or no effects in earlier grades because of the omission of children at higher risk of failure or promotion from the sample.

Finally, findings from many studies are neither reliable nor generalizeable due to extremely small sample sizes and unrepresentative samples. Also, very often studies collected their own data for a small sample of children instead of using larger secondary data. Samples constructed in this manner could only consist of children whose parents agreed to participate in the study, thereby adding to the selection problem.

Few studies have explored the potential age-schooling interaction, which would examine whether younger entrants gain more or less from schooling than older entrants. Morrison et al. (1997) examine the impact of entrance age on growth in reading and mathematics achievement in younger 1st graders, older 1st graders, and older kindergartners using a sample of 539 children from 26 public elementary schools in a moderately large city in western Canada. Children were divided into the three comparison groups based on their month of birth. The authors find that younger 1st graders score just over 3 points lower in reading and over 5 points lower in math compared to older 1st graders. However, younger 1st graders made as much progress over the school year as did older 1st graders. Morrison et al. (1995) use a similar strategy to examine the effect of entrance age on the development of memory and phonological segmentation in 1st grade children. They too find that younger 1st graders made as much progress during the school year as older 1st graders in the growth of memory and language skills.

Mayer and Knutson (1999) use data from the National Longitudinal Survey of Youth (NLSY) mother-child files for 1986 to 1992 to examine the effect of early enrollment on children's cognitive test scores. The authors use exogenous variation in birth dates to estimate the entrance age effect. After controlling for amount of schooling, they estimate that a one year delay in kindergarten entrance has no significant effect on Peabody Individual Achievement Test (PIAT) math scores but reduces PIAT reading scores by 2 points (effect size = 0.18 standard deviation). In addition, children who enroll in school early are found to gain as much over time as those who enroll at an older age. However, the NLSY sample does not allow the authors to compute the enrollment age accurately since it does not provide information on how many grades a child skipped or repeated. The prevalence of grade repetition is significantly high in their sample (19 percent of 10 and 11 year olds repeated a grade at some time during their schooling), which is likely to bias their estimates downwards. The authors' calculation is more likely to overestimate the enrollment age for those who repeat grades. At the same time, children who repeat grades are more likely to score lower on achievement tests.

This study adds to the literature in a number of ways. First, I examine not only how entrance age affects academic performance in the beginning of kindergarten but also whether younger entrants learn more or less over time. Second, unlike previous studies this paper accounts for the endogeneity of kindergarten entrance age (or selection bias) using instrumental variables estimation and provides *causal* estimates of the effect of entrance age on children's academic achievement. Third, the entrance age effect is allowed to vary across subpopulations so as to examine whether at-risk children benefit more or less from delaying entrance compared to the rest of the population. Finally, unlike most previous studies, this study uses a national probability sample of kindergartners in the U.S., which allows it to generate estimates that are reliable and generalizeable.

## 3. DATA

The data analyzed come from the Early Childhood Longitudinal Study – Kindergarten Class (ECLS-K), which surveyed a nationally representative cohort of kindergartners from about 1,000 kindergarten programs in fall and spring of the 1998-1999 school year. This is a panel study where the initial sample of children will be followed-up till grade 5, with data collection on the full sample in the spring of grades 1, 3 and 5. The ECLS-K sample was collected using a dual frame, multistage sampling design with oversampling of Asians and children with disability. NCES (1999) provides details of the survey design and instruments. This paper uses data collected during the fall and spring of kindergarten and spring of grade 1.[2]

The primary advantage of this data set is that it includes detailed information on children's school performance in multiple time periods. The longitudinal aspect of these data allows analysis of whether younger kindergarten entrants gain more or less than older entrants with regards to test scores between entering kindergarten and completing grade 1. Another unique feature of this data set is that it contains information on kindergarten cutoff dates at the school level. Other large data sets rarely include such detailed information and therefore studies have had to use state level cutoff dates (Langer, Kalk & Searls, 1984). This was problematic for two reasons. First, private and charter schools within a state can have different cutoff dates than the state

[2] The ECLS only surveyed a 30 percent subsample in fall of grade 1 and therefore these data are not used in this paper.

requirement. Second, some states do not have any state level cutoff date policy and allow the local education agencies (LEA's) to establish their own cutoff dates.[3] As a result, previous studies have had to drop such states from their analysis. By providing information at the school level, the ECLS allows the inclusion of children from such states and also generates variation in cutoff dates across schools within a state. The ECLS also collected data on school start dates, children's birth dates and year in which they entered kindergarten. This information can be used to compute the kindergarten entrance age very accurately.

Extensive background information in these data on the study participants provides a rich set of control variables in the analysis. The data contain detailed information on demographics, and school, teacher and classroom characteristics. There is also detailed information about the parents of the kindergartners, including family composition, employment status and educational background of the parents.

Since the ECLS is a panel survey, one major concern regarding the data was the extent of attrition in the sample as children progressed from kindergarten to subsequent grades. Attrition is especially important in the context of this paper because I seek to examine whether learning over time is different between older and younger kindergarten entrants. If attrition is not random then estimates generated using the sample of non-attritors may be biased. There were 18,664 kindergartners in the fall that

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[3] In 1998, there were 5 states that allowed the local education agencies to decide their cutoff dates—Colorado, Massachusetts, New Hampshire, New Jersey and Pennsylvania.

had a reading, math or general knowledge test score in fall of kindergarten.[4] Of these, 95 percent had a cognitive assessment in spring of kindergarten. A significant percent of children attrited from the sample between spring kindergarten and spring grade 1 (17 percent of the original sample). The attritors were comprised primarily of those who changed schools between kindergarten and grade 1 (movers). A distinguishing feature of the ECLS-K is that the study followed up all movers from a random 50 percent of base year schools. Therefore, most of the children who were lost to follow up between spring kindergarten and spring grade 1 were those who were randomly selected for no follow up (12 percent). As a result, most of the attrition from the original sample of children is random and would not bias the estimates. The remaining source of attrition in the sample is due to non-response in both the stayers and movers (4.7 percent), and children who could not be located (0.7 percent). Observable characteristics of stayers and attritors are compared using fall kindergarten data (see Table 1a). Children with more educated mothers and whites are less likely to attrit from the sample. There is no difference in the mean kindergarten entrance age of attritors and stayers. However, stayers scored higher than attritors at baseline.

A significant number of schools were missing data on cutoff dates (19 percent) or start dates (17 percent) for the school year. Data on school start dates was critical for

[4] About 74 percent of the 1,277 schools sampled agreed to participate. There was a 90 percent completion rate for the child assessment, conditional on school's participation in the study. See NCES (1999) for more details on response rates.

constructing the kindergarten entrance age variable. All public schools that were missing a start date were assigned the start date of the school district they belonged to. In case of private schools, they were assigned the most common start date among other private schools within the state. Data on cutoff dates was essential for constructing the instruments for kindergarten entrance age. Again, different approaches were used for addressing the missing data on cutoff dates for public and private schools. All public schools that were missing a cutoff date were assigned the state cutoff date. For private schools, they were assigned the modal cutoff date among other private schools in the state. In the end, there were only 4 schools that could not be assigned a cutoff date or start date because the state where the school was located was unknown. These were dropped from the analysis.

I limit the analysis to first time kindergartners only, which results in a sample of 13,818 children with a math, reading or general knowledge test score at the three time points considered in the analysis. The exact analysis sample varied in the different regressions because of differences in the availability of reading, math and general knowledge scores over time.

*Dependent Variables*

The primary outcome of interest in this chapter is children's academic achievement in school. Children's scores on reading, math and general knowledge tests are used as measures of academic achievement.[5] In each subject area, children were administered a two-stage assessment. In the first stage, children received a 12 to 20 item routing test. Performance on the routing items guided the selection of one of the several alternative second-stage tests. The second stage test contained items of appropriate difficulty for the level of ability indicated by the routing test.[6] The tests included both multiple choice and open-ended items. Data were collected using computer-assisted interviewing methodology.[7] The same mathematics and general knowledge assessments were administered at the three study periods. For reading, the same assessment was administered in fall and spring of kindergarten but the number of reading items was increased in the spring grade 1 assessment by adding more difficult vocabulary words and text in order to eliminate the possibility of "ceiling effects".

Since not all children took the same test due to the two-stage assessment approach, ECLS computed scores based on the full set of test items using Item Response Theory (IRT) procedures.[8] The IRT scale scores represent estimates of the number of

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[5] The general knowledge assessment consisted of science and social studies material. The science items measured two broad classes of science competencies: a) conceptual understanding of scientific facts, and b) skills and abilities to form questions about the natural world, to try to answer them on the basis of the tools and evidence collected, and to communicate answer and how the answers were obtained. Social studies material included questions relating to history/government, culture, geography and economics.

[6] Psychometrically, adaptive tests, where children take tests that are suitable for their ability, are considered to be more efficient compared to the "one-test-fits-all" administrations since the reliability per unit of testing time is greater (Lord 1980). Adaptive testing also minimizes the potential for floor and ceiling effects, which can affect the measurement of gain in longitudinal studies.

[7] The complete direct assessment, which included cognitive, psychomotor and physical components, took approximately 50-70 minutes.

[8] IRT uses the pattern of right, wrong and omitted responses to the items actually administered in a test and the difficulty, discriminating ability, and "guess-ability" of each item to place a child on a continuous

items students would have answered correctly if they had taken all of the 92 questions in the first and second stage reading forms, the 64 questions in all of the mathematics forms, and the 51 general knowledge items. I use the IRT scale scores for the three subjects as the dependent variable in the academic achievement regressions.

*Key Independent Variable*

The key independent variable in the analysis is the age at which the child entered kindergarten. The age in months is computed accurately using the child's birth date and the start date of the school year.

*Explanatory Variables*

A variety of child, family and school level variables are included as additional explanatory variables in the estimation. Child level variables include race, gender, and disability status.[9] Family level variables include household composition (measured by number of siblings, number of adults in the household), mother's education, primary language spoken at home, and poverty status. School level variables include size of the school as measured by the enrollment, percentage that are minorities, public or private

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ability scale. This makes it possible to estimate the scores the child would have achieved if all the items in all of the test forms had been administered. The reliability of the ability measure, theta, was high – 0.93 for reading, 0.92 for math, and 0.88 for general knowledge.

[9] Disability status equals 1 if the child was diagnosed with attention deficit disorder, hyperactivity, problem with coordination of limbs, problem communicating, hearing or vision impairment, or received any kind of therapy before kindergarten.

school, and region.[10] In addition, since children were not all assessed on the same day within each wave, all regressions also control for time in school.[11]

The means and standard deviations for the dependent and independent variables by kindergarten entrance age are reported in Table 1b. Boys, whites, and children with disabilities are more likely to enter kindergarten at an older age. On the other hand, children from poor and less education families are more likely to enter kindergarten at a younger age. There appears to be no difference in the kindergarten entrance age for children in private and public school.

## 4. ANALYTIC STRATEGY

The primary goal of this chapter is to examine whether entering kindergarten at an older age gives children an initial advantage in kindergarten that persists through subsequent grades. The model described below compares test scores of older and younger entrants within each grade, thereby controlling for the amount of schooling completed. However, older and younger entrants within a grade not only differ in their kindergarten entrance age but also differ in their chronological age. As a result, the

[10] Minorities include children who are either of Hispanic origin or who were American Indian or Alaskan Native, Asian, Black or African American, or Native Hawaiian or other Pacific Islander.

[11] In alternate specifications, I included additional explanatory variables in the test score equations, such as teacher (race, certification) and classroom (class size, percent minority) characteristics, measures of parent-child interaction and child's birth weight. Inclusion of these variables reduced the sample size by almost 30 percent. I tested the main model using the smaller sample and found that the estimates of the entrance age effect reduced by about 1 point. However, inclusion of the additional regressors did not change the entrance age coefficient significantly.

entrance age effect is not identified separately from the "age effect" when we are interested in outcomes of school-age children. An alternate approach that can be used involves comparing the test scores of older and younger entrants at the same chronological age. In this case, the entrance age effect cannot be identified separately from the "schooling effect" since younger entrants would also have more years of schooling. The rationale for focusing on same-grade comparisons is that students are now expected to demonstrate proficiency in their classes and on tests at the end of each grade level, regardless of how old they are. This continues all the way through high school, and many states are requiring students to pass exit exams to graduate, regardless of their age. In addition, with the passing of the No Child Left Behind Act of 2001, there is significant emphasis on assessing students' performance starting in early grades, making same-grade comparisons increasingly relevant in the current environment. In addition, the traditional approach followed in the entrance age literature compares children's outcomes within a grade and therefore I follow this approach in this paper as well.

Children's outcomes are measured at three points—fall kindergarten (when children enter kindergarten), spring kindergarten (end of kindergarten), and spring grade 1 (end of first grade). Test scores in kindergarten and grade 1 ($Y^{FK}$,$Y^{SK}$, $Y^{S1}$) are modeled as a function of child ($X$), family ($F$), and school characteristics ($S$).[12] In addition, children's academic achievement is hypothesized to depend upon the age at which they are exposed to schooling, or the kindergarten entrance age ($A$). I estimate the following system of equations:

Fall-Kindergarten: $$Y^{FK} = \beta^{FK} A + \alpha_1 X + \alpha_2 F + \alpha_3 S + \varepsilon^{FK} \quad (1)$$

Spring-Kindergarten: $$Y^{SK} = \beta^{SK} A + \gamma_1 X + \gamma_2 F + \gamma_3 S + \varepsilon^{SK} \quad (2)$$

Spring-Grade 1: $$Y^{S1} = \beta^{S1} A + \eta_1 X + \eta_2 F + \eta_3 S + \varepsilon^{S1} \quad (3)$$

where, $\varepsilon^{FK}, \varepsilon^{SK}, \varepsilon^{S1}$ are random error terms. $\beta^{FK}$ , $\beta^{S1}$ and $\beta^{SK}$ can be interpreted as the effect of kindergarten entrance age on children's academic achievement in the beginning of kindergarten, at the end of kindergarten, and at the end of first grade, respectively. Comparison of $\beta^{FK}$ with $\beta^{S1}$ and $\beta^{SK}$ indicates whether the initial gap between younger and older kindergarten entrants widens or narrows over time. If $\beta^{S1} > \beta^{SK} > \beta^{FK}$, older kindergarten entrants gain more than younger entrants over the first two years of school. Similarly, $\beta^{S1} < \beta^{SK} < \beta^{FK}$ implies that younger entrants gain more than older entrants over time.[13]

Kindergarten entrance age is determined from the household's utility maximization. As I discuss in chapter 3, parents choose the child's kindergarten

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[12] In an alternate specification, I included test scores from the previous assessment as an additional regressor in the test score equations. The estimated entrance age effects did not change significantly under this new specification.

[13] Comparing the entrance age effect in kindergarten and first grade is akin to estimating a model where the difference between test scores in two subsequent grades are regressed on the entrance age.

entrance age and levels of other choice variables so as to maximize the household's utility, subject to household budget and time constraints. These choices depend upon parental and child characteristics and also on other exogenous factors, such as price of non-parental care, household income and market wages. Previous studies have identified a number of factors that are related to kindergarten entrance age, such as child's gender, disability and parents' socio-economic status. Specifically, they find that boys, children with developmental problems, and whites are more likely to delay entrance (Graue & DiPerna, 2000; Cosden, Zimmer & Tuss, 1993; Zill, Loomis & West, 1997). A linear specification of the structural equation for kindergarten entrance age can be written as follows-

$$A = \delta_1 X + \delta_2 F + \delta_3 Z + \mu \qquad (4)$$

where, $Z$ includes variables that affect entrance age but not academic achievement.

It can be argued that parent and child characteristics that influence children's school performance would also influence the kindergarten entrance age that parents would choose. For example, unobservable factors such as child's maturity or parental motivation not only influence parents' decision regarding entrance age but may also be related to child outcomes. It is conceivable that parents who feel that their children are less mature or have developmental delays are more likely to delay their child's entry into school. These children are also more likely to perform worse academically. Moreover, parents that are highly involved in their children's education may be more likely to both delay kindergarten entrance and make other investments in their child that improve school performance. In that case, the unobservable factors that determine school performance would be correlated with the unobserved factors that determine entrance age i.e. $Cov(\varepsilon, \mu) \neq 0$. Estimating equations (1)-(3) using Ordinary Least Squares (OLS) would lead to biased estimates of the effect of kindergarten entrance age on children's school performance. As discussed above, the correlation in the unobservables affecting test scores and entrance age could generate positive or negative bias in the OLS estimates of $\beta$'s.

I use instrumental variables (IV) estimation to obtain *causal* estimates of the effect of entrance age on children's academic achievement. IV estimation uses one or more observable factors (or, instruments) that influence entrance age but do not directly affect children's academic achievement to mimic a randomization of children to different kindergarten entrance ages. When valid, IV estimation generates estimates that are not contaminated with selection bias. The validity of this approach depends upon two conditions—(1) entrance age is highly correlated with the instruments, even after controlling for X and F, and (2) the instruments are uncorrelated with any unobservable factors that affect children's academic achievement. While condition (1) is testable, condition (2) is an assumption whose validity can be explored extensively but not proven. In order to estimate $\beta$'s with a causal interpretation, we would need to have some variables in equation (4) that can be excluded from equations (1)-(3). These variables are denoted by $Z$ in equation (4). Formally, identification of $\beta$ would require that both $Cov(A,Z) \neq 0$ and $Cov(Z,\varepsilon) = 0$.

The errors in equations (1)-(3) are correlated because these are test scores over time for the same children. When errors across equations are correlated, then under certain conditions estimating the system of equations simultaneously generates more efficient estimates. I estimate the system of equations (1)-(3) simultaneously.[14] OLS estimates are generated from a seemingly unrelated regression model (SUR) and the IV estimates are generated by Three Stage Least Squares (3SLS). See Appendix A for a description of SUR and 3SLS models. These models were estimated using STATA version 7.

Another issue in these data is the clustered sampling design. First schools were sampled within primary sampling units and then children were sampled within schools. The errors for children within a school are likely to be correlated due to this clustered nature of the data. The SUR and 3SLS procedures in STATA did not allow the computation of the Huber-White standard errors, therefore, I compared the corrected and uncorrected (not accounting for clusters) standard errors using equation-by-equation Two Stage Least Squares regressions. In all cases, correcting for clustering did

[14] Estimates from a simultaneous model are more efficient than estimates from equation-by-equation OLS when there are some regressors that are different across the equations. In the model described in this paper, only one regressor, time in school, was different across the three equations. As a result, the efficiency gains from simultaneous estimation were minimal. However, one advantage of the simultaneous models is that I can formally test for differences in the entrance age coefficient across equations.

not significantly affect the standard errors of the estimates, and preserved the statistical significance of the entrance age coefficient.

It is hypothesized here that the entrance age effect is homogenous across the sampling strata (schools or clusters of schools). In this case, unweighted regression estimates are more efficient than weighted regression estimates (Deaton, 1997). However, if the entrance age effect varies across strata then both weighted and unweighted estimates are inconsistent. Since in neither case there is an argument for weighting, all regression estimates presented in this paper are unweighted.[15] In addition, I allow for heterogeneous effects of entrance age by estimating separate models for specific subpopulations, such as poor and disabled children and boys.

In the next section, I describe three instruments for kindergarten entrance age that are included in $Z$ and discuss the validity of each.

*Instruments*

A unique opportunity to construct instruments for kindergarten entrance age comes from two sources—variation in birthdays, and variation in kindergarten entrance

[15] Note, however, that weighting is always appropriate when estimating population means or other descriptive statistics using data from a multistage sampling design.

age policies.[16] I use these two sources of variation to construct the following three instruments for kindergarten entrance age.

1. Number of days between child's 5th birthday and school's cutoff date

Variation in birthdays within a year is arguably random and therefore presents one source of exogenous variation in entrance age. Children who have their 5th birthday just before the school cutoff date are eligible to enter kindergarten in that school year, whereas those who have birthdays immediately after the cutoff date need to wait an additional year in order to be eligible to enter kindergarten. As a result, children with birthdays immediately before and after the cutoff date are almost one year apart in their entrance age, on average. Therefore, the number of days between a child's 5th birthday and the school cutoff date would be a strong predictor of her entrance age. This approach differs from previous studies that have also exploited the naturally occurring variation in birth dates. The IV approach "constructs" a new entrance age variable for all children using variation in their birth dates. By doing so, it purges the new entrance age variable of the unobservables that are correlated with academic achievement and leaves the estimate of the entrance age effect unbiased.

[16] Angrist and Krueger (1991) use these two sources of variation to examine the effect of age of entry on years of schooling completed. Eide and Showalter (2001) have used exogenous variation in birth dates to examine the effect of grade retention on educational and labor market outcomes.

Figure 1 plots the mean entrance age against this instrument. A value of 1 for the instrument indicates that the child's 5$^{th}$ birthday was a day after the cutoff date and a value of 365 indicates that the child's 5$^{th}$ birthday coincided with the cutoff date. As expected, the mean entrance age of children with birthdays just after the cutoff date is higher than the mean entrance age of children with birthdays on or before the cutoff date.

It is assumed here that birthdays are randomly distributed over a year and that the month or season of birth has no direct effect on children's academic achievement other than through the kindergarten entrance age. However, there may exist situations under which this assumption is called into question. First, there is a small body of literature claiming that birth month may be directly related to child outcomes (Huntington, 1938; Warren and Tyler, 1979). However, it has often been dismissed due to inconsistent findings. Second, parents may anticipate the entrance age policy in their district and choose to have childbirth at a certain time of the year. While these behavioral patterns cannot be explicitly tested in my data, I examine whether there are any significant seasonal patterns in the proportion of children born in various months of the year. Table 2a shows the distribution of birth month for children in my sample. It appears that birth months are uniformly distributed across the year. Third, parents may choose to relocate to a different state or put their child in a private school that has a preferred cutoff date. I compared the mean kindergarten entrance age of children in public versus private schools and found that there was no statistically significant difference in the minimum entrance age requirement or the mean kindergarten entrance age across public and private schools. As a final check, I divided my sample into four groups based on the value of the instrument and compared the observable characteristics of children across these groups (see Table 2b). I find that children in these groups had remarkably similar characteristics suggesting that variation in the instrument is exogenous.

2. <u>Minimum age in months required on first day of school</u>

There is variation in schools, both across and within states, in the cutoff date for kindergarten entrance. These dates vary substantially across states, ranging from June in Indiana to January in Connecticut and Vermont (see Table 3). In addition, while all public schools within a state are required to follow the state cutoff requirement, private and charter schools can typically establish their own cutoff dates. All else equal, children living in states with a later cutoff date would be on average younger than children living in states with an earlier cutoff date. For example, California and Texas have kindergarten entrance cutoff dates on December $2^{nd}$ and September $1^{st}$, respectively. Assuming that schools in California and Texas start on September $1^{st}$, kindergartners in California will have to be at least 4 years and 9 months old to be eligible to enter kindergarten, whereas kindergartners in Texas will have to be 5 years old. As a result, the average kindergarten entrance age will be higher in Texas compared to California. Figure 2 shows the relationship between kindergarten entrance age and the school's minimum entrance age requirement. As expected, the mean entrance age is higher in schools where the minimum entrance age required is higher.

3. <u>State's upper age requirement for entering school</u>

State kindergarten entrance age policies also specify an age by which the child must be in school. There is some variation across states in this policy also (see Table 3). The upper age limit is 5 years in 8 states, 6 years in 22 states, 7 years in 19 states and 8 years in 2 states. It can be argued that children living in states with a higher upper age requirement would be on average older when they enter kindergarten than children in states with a lower upper age requirement. I construct a dichotomous variable for whether the upper age requirement for kindergarten entrance is under 7. I find that children in states with an upper age limit of 5 or 6 years are on average younger (mean entrance age = 64.8 months) when they enter kindergarten than children in states with an upper age limit of 7 or more years (mean entrance age = 66 months).

It is assumed here that kindergarten entrance age policies do not have any direct effect on children's academic achievement, except through their impact on entrance age. While variation in state policies has often been used to instrument for individual choice variables, such as purchasing health insurance, smoking, years of schooling etc.

(Angrist and Krueger, 1991; Evans and Ringel, 1999; Goldman et. al 2001), state policies may themselves be endogenous. For example, states with a higher minimum entrance age may also make other investments in their school systems that favorably impact children's school performance. I compared the per-pupil expenditures in 1998 in states with a higher minimum entrance age requirement to states with a lower minimum entrance age requirement to see if the former group of states was spending more on students compared to the latter group of states. I found that states with a higher minimum entrance age requirement had slightly lower per-pupil expenditures compared to states with a lower minimum entrance age requirement, but this difference was not statistically significant.[17] However, it is possible that states make other investments that may not be captured by per-pupil expenditures. As mentioned earlier, another concern may be that parents may choose to locate to a different state or put their child in a private school with a preferred cutoff date. However, there was no statistically significant difference in the minimum entrance age requirement between public and private schools. Since the number of instruments is greater than the number of endogenous variables, I test whether the additional instruments (in this case, the entrance age policy instruments) are valid in the sense that they are uncorrelated with the errors in the test score equations (Hausman, 1978). The results of the overidentification tests are discussed in the results section.

[17] Per-pupil expenditure data by state from 1998 were obtained from the Digest of Education Statistics 2000, National Center for Education Statistics, U.S. Department of Education (Table 168).

## 5. RESULTS

I begin by presenting the gross relationship between kindergarten entrance age and test scores as seen in the data. Figures 3-5 plot the mean IRT scores by kindergarten entrance age for math, reading and general knowledge, respectively.[18] The positive slopes in each of the figures indicate that older kindergarten entrants have higher test scores than younger entrants. The slope is the highest for general knowledge, followed by math and reading. The vertical distance between the lines measures the gain in test scores between consecutive assessments for each entrance age. It appears from the data that both older and younger kindergarten entrants gain almost the same amount over the first two years of school. In other words, the initial achievement gap between younger and older entrants remains constant till the end of grade 1. Another striking feature of these graphs is that entrance age appears to have a linear relationship with test scores. Therefore, I specify kindergarten entrance age linearly in every specification.

The remainder of this section proceeds as follows. The full sample results are discussed separately for math, reading and general knowledge. Within each subject area, I discuss the OLS and IV estimates of the system of equations (1)-(3). The same models are also estimated separately by poverty status, disability status, and gender, the results of which are discussed in separate sections.

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[18] I restrict the range of entrance age in Figures 3-5 to between 56 months and 75 months because of very low sample sizes (below 50) for entrance ages outside this range.

*Math Achievement*

Even after controlling for observable differences in child, parent and school characteristics, the strong positive relationship between entrance age and math test scores remains. Table 4 column 1 reports the OLS estimates for equation 1. These estimates suggest that children who enter kindergarten a year older score 5.44 points higher in math in the fall of kindergarten. In spring kindergarten, the gap becomes larger—children who enter kindergarten a year older score 6.10 points higher (see Table 4, column 2). A year later, in spring of grade 1 the gap reduces to 4.87 points (see Table 4, column 3). The math achievement gap at each assessment is statistically significant. In addition, the change in the achievement gap between assessments is also statistically significant.

The IV estimates of the effect of kindergarten entrance age on math achievement are reported in columns 4-6 of Table 4.[19] The IV estimates are greater than the OLS estimates suggesting that OLS estimates are biased downwards. According to the IV estimates, children who enter kindergarten a year older score 6.12 points higher in math

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[19] Estimates from the "first-stage" regression are reported in Appendix B. The three instruments were jointly significant ($F(3, 13702)= 4726.71$). The adjusted R-squared of the first stage regression was 0.54. Overidentification tests were performed using equation-by-equation two stage least squares to test the validity of the entrance age policy instruments. The null hypothesis of zero correlation between the instruments and the errors in equations (1)-(3) could not be rejected for the fall K math equation, but was rejected for the spring K and spring G1 math equations. The spring K and spring grade 1 math equations were re-estimated without the two entrance age policy instruments and the estimates of the entrance age coefficient changed only by one-half point.

in fall of kindergarten.[20] At the end of kindergarten, the math achievement gap increases to 7.60 points, which is statistically significant. However, at the end of grade 1, the gap reduces again to 6.17 points, which is not statistically different from the initial gap estimated in fall kindergarten.

Figure 6 illustrates the effect of delaying kindergarten entrance age from 5 years to 6 years on math achievement over the first two years of school. The graph plots the average predicted (from IV estimates) math score if all children delayed kindergarten entrance age from 5 years to 6 years. Delaying entrance age by one year raises math scores in the beginning of kindergarten by almost 6 points. Over time, the gain in math achievement does not depend upon the entrance age—gain in math scores during the first two years of school is the same whether kindergarten entrance is delayed or not. In terms of standard deviation units, the effect on math scores of delaying kindergarten entrance age from 5 years to 6 years is 0.85.

Estimated coefficients of other explanatory variables in the model had expected signs. For example, the results indicate that minorities, children with disabilities, and children from low income and less educated families had lower test scores.

[20] These estimates also allow same-age comparisons of older and younger entrants. I find that the difference in math test scores at age 7 of a child who entered kindergarten at age 6 versus one who entered kindergarten at age 5 is –8.61 points. The younger entrant scores higher at age 7 since she receives an additional year of schooling.

*Reading Achievement*

Table 5 reports OLS and IV estimates for equations (1)-(3) using reading IRT scores as the dependent variables. After controlling for observable differences, children who enter kindergarten one year older score 4.64 points higher in reading in fall kindergarten (see Table 5, column 1). This initial reading achievement gap widens to 5.4 points at the end of kindergarten and stays almost the same till the end of grade 1 (see Table 5, columns 2 and 3). The increase in achievement gap between younger and older entrants between fall and spring of kindergarten is statistically significant. The marginal increase in the gap between spring kindergarten and spring grade 1 is not significant.

The IV estimates are reported in columns 4-6.[21] Again, IV estimates are positive and larger than OLS estimates indicating that OLS estimates are biased downwards. The IV estimates are between 0.8-1.4 points higher than OLS estimates. While the magnitude of the entrance age effect is larger, the pattern in the achievement gap is similar to the one seen from OLS estimates. The reading achievement gap between children whose entrance age is one year apart is 5.46 points, with older entrants scoring higher than younger entrants.[22] Over the kindergarten year, older entrants gain more than younger entrants, which results in a widening of the achievement gap to 6.78

[21] The overidentification test could not be rejected in any of the three reading equations, suggesting that the additional instruments are valid.
[22] The difference in reading test scores at age 7 of a child who entered kindergarten at age 6 versus one who entered kindergarten at age 5 is –16.2 points.

points. This increase in gap is statistically significant. However, this gap stays almost the same until the end of grade 1 (6.84 points).

Figure 7 illustrates the effect of delaying kindergarten entrance age from 5 years to 6 years on reading achievement over the first two years of school. Delaying entrance age by one year raises reading scores in the beginning of kindergarten by about 6 points (effect size = 0.63). Older entrants gain slightly more during the first two years in school compared to younger entrants, which suggests a slight widening of the reading achievement gap between older and younger entrants.

*General Knowledge Achievement*

The results for general knowledge are different compared to reading and math. Columns 1-3 in Table 6 report OLS estimates for fall kindergarten, spring kindergarten and spring grade 1 equations. These estimates suggest that the initial gap in general knowledge between older and younger entrants narrows over time. Specifically, children who enter kindergarten a year older score 5.87 points higher in fall kindergarten. This initial gap reduces marginally over the kindergarten year to 5.58 points although the gap is statistically significant. Younger entrants gain even more during grade 1 compared to older entrants, which narrows the general knowledge achievement gap further to 3.96 points at the end of grade 1.

Columns 4- 6 in Table 6 report the IV estimates.[23] Again, the IV estimates are positive but larger than OLS estimates with differences between the two estimates ranging between 0.55-0.78 points. The pattern of changes in the initial achievement gap is similar to that suggested by OLS estimates. According to IV estimates, a one year delay in kindergarten entrance leads to 6.42 points higher in fall kindergarten. This initial advantage reduces marginally to 6.36 points by the end of kindergarten (not statistically significant), but reduces further to 4.68 points by the end of grade 1. While the decrease in the achievement gap over time is statistically significant, the effect of delaying kindergarten entrance age is still substantial at the end of two years in school.

Figure 8 illustrates the effect of delaying kindergarten entrance age from 5 years to 6 years on general knowledge achievement over the first two years of school. Like math and reading, delaying entrance age by one year raises general knowledge scores in the beginning of kindergarten by 6 points (effect size = 0.86). However, entering at age 5 is associated with higher gains in general knowledge scores during the first year in school compared to entering at age 6, which suggests a slight narrowing of the achievement gap between younger and older entrants.

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[23] The overidentification test could not be rejected in any of the three general knowledge equations, suggesting that the additional instruments are valid.

*Heterogeneous Effects*

The estimates discussed so far capture the average entrance age effect in the population. I also examine whether the entrance age effect differs by poverty, disability status, and gender. These results are discussed below. Although the full system of equations is estimated, the results are presented only for the fall kindergarten and spring grade 1 equations. Estimates for the full model, including estimates for other covariates are available from the author upon request.

**Poverty Status**

Table 7 reports the IV estimates of the effect of delaying kindergarten entrance by one year by poverty status. These estimates are generated from separate regressions for children below the poverty line and those at or above the poverty line. These results suggest that the effect of entrance age differs significantly by poverty status. In fall kindergarten, the entrance age effect on math scores is significantly lower among poor children (4.7 points) compared to children at or above the poverty line (6.5 points). However, the achievement gap between older and younger entrants widens significantly over time among poor children i.e the scores of older entrants increase more rapidly than do scores of the younger entrants, but the initial achievement gap between older and younger entrants narrows marginally among non-poor children.

In reading achievement, the entrance age effect is almost twice as large for non-poor children compared to poor children. Among poor children, the gap between older and younger entrants almost doubles by the end of grade 1, while among non-poor children it increases by only a sixth. Like math and reading, the entrance age effect on general knowledge scores in the beginning of kindergarten is stronger for children above the poverty line. Over time, the achievement gap reduces by almost a third among non-poor children but remains at its initial level among poor children.

These results suggest that while poor children gain less from delaying kindergarten entrance initially compared to children from non-poor families, their returns to delayed entrance become larger over time.

**Disability Status**

Table 8 reports the IV estimates of the effect of a one-year delay in kindergarten entrance on test scores from separate regressions for children who have a disability and those who do not.[24] The findings here are similar to those reported in the previous section. The entrance age effect is initially greater for children who are not disabled. However, the entrance age effect becomes stronger for disabled children over time. In math, the initial gap between older and younger entrants increases by almost a third among disabled children, but remains constant over time among children with no

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[24] The effect of entrance age may also vary by type of disability but this is not examined here owing to insufficient sample sizes.

disability. In reading, the initial achievement gap doubles over time among disabled children, but only increases by a fifth among children with no disability. Finally, in general knowledge, the initial gap reduces by only a fifth among disabled children, but reduces by almost a third among children with no disability.

**Gender**

It is commonly believed that younger boys are more at risk for underachievement in school than younger girls. Previous studies have found that boys are more likely to experience delayed kindergarten entrance because of this belief (Graue & DiPerna, 2000; Cosden, Zimmer & Tuss, 1993; Zill, Loomis & West, 1997). Table 9 reports the effect of delaying kindergarten entrance on test scores from separate regressions for boys and girls. Unlike poverty and disability status, the entrance age effect on math and general knowledge achievement does not vary significantly between boys and girls. The initial achievement gap between older and younger entrants is similar for both boys and girls. Over time, the general knowledge gap reduces while the math achievement gap remains constant for both boys and girls. In reading, the initial effect of delaying entrance age is stronger for girls than boys. However, by the end of grade 1, the gap increases by more than 50 percent for boys but remains constant for girls. In other words, entering kindergarten at an older age has a significant effect on reading test score levels after two years in school for boys as well as girls. However, delaying entrance has a positive effect on test score gains among boys but not among girls.

## 6. CONCLUSIONS

In this chapter, I use exogenous variation in birth dates and kindergarten entrance age policies to generate instrumental variable estimates of the effect of delaying kindergarten entrance on children's academic achievement. Specifically, I examined whether delaying kindergarten entrance leads to higher academic achievement in the beginning of kindergarten. In addition, I examined whether the initial gains from delaying entrance magnify or diminish over subsequent grades i.e. whether the rate at which children learn differs by kindergarten entrance age.

The results indicate that delaying kindergarten entrance is associated with a significant increase in math, reading and general knowledge test scores at the beginning of kindergarten. According to the IV estimates, a one-year delay in kindergarten entrance leads to a 6.12, 5.4 and 6.4 point increase at entry into kindergarten in math, reading and general knowledge test scores, respectively. After two years of schooling, this initial advantage remains constant for math, increases by just over a point for reading, and reduces by a quarter for general knowledge. The effect sizes associated with a one year delay in kindergarten entrance on test scores after two years in school are sizeable—0.85, 0.78 and 0.62 standard deviations for math, reading and general knowledge, respectively. These estimates are large compared to effect sizes found in other studies assessing returns to educational inputs. For example, evidence from the Tennessee Class Size Reduction experiment shows that effect sizes associated with four years in small classes at third grade vary from 0.25-0.4 standard deviations, which are substantially smaller than those found in this paper (Grissmer & Flanagan, 2000). Findings from this chapter imply that the initial advantage of entering kindergarten at an older age remains sizeable after two years in school.

Comparison of OLS and IV estimates shows that OLS estimates are biased downward. OLS estimates fail to control for unobservable factors that affect both kindergarten entrance age and children's academic performance, and therefore suffer from selection bias. One potential explanation for the downward bias may be that parents of children who have high ability or are gifted send their child to school even before s/he is eligible since some states allow children with exceptional ability to be exempted from the entrance age policy. In addition, parents of children with developmental delays may intentionally delay their child's entrance into kindergarten. Both high ability children entering at a younger age and developmentally delayed children entering at an older age may lead to a downward bias in the OLS estimates. These findings suggest that previous studies that have failed to account for the selection bias underestimate the effect of delaying kindergarten entrance.

The impact of delaying kindergarten entrance on academic achievement differs by poverty and disability status, but the results are mixed for gender. The effect of delaying kindergarten entrance is initially smaller for poor and disabled children but becomes significantly stronger over time—the initial entrance age effect doubles in reading and increases between 30-50 percent in math, at the end of first grade. Among non-poor and non-disabled children, the initial entrance age effect was initially larger but remained constant during the two years. These results suggest that kindergarten entrance age has a significant effect on value added or gains in test scores for poor and disabled children but has a small or negligible effect for non-poor and non-disabled children.

**Policy Implications**

This study was motivated by the recent trend in states raising the minimum entrance age into kindergarten. The natural question that follows, therefore, is whether states should be advised to raise the minimum entrance age into kindergarten so that children enter school at an older age. The analysis presented in this chapter is only one important piece of the broader analysis that is needed to address this question. It examines whether there are any benefits to delaying kindergarten entrance in terms of children's academic performance after two years in school. The findings from this paper suggest that there is a sizeable increase in test scores after two years in school if children enter kindergarten a year older. While these effects in the early school years may be important for their own sake, from a policy perspective it is also important to know whether these benefits persist in the long run. Although there appear to be benefits to delaying kindergarten entrance in the short run, they may diminish in later grades as children grow older and receive exposure to common instruction and environments. However, to the extent that early success is a predictor of later outcomes, these early school achievement gaps may be important (Hutchison, Prosser & Wedge, 1979; Connolly, Micklewright & Nickell, 1992; Robertson & Symons, 1996; Harmon & Walker, 1998; Currie & Thomas, 1999). For example, Currie and Thomas (1999) found that test scores at age 7 were very strong predictors of future test scores, educational attainment and labor market outcomes at ages 23 and 33 years. In particular, men and women in the lowest quartile of the reading test score distribution had wages 20 percent lower at age 33 than those who scored in the highest quartile. Future waves of the ECLS-K data will also permit testing this hypothesis empirically for the sample of children used in this paper.

However, any decision to raise the minimum entrance age must weigh the long-term benefits against the long-term costs associated with the policy change. As I find in Chapter 3, raising the minimum entrance age for kindergarten would force some children to stay out of school for an additional year and would impose costs on families, such as child care costs and lost wages from reduced labor force participation of mothers in order to care for their children. However, some of these private costs may be offset by postponement of the public costs of educating these children by one year. Delaying kindergarten entrance may have other unintended side effects as well. For example, Angrist and Krueger (1991) found that children who enter kindergarten at an older age complete fewer years of schooling due to the compulsory education laws. On the other hand, there is also some evidence suggesting that older entrants are less likely to be retained in grades, which would reduce the public costs of educating these children (Eide & Showalter 2001).

Findings of this study suggest that benefits of delaying kindergarten entrance may vary across different population subgroups—there is a significant effect on value added from schooling for poor and disabled children but not for non-poor and children with no disability. At the same time, costs of delaying kindergarten entrance are also likely to differ significantly across subpopulations. For example, child care costs make up a much larger proportion of a poor family's income compared to a rich family's income (Casper 1995). Therefore, states should be cautious before implementing any blanket policies that raise the minimum entrance age for all children. Policies that weigh the benefits and costs of delaying kindergarten entrance on a case-by-case basis may be more appropriate.

## CHAPTER 3 – Effect of Kindergarten Entrance Age Policies on the Child Care Needs of Families

### 1. INTRODUCTION

Chapter 2 describes the rising trend in minimum entrance age requirements in recent years. The primary motivation behind this trend is to allow children to enter school at a time when they are ready for school. It is believed that older children are more mature when they enter kindergarten and are therefore likely to perform better in school compared to younger children.[25] Hence, these policies are ultimately seeking to improve children's performance in school.

As mentioned in the previous chapter, a little-noticed, but potentially large, consequence of raising the minimum entrance age is that it imposes additional childcare costs on families whose children are forced to stay out of school for an additional year. Moreover, some of these children may be left without access to quality childcare alternatives. There is evidence that disadvantaged children at preschool ages are less likely to be in high-quality care compared to advantaged children (Federal Interagency Forum on Child and Family Statistics, 2001). This differential access to high-quality care may widen disparities in school readiness and achievement between advantaged and disadvantaged children when children are forced to stay out of school for an additional

[25] The idea that older entrants perform better in school than younger entrants is not a well-established finding. The rising trend in minimum entrance age was in response to some of the early studies in this area that found benefits of entering school at an older age. See Stipek (2002) for a review of the entrance age debate. Chapter 2 of this dissertation provides new evidence on the effects of delaying kindergarten entrance age on academic achievement.

year. In addition, a rise in the minimum entrance age also imposes huge costs on families because they must bear an extra year of either monetary or time costs of childcare. Most states have only considered potential achievement effects of entrance age but have so far ignored these types of impacts of entrance age.

In order to assess the potential impact of changes in entrance age policies it is important to understand how families decide what age to send their child to school. Previous research in this area has been sparse and lacked a clear theoretical framework to examine these decisions. Some states have attempted to estimate the number of children affected by entrance age policies using a simple calculation. These mechanistic estimates use the population of 5 year olds in a state to extrapolate the number of children that will become ineligible to enter kindergarten under a new cutoff date. These methods suffer from two major limitations. First, they do not take into account the behavior of parents and the impact of socio-economic factors on entrance age decisions. Instead, they assume that all parents send their children to kindergarten at the earliest possible age. In fact, many parents choose to hold their children out of school for additional time even after they become eligible to enter kindergarten. Second, the mechanistic approach cannot predict which sub-populations will be most affected by entrance age policies and are therefore not able to generate precise estimates of the need for various types of childcare and the costs associated with them. For example, it is conceivable that poor families may want to send their child to school earlier than other families because public schooling is free compared to paid childcare, and are therefore more likely to be affected by changes in entrance age policies.

This chapter fills a major gap in the literature by developing an economic model for understanding how parents make kindergarten entrance age decisions for their children and what factors influence these decisions. Such a model would help understand how significant are constraints imposed by entrance age policies and what types of families they will affect. In addition, the model also allows us to simulate the effects of specific entrance age policy changes. Specifically, it will help estimate: -

(i) How many children will be forced to enter kindergarten later due to an increase in the minimum entrance age?

(ii) Which children will be affected by these changes? Are certain disadvantaged sub-populations more likely to be affected?

(iii) And finally, what is the additional burden of childcare costs on the families of children affected by the policy change?

This research will guide state policy makers in designing better entrance age and childcare policies that will take into account the impact of entrance age policies on the childcare needs of children that are forced to stay out of school for additional time. By identifying characteristics of these children it will help to better target early childhood programs. These issues are of great importance to policy makers as demonstrated by a recent example. Maryland's State Board of Education voted just last year in favor of moving the cutoff date for kindergarten from Dec 31 to Sept 1.[26] Even though the shift will be phased in over six years, there was a lot of concern that children whose parents could not afford private preschool would be deprived of early education.

This chapter is organized as follows. Section 2 presents the relevant background and literature review. Section 3 outlines a theoretical model for kindergarten entrance age decisions and the model's predictions. Section 4 describes the data used for the analysis. Section 5 details the empirical strategy. Sections 6 and 7 present the results and conclusions, respectively.

## 2. BACKGROUND AND LITERATURE REVIEW

This section begins with a brief description of kindergarten entrance age policies in the U.S. Next, I describe the costs and utilization of childcare. And finally, I review the current literature on what factors have been shown to affect kindergarten entrance age and related decisions.

### 2.1. Kindergarten Entrance Age Policies

The goal of kindergarten minimum entrance age policies is to ensure that children enter school at an age when they are "ready to learn". However, there is considerable debate in the research community regarding what characteristics define children's readiness for school and how these can be measured. The National Education Goals Panel (NEGP) has identified 5 dimensions of early development and learning that

[26] For more information, see <http://www.msde.state.md.us/pressreleases/2002/may/2002_0523.htm>

are important for school readiness: physical well-being and motor development; social and emotional development; approaches towards learning; language development and cognition; and general knowledge. While these dimensions highlight broad categories, there are no standard measures that exist that can be used to capture these dimensions. Recent surveys of teachers and parents regarding perceptions of the aspects important for children's school readiness indicated that they were more likely to rate physical health, being rested and well nourished, ability to communicate needs, wants and thoughts verbally, and being enthusiastic and curious in approaching new activities to be of high importance (NCES, 1993; West, 1993; Carnegie Foundation, 1991). A number of readiness assessment tools are currently in use by schools across the nation (see Mehaffie and McCall, 2002). However, reviews of these instruments suggest that there are multiple problems inherent in the measures (Crnic and Lamberty, 1994; Shepard, Taylor and Kagan, 1996). Some of these problems included failure to find high correlations between school readiness assessments and later academic success; and low reliability and validity of the assessments.

In the absence of any standard measures for determining children's school readiness, states have traditionally used chronological age as the standard for judging children's readiness for school. In a recent survey of state policies and definitions of school readiness in the U.S., Saluja, Scott-Little and Clifford (2000) found that no state had an official statewide definition of school readiness, and that age was the criterion most often used to determine eligibility for kindergarten.

Kindergarten entrance age policies in the U.S. typically establish two criteria[27] – (1) a cutoff date by which the child must complete 5 years of age to be eligible to enter kindergarten, and (2) a maximum age at which the child must be in kindergarten. Tables 1a and 1b report the kindergarten entrance age policies by state in 1998.[28] There is a wide variation in cutoff dates across states ranging from June 1st in Indiana to January 1st in Connecticut and Vermont. These dates imply minimum entrance age requirements of about 5 years 3 months in Indiana and 4 years 8 months in Connecticut and Vermont, with the rest of the states falling in between. These entrance age requirements are fairly strictly enforced in public schools; however, exemptions from the policy are allowed under certain circumstances. In most states, children who are identified as gifted or talented are allowed to enter kindergarten at an age earlier than when the child becomes eligible. In many cases, this is determined by means of readiness assessment tests. In other states, such as North Carolina, the child must have an IQ in the top 2 percent in the nation to be exempted from the policy.

The last two decades have seen a considerable increase in the minimum entrance age for kindergarten in the U.S. More and more school districts have moved away from

[27] While public schools require children to meet the state established entrance age criteria, private and charter schools are allowed to establish their own cutoff dates.
[28] The data analyzed in this chapter include kindergartners in 1998.

later cutoff dates (December/January) to earlier cutoff dates (September). In 1975, 43 percent of reporting schools had a December or January cutoff date while 15 percent had a September cutoff date (Kennedy, 1975). In 1998, this pattern reversed completely. Data from the Early Childhood Longitudinal Study (ECLS-K) show that in 1998 only 20 percent of the schools had a December cutoff date while 50 percent had a September cutoff date. By requiring children to complete 5 years of age at an earlier date, these policy changes have effectively increased the minimum entrance age requirement for kindergarten. Such actions have been motivated by numerous studies that have suggested a positive correlation between entrance age and school performance (Langer et al. 1984, Uphoff & Gilmore 1985, Dipasquale et al. 1980, Diamond 1983, Maddux 1980, Bisanz et al. 1995, Davis et al. 1980, Breznitz & Teltsch 1989). State policy makers have interpreted this positive correlation as a causal link between entrance age and school performance and are seeking to raise children's achievement by raising the age at which they enter kindergarten. However, findings from more recent research have found effects in either direction leaving the stated benefits of delayed entrance age questionable.[29] Yet, findings presented in chapter 2 imply that there is a sizeable positive effect on children's academic achievement in the first two years in school from entering kindergarten at an older age.

[29] Chapter 2 provides a review of the entrance age literature.

## 2.2. Childcare Costs and Access to High-Quality Childcare

The National Education Goals Panel established eight education goals, the first of which states – "By 2000, all children will start school ready to learn" (National Education Goals Panel, 1999). In order to achieve this goal, the panel stated that *all* children should have access to high-quality and developmentally appropriate preschool programs that help prepare them for school.[30] However, the current state of childcare access and utilization demonstrates that this goal is far from being achieved. First, although states have increased investments in prekindergarten initiatives over the last decade, these have not been sufficient to ensure that high-quality programs are available to all children at risk, let alone all children. In 1996, only 36 percent of children between the ages of three and five, but not yet in kindergarten, who were living in families earning less than $15,000 were enrolled in public or private prekindergarten (Blank et al., 1999). Second, public preschools are not widely available. In 2000, only 17 states reported having a state preschool policy that required districts to provide preschool programs (Council of Chief State School Officers, 2000). Third, high cost of childcare may pose significant barriers to childcare use. According to one report, the average annual cost of center care for a 4-year-old in an urban area is more than the average annual cost of public college tuition in all but one state (Schulman, 2000).

[30] There is considerable evidence suggesting that participation in high-quality early childhood programs has positive effects on achievement, test scores, high school graduation rates, and earnings, as well as long term negative effects on criminal activity and welfare use (Currie, 2001; Karoly et al., 1998; Cost, Quality and Outcomes Study, 1995). In particular, these studies have found that participation in early childhood programs has the greatest payoff for the most disadvantaged children.

Hence, it is likely that children forced to stay out of school due to a rise in the minimum entrance age may not participate in high-quality early childhood programs.

Entrance age polices may impose huge costs on parents of some children. An additional year of childcare resulting from an increase in the minimum entrance age would increase the burden of childcare costs. These policies will be especially burdensome for poor families who spend as much as 18 percent of their income on childcare (Casper, 1995). In addition, some parents may have to reduce their labor force participation and/or hours worked to care for their children, thereby increasing time costs of childcare.[31]

Entrance age policies may be particularly costly for families transitioning off welfare. Welfare mothers may have to reduce the number of hours worked or delay their entry into the labor force to care for their out of school children. A study of the Aid to Families with Dependent Children (AFDC) population in Illinois found that 20 percent of women reported having to quit school or a training program and over a third has serious work related problems within last 12 months due to childcare problems (Seigel and Loman, 1991). In addition, 20 percent reported having returned to public assistance because of childcare problems. Even though welfare reform has empowered states to provide childcare subsidies to low-income families, states are struggling to

[31] Some parents may also increase their hours worked in order to afford the additional child care.

meet the childcare needs of all low-income families (Adams and Rohacek, 2002). Changes in entrance age policies may exacerbate these needs even further.

### 2.3. Factors Associated With Kindergarten Entrance Age and Related Decisions

There is very little research that investigates the relationship between socio-economic factors and entrance age decisions of parents. A study by the National Center for Education Statistics (NCES) found that 9 percent of first- and second-graders had entered kindergarten later than when they first became eligible (NCES, 1997). These children tend to be boys, whites and children that are relatively young when they are first eligible to enter kindergarten (NCES, 1997; Cosden, Zimmer and Tuss, 1993; McArthur and Bianchi, 1993). Evidence regarding the association between parents' education and delayed kindergarten entry is less consistent. (McArthur and Bianchi, 1993; NCES, 1997).

Most research looks at the impact of socio-economic factors on decisions such as childcare choice and mother's work, which are related to desired entrance age. These studies suggest that both the decision to become employed and the decision to purchase market childcare are sensitive to childcare costs (Blau and Robins, 1988; Connelly, 1992; Leibowitz, Klerman and Waite, 1992; Ribar, 1992; Hotz and Kilburn, 1995). Higher price of childcare is associated with lesser likelihood of families using that type of care. The estimates of price elasticity of mode choice range from –0.12 to –0.34 for non-parental childcare modes. These findings suggest that an increase in childcare costs may induce some parents to substitute away from childcare by either caring for the child themselves or by sending their child to school early since public schooling is free. In addition, an increase in childcare costs is associated with lesser likelihood of mothers being employed. Gelbach (2002) finds that public school enrollment has a positive and significant impact on the labor supply of mothers of five year olds. He estimates that free public schooling for a five-year-old increases labor supply measures by 6-24 percent for single mothers and between 6-15 percent for married mothers. He argues that providing access to public school can be viewed as offering a 100 percent marginal price subsidy for childcare of fixed quality. In addition, he finds that access to public- and less expensive private preschool programs leads to greater labor supply of mothers of both three and four year olds. These findings suggest that later entry into school as a result of changes in entrance age policies may also have a large impact on mother's labor supply behavior.

Childcare and maternal work decisions are also related to market wages faced by the mother. Higher maternal wages are associated with a significantly higher probability of paying for care with an estimated wage elasticity of about 0.67 (Blau and Hagy, 1998). As suggested by Gelbach (2002), an alternative to childcare for preschoolers may be free public schooling. Therefore, maternal wage is likely to have an effect on parents' kindergarten entrance age decisions for their child.

## 3. AN ECONOMIC MODEL OF KINDERGARTEN ENTRANCE AGE DECISIONS

This section develops a one period model of parents' kindergarten entrance age decisions. Parents are assumed to derive utility from their children's quality (Q) and households' consumption of a composite market good (G). The utility function U[.] is assumed to be concave in Q and G.

(5) $$U[Q,G]$$

In the most general form, the child's quality (Q) depends upon the time that the child spends in non-maternal childcare ($T_c$), time in maternal care ($T_m$), time in school ($T_s$), and consumption of the composite good G.

(6) $$Q = Q[T_c, T_m, T_s, G]$$

The function Q[.] is assumed to be concave in each of its arguments. The production technology for child quality may also be a function of the child's age or maturity. For example, as the child grows older, the returns to time in school may increase making time in school more attractive for parents over time.

In each time period, the child's total time can be spent between non-maternal childcare ($T_c$), maternal care ($T_m$), or in school ($T_s$). $T_c$, $T_m$ and $T_s$ are normalized so as to sum to 1. I assume that only one type of non-maternal childcare is used in order to keep the model tractable. Therefore,

(7) $$T_c + T_m + T_s = 1$$

In this model, schooling is modeled as a continuous choice, although schooling decisions are typically discrete in that parents may choose whether to contract to send their child to a half-day or full-day kindergarten. Therefore, in a discrete model, parents could choose between 0 hrs/day ($T_s$=0), 4 hrs/day ($T_s$=1/6) or 8 hrs/day ($T_s$ =1/3) of time in school, although they can typically pick up their child from school at odd times of need be. The continuous specification for time in school is merely a simplification for exposition purposes. Parents are assumed to maximize the static model in every time period. Therefore, parents send their child to school if the optimal time in school crosses a certain threshold. In this model, this threshold is likely to lie in the interval [0, 1/6]. The period in which $T_s$ crosses this threshold can be thought of as the age of entry into kindergarten. Therefore, an increase in the optimal time in school would increase the likelihood that this threshold is crossed in an earlier period, thereby implying an earlier kindergarten entrance age.

Mothers allocate their time between working ($T_w$) and caring for their children ($T_m$), thereby assuming that mother's entire leisure time is spent caring for her children at home. This is merely a simplifying assumption. As a result, mothers need to either purchase non-maternal childcare or schooling for the child during the time that she works.

(8) $$T_m + T_w = 1$$

Finally, the budget constraint faced by the family is as follows. All prices are normalized with respect to the price of the good G. The price of schooling captures the cost per unit time of sending the child to school. This price is typically zero or close to zero for parents who send their child to public schools but is non-zero for parents who send their child to private school.

(9) $$w(1-T_m)+\bar{W}=p_cT_c+p_sT_s+G$$

where,

$w$ = Mother's market wage

$\bar{W}$ = Non-labor income

$p_c$ = Price of non-maternal childcare

$p_s$ = Price of schooling

All prices and wages are assumed to be exogenously determined. The non-labor income is assumed to be exogenous and is a combination of the earnings of all remaining members of the household and the mother's non-labor income.

**3.1. Maximization Problem in the Absence of Entrance Age Policies**

Given these assumptions, the parents' utility maximization problem in the absence of kindergarten entrance age policies is as follows:

$$\underset{T_s,T_m}{Max} \quad U[Q,G]$$

Subject to

$$Q = Q[T_c, T_m, T_s, G]$$
$$T_c + T_m + T_s = 1$$
$$T_m + T_w = 1$$
$$w(1 - T_m) + \overline{W} = p_c T_c + p_s T_s + G$$

The first order conditions from this model are shown below:

(10) $$U'_Q Q'_{T_s} - \lambda_1 p_s - \lambda_2 = 0$$

(11) $$U'_Q Q'_{T_c} - \lambda_1 p_c - \lambda_2 = 0$$

(12) $$U'_Q Q'_{T_m} - \lambda_1 w - \lambda_2 = 0$$

(13) $$U'_Q Q'_G + U'_G - \lambda_1 = 0$$

(14) $$w(1 - T_m) + \overline{W} = p_c T_c + p_s T_s + G$$

(15) $$T_c + T_m + T_s = 1$$

where, $\lambda_1$ and $\lambda_2$ are the marginal utilities of money and time, respectively.

Conditions (6)-(9) imply that households will choose an allocation of the child's time between school, non-maternal childcare and maternal childcare that will equate the marginal benefit of each to their marginal cost. The marginal benefits will come in the form of increased child quality, which will in turn increase parents' utility. However, these benefits will come at the expense of additional money and time. Since the price of public schooling is close to zero, condition (6) implies that at the optimum the marginal benefit from schooling will equal the marginal cost of the child's time. Similarly, condition (9) implies that households will choose a level of consumption where the marginal utility from consumption equals its marginal cost. Finally, the optimal quantities of $T_c$, $T_m$ and $T_s$ must satisfy the budget and time constraints, as indicated by conditions (10) and (11).

The optimal choice of $T_s$ in this model denotes parents' *desired* time in school for their child. In case the production technology for child quality is such that the returns to time in school increase with the child's age, then the desired time in school would increase over time. In reality, parents are constrained in their choice of time in school. For example, in most cases parents may only choose between half-day and full-day kindergarten.[32] In this situation parents may decide on a threshold level of desired time in school, beyond which they would send their child to kindergarten. For example, parents may enter their child into half-day kindergarten when the desired time in school exceeds half-day of kindergarten.

The concept of *desired* entrance age is crucial because it takes into account the fact that parents may choose to either delay kindergarten entrance beyond when the child becomes eligible for entry, or send their child to school even before s/he is eligible to enter. In other words, the desired entrance age is the age at which parents would choose to send their child to kindergarten in the absence of entrance age policies.

It is important to note, however, that parents' desired time in school may be different from what may be developmentally optimal from the child's perspective. For example, the presence of a budget constraint in the model, wherein parents face costs

[32] As mentioned earlier, parents always have the option of picking up their child from school earlier. The continuous specification of time in school in this model accommodates for this behavior as well.

for time in non-maternal childcare, school and maternal care, leads parents to choose quantities that equate the marginal benefit to the marginal cost. Instead, if the objective were to maximize the child's utility as perceived by the parents, which would depend upon the child's quality, the optimal choices would be those at which the marginal benefits equaled zero. In other words, the desired entrance age from the child's perspective would be higher than the desired entrance age from the parents' perspective. Therefore, one may argue that entrance age policies that delay kindergarten entrance until a certain age may in fact be beneficial for children whose parents would have chosen an earlier entrance age than what is optimal from the child's perspective.

### 3.2. Predictions From the Economic Model

This section discusses how parents respond to changes in exogenous factors such as prices, wages and income, in the context of the model described in the previous section. Changes in prices and wages generate income and substitution effects that may generate opposite movements in the time allocation across school, maternal care, and non-maternal childcare, leaving the end direction of the effect to be determined empirically.

Changes in the price of non-maternal childcare and schooling will have both an income effect as well as a substitution effect. Consider the case where there is an increase in the price of non-maternal care. If time in non-maternal childcare, school and maternal care are normal goods then the reduction in the family's real income will have a downward effect on the optimal choices of each. In addition, the increased price will lead to a substitution away from time in non-maternal childcare towards more time in school and maternal care. Therefore, an increase in the price of non-maternal childcare will decrease the time spent in non-maternal childcare. However, the effect of this price change on the time spent in school and maternal care is ambiguous and will depend upon the size of the income effect relative to the substitution effect. The size of the income effect on time in school will depend upon a number of factors, such as the child's age and prices of non-maternal care and schooling. When children are young, parents may view maternal care as more appropriate for their child compared to formal schooling. In this situation, it is likely that an increase in real income would lead parents to choose more maternal care for their child. This would suggest that the income effect from an increase in the price of non-maternal care would reinforce the substitution effect. However, as the child gains maturity over time, parents may view formal schooling as more appropriate than other types of care. For example, time spent in school related activities such as homework and intramural activities may increase with parents' income. In this situation the income effect from an increase in the price of non-maternal child care would work against the substitution effect. The size of the substitution effect on time in school from an increase in the price of non-maternal childcare will depend upon the degree to which time in school and non-maternal childcare are substitutes for the parents. For example, early childhood education programs may be relatively more similar to kindergarten compared to day-care centers due to the educational component in these programs. Therefore, if non-maternal childcare is provided through early childhood education programs, the substitution effect may be stronger. If the substitution effect is larger than the income effect, this price change will lead to an increase in the optimal time spent in school. In other words, an increase in the price of non-maternal childcare will lower parents' desired entrance age for kindergarten.

An interesting prediction from the model is regarding changes in the price of schooling. Since price of public schooling is close to zero, the model implies that subsidization of public schooling leads parents to send their child to school earlier than if they faced the full price of schooling. Moreover, even a slight change in child care prices may lead to shifts toward time in school. This may be especially relevant for parents with the choice to enroll the child in school and for children who are "old enough" to enter school.

The impact of a change in mother's wage will also have income and substitution effects. An increase in the wage will on the one hand encourage mothers to substitute away from caring for their children towards working. On the other hand, the income effect of the increased wage will increase the mother's demand for time with the child, if time in maternal care is a normal good. If the substitution effect dominates the income effect, a rise in maternal wage will lead parents to substitute away from time in maternal care to time in school and non-maternal childcare. The relative size of the two effects would depend upon the responsiveness of time in maternal care to changes in income and wages.

The effect of an increase in non-labor income on time in school, maternal care and non-maternal childcare is ambiguous, but will increase the consumption of the composite good, G. The reason for the ambiguous effects is the child's time constraint that prevents an increase in the time spent in all three alternatives together. The allocation of time across the three alternatives will depend upon the income elasticity of the three choices. As mentioned earlier, the income elasticity of time in school may become very small as the child gets older.

### 3.3. Maximization Problem in the Presence of Entrance Age Policies

In the presence of kindergarten entrance age policies, the family faces a constrained maximization problem. As discussed earlier, kindergarten entrance age policies typically establish a cutoff date during the academic year by which children must complete 5 years of age in order to be eligible to enter kindergarten. These cutoff dates imply a minimum entrance age requirement on the first day of school. This policy is captured by the following additional constraint in the model.

$$T_s = 0 \quad \forall t < t_L \tag{16}$$

This constraint implies that the child is required to stay out of school until period $t_L$ after which parents are allowed to choose the amount of time in school as in the unconstrained problem earlier. Parents who would have chosen a non-zero value for time in school in periods prior to $t_L$ in the absence of the entrance age policies would now be forced to restrict time in school to zero for those periods. However, for parents who would have chosen not to send their child to school in periods prior to $t_L$ this additional constraint would not be binding. Therefore, the child's observed entrance age into kindergarten would now be a function the parents' desired entrance age and the entrance age policy that they face.

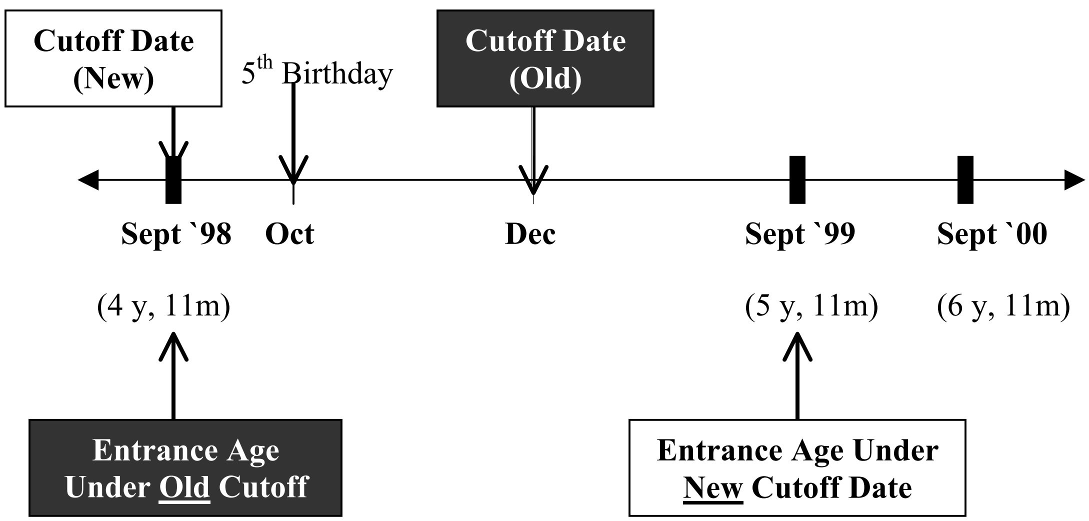
### 3.4. An Illustration of the Effect of a Change in Entrance Age Policy on Parents' Entrance Age Decisions

In the presence of entrance age policies, parents are constrained to choose from a limited set of possible entrance ages, which depends upon the child's birth date, school's start date and entrance age policies. The earliest age at which a child can enter kindergarten differs for each child due to differing birth dates, school start dates and state cutoff dates. Consider a child, Chris, whose birth date is Oct 1, 1993 and her school's start date and cutoff date are Sept 1 and Dec 1, respectively (see Figure A). Also, the state where Chris lives requires all children to be in kindergarten at age 6.

Chris's school requires that a child be at least 4 years and 9 months old when the school year begins in 1998 to be eligible to enter kindergarten. On the first day of school in 1998, Chris will be 4 years and 11 months old and this is the earliest age at which she can enter kindergarten. Assuming that kindergarten enrollment is only open once a year, Chris can enter kindergarten at the following possible ages - 4 years 11 months, 5 years 11 months, or 6 years 11 months. If Chris's parents desired to send her to kindergarten at age 4 then they will be forced to wait till she is 4 years 11 months old. Similarly, if they wanted Chris to enter school at age 7 then they will be forced to send her to school at 6 years 11 months. If they wanted to send her to kindergarten at age 5 then they are faced with two options – send Chris to kindergarten a month earlier at 4 years 11 months or wait for 11 months and send her at 5 years 11 months.

Now, consider the impact of a change in the state's cutoff date from Dec 1 to Sept 1. This raises the minimum entrance age requirement in Chris's school from 4 years 9 months to 5 years. The impact of this change on Chris's entrance age is shown in Figure 1. If Chris's parents had desired to send her to kindergarten at age 4 then under the old cutoff date they will would send Chris to school at 4 years 11 months. However, under the new cutoff date, Chris's parents will be forced to delay her entrance until she is 5 years 11 months old. Therefore, we see that raising the minimum entrance age will force some children to enter kindergarten a year later.

**Figure A: Impact of a Rise in Minimum Entrance Age on Age of Entry into Kindergarten**




## 4. DATA

This research primarily uses base year data from the Early Childhood Longitudinal Study (ECLS-K), with contextual data from other sources such as the State Occupational Employment and Wage Data and the Current Population Survey.

### 4.1. Early Childhood Longitudinal Study – Kindergarten Class (ECLS-K)

The ECLS-K surveyed a nationally representative cohort of kindergartners from about 1,000 kindergarten programs during the 1998-99 school year. These children were selected from both public and private kindergartens, offering full-day and part-day programs. The sample consists of children from different racial/ethnic and socioeconomic backgrounds and includes an oversample of Asian children, private kindergartens and private school kindergartners. NCES (1999) provides details of the survey design and instruments.

The ECLS-K is the first ever survey of its kind and is an extremely rich source of information. The dataset has extensive information on children's demographics, age of entry into kindergarten, and school kindergarten entrance cutoff dates. Furthermore, these data contain detailed information about the types of preschool and elementary programs in which children participate and the services they receive. Also, there is detailed information on family background and parent characteristics.

The ECLS data contains rich information on kindergarten cutoff dates. Most states establish kindergarten entrance age policies, which specify a cutoff date by which children must complete five years of age in order to be able to enter kindergarten. As many as 5 states have no state level kindergarten cutoff date and allow the individual school districts in the state to decide the cutoff date. Private and charter schools are typically allowed to establish their own cutoff date policies. Since ECLS collected information about cutoff dates at the school it has cutoff dates for each child sampled from the 5 states with no state level cutoff date policy and also contains cutoff dates for children in private schools. The study also collected information about school start dates from each school participating in the study. These variables allow me to compute accurate measures for the earliest age at which a child is eligible to enter kindergarten.

### 4.2. State Occupational Employment and Wage Data

Data on average hourly wages of childcare workers (OES code: 68038) by state were obtained from the State Occupational Employment and Wage Data collected by the Bureau of Labor Statistics (BLS). The BLS, through its Occupational Employment Statistics (OES) program, conducts a yearly mail survey designed to produce estimates of employment and wages for specific occupations. The OES program collects data on wage and salary workers in non-farm establishments in order to produce employment and wage estimates for over 700 occupations. Data from self-employed persons are not collected and are not included in the estimates. The OES program produces these occupational estimates by geographic area and by industry. Estimates based on geographic areas are available at the National, State, and Metropolitan Area levels.

### 4.3. State Child Care Regulations Data

Data on state child care regulations were obtained from the 1999 Children's Defense Fund Survey of Child Care Administrators and Licensors (Blank and Poersch 2000). The child care regulation variable used in this paper include (1) child to staff ratio for 4 year olds, (2) whether family care providers are regulated, and (3) whether state requires any early education training for child care center providers. Descriptive statistics of these variables are reported in Table 2.

### 4.4. Current Population Survey (CPS)

Data on average weekly wage for women 23-49 years of age by state were compiled using the March 2000 supplement data from the CPS. The CPS is a monthly survey of approximately 50,000 households that has been conducted for over 50 years. It is conducted by the United States Department of Labor, Bureau of Labor Statistics, and the United States Census Bureau. The households interviewed in the CPS are a probability sample, selected to represent the civilian non-institutionalized population at state and national levels. The CPS Annual Demographic Survey (March Supplement) collects in-depth information on labor force characteristics including age, education, gender, state of residence, employment status, wages and income.

### 4.5. Sample Description

The analysis sample consists of 15,700 first-time kindergartners who were surveyed in the fall of their kindergarten year (1998).[33] The means and standard deviations of the variables used in the analysis are reported in Table 2. The mean kindergarten entrance age is 65 months (5 years and 5 months).

Using information on the child's birthdate and the school's cutoff and start dates, I estimate that about 5 percent of the kindergartners in the ECLS-K sample had

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[33] The sample size was reduced from the original sample of children surveyed in the fall kindergarten wave due to non-response on the fall kindergarten and/or spring kindergarten parent questionnaires (14%).

experienced delayed kindergarten entrance i.e. these children entered kindergarten later than when they first became eligible. This estimate is higher (7 percent) when I use parent reports of whether the child delayed kindergarten entrance. Previous estimates from the 1993 and 1995 National Household Education Surveys (NHES) report higher estimates of delayed entrance. In both surveys, 9 percent of first- and second-graders experienced delayed kindergarten entrance, as reported by parents (U.S. Department of Education, 1997).[34] In the ECLS-K sample, just under 2 percent entered kindergarten earlier than when they would be eligible to enter.

Two key variables hypothesized to influence kindergarten entrance age decisions include childcare prices and mother's market wage. The ECLS collected data on childcare costs by asking parents about their childcare utilization, mode of child care and expenditures. These data were used to construct predicted childcare prices for all children in the sample. A detailed description of the approach is provided in the next section. One limitation of the ECLS-K data is that it did not collect data on mother's wages. Therefore, I use proxies for mother's market wage, such as the average female wage rate in the child's state of residence and mother's education.

Parents' kindergarten entrance age decisions may also depend upon child characteristics, such as gender, race-ethnicity, disability status and birth weight. As indicated earlier, previous research has shown that boys are more likely to experience

[34] The NHES survey sample that were used were weighted to make them representative of the entire population of first- and second-graders.

delayed kindergarten entrance compared to girls. Parents of disabled children may also be more likely to hold their child out of school so as to give them the additional age advantage. In addition, I also include family characteristics such as household income, presence of younger and older siblings in the household as well as other adults, and mother's education.

## 5. EMPIRICAL STRATEGY

The economic model from section 3 demonstrated how different factors influence parents' desired kindergarten entrance age. Moreover, the actual age at which a child enters kindergarten depends upon both the parents' desired entrance age as well as the entrance age policy that they face. The empirical strategy in this paper starts by first estimating an empirical model for the desired entrance age. The estimated parameters from this model are then used to examine how the imposition of and changes in entrance age policies would impact children's kindergarten entrance age.

### 5.1. Maximum Likelihood Model of Desired Entrance Age

Parents' desired entrance age for their child is unobservable and is modeled as a continuous latent variable $D_i$. Let $O_i$ be a discrete variable that measures the observed entrance age. The discrete observed outcome, $O_i$, can be viewed as a reflection of an underlying regression:

(17) $D_i = X_i\beta + \varepsilon_i$

where, $X_i$ is a vector of covariates that are related to the desired entrance age. This vector would include socio-economic variables that affect entrance age decisions, such as race-ethnicity, child's gender, parental education, poverty status, number of siblings and adults in the household, family income, proxies for mother's wage and estimated price of market childcare.

Let $EA_i$ be the earliest age (in months) at which a child is eligible to enter kindergarten. $EA_i$ would differ across children because of differing birth dates and school cutoff and start dates. Let $K_i$ be the age (in months) by which the state requires the child to be in kindergarten. This implies that the parents have to choose from the following set of possible entrance ages: $EA_i$, $EA_i+12$, $EA_i+24,\ldots,K_i$. However, as described earlier in the paper, there are a small percentage of children who are allowed to enter school before they are officially eligible under certain circumstances, typically, when the child is gifted or talented. Therefore, the observed entrance age can take one of the following values,

(18) $O_i \in \{EAi\text{-}12,\ EA_i, EA_i+12, EA_i+24, \ldots., K_i\}$

To be able to establish a relationship between $O_i$ and $D_i$ we need to have a hypothesis about how parents choose an entrance age given their desired entrance age. In particular, I assume that parents send their child to kindergarten at the allowable age that is closest to the desired entrance age.[35] For example, if parents desired to send their child to kindergarten at age 5 but could either do so at age 4 years 11 months or 5 years 11 months then they would choose to send the child at age 4 years and 11 months. Based on this decision rule, the relationship between $O_i$ and $D_i$ can be characterized as follows:

(19) If $O_i = EA_i - 12$, then $D_i \in \{0, EA_i - 6\}$

(20) If $O_i = EA_i$, then $D_i \in \{0, EA_i + 6\}$

(21) If $O_i = EA_i + j$, then $D_i \in \{EA_i + j - 6, EA_i + j + 6\}$

(22) If $O_i = K_i$, then $D_i \in \{K_i - 6, \infty\}$

Condition (13) implies that parents who sent their child to kindergarten at an age earlier than when the child becomes eligible, $EA_i - 12$, would have a desired entrance age earlier than or equal to $EA_i - 6$. Condition (14) implies that parents who sent their child to kindergarten at the earliest age s/he was eligible, $EA_i$, then their desired entrance age must have been less than or equal to $EA_i + 6$. Similarly, an observed entrance age of $EA_i + 12$ implies that the desired entrance age must be between ages $EA_i + 6$ and $EA_i + 18$. Finally, condition (16) implies that parents who sent their child to kindergarten

[35] An alternate assumption could be that parents always prefer to delay the child's entry into kindergarten rather than send the child earlier than the desired age. However, in some instances this assumption may be less reasonable. For example, consider a case where the desired entrance age is 5 years and 3 months but the child can either enter at 5 years, 2 months or 6 years, 2 months. In this case, the parent may prefer to send the child to kindergarten a month earlier than desired instead of waiting for another 11 months. In two alternate specifications, I assumed different decision rules – (a) parents always choose the later date, and (b) parents always choose the earlier date. The estimates from both these specifications were very similar to the estimates presented in the paper.

at the mandatory upper age limit, $K_i$, must have a desired entrance age greater than or equal to $K_i - 6$.

I use maximum likelihood estimation (MLE) procedures to estimate the parameters, $\beta$, in (13). The MLE estimates will be used to simulate the effect of changes in kindergarten cutoff dates on the number of children that will have to enter school later. The probabilities of observing each of the possible entrance ages are as follows:

(23) $\Pr[O_i = EA_i - 12] = \Pr[D_i \leq EA_i - 6]$

(24) $\Pr[O_i = EA_i] = \Pr[D_i \leq EA_i + 6]$

(25) $\Pr[O_i = EA_i + j] = \Pr[EA_i + j - 6 < D_i \leq EA_i + j + 6]$
$\forall j = 12, 24, ..., K_i - 12$

(26) $\Pr[O_i = K_i] = \Pr[D_i > K_i - 6]$

Assuming that the errors $(\varepsilon_i)$ are distributed normally with mean zero and variance $\sigma^2$, the above probabilities can be written as follows:[36]

(27) $\Pr[O_i = EA_i - 12] = \Phi[\frac{EA_i - 6 - X_i\beta}{\sigma}]$

(28) $\Pr[O_i = EA_i] = \Phi[\frac{EA_i + 6 - X_i\beta}{\sigma}]$

(29) $\Pr[O_i = EA_i + j] = \Phi[\frac{EA_i + j + 6 - X_i\beta}{\sigma}] - \Phi[\frac{EA_i + j - 6 - X_i\beta}{\sigma}]$
$\forall j = 1, 2, ..., K_i - 12$

[36] In order to check sensitivity to the distributional assumption, the ML model was estimated assuming a lognormal distribution for the desired entrance age. The estimates (not reported here) were similar to the ones obtained from the normality assumption.

(30) $\Pr[O_i = K_i] = 1 - \Phi[\frac{K_i - 6 - X_i\beta}{\sigma}]$

where $\Phi$ is the cumulative density function of a standard normal distribution.

The log likelihood function of the sample is given by:[37]

(31) $LogL = \sum_{i=1}^{n} Log \Pr[O_i]$

The log likelihood is maximized with respect to $\beta$ and $\sigma$ to obtain the maximum likelihood estimates. Huber-white standard errors are estimated to account for the clustered nature of the data by school. For the reasons described in chapter 2, the ML estimates are not weighted, however, weights are used when simulating the impact of changes in entrance age policies.

**5.2. Estimating Childcare Prices**

One of the key variables hypothesized to influence the kindergarten entrance age decision is the childcare prices facing the family. However, childcare costs are only observed for families that choose to purchase market care. I estimate a sample selection model that generates a predicted hourly price of childcare for all children in the sample. The selection equation is a probit indicating whether the family used paid childcare. The dependent variable in the underlying regression is the cost per child per hour of childcare used. The inverse mills ratio is identified by variables indicating the presence

[37] Since there are multiple children from the same classroom and school in the sample, I use robust maximum likelihood techniques to account for correlated observations. See Greene (2000) section 11.5.6 for a discussion.

of alternate caregivers in the household. These variables have been commonly used in the previous literature for identification (Ribar, 1992; Connelly, 1992; Powell, 1997, 2002; Michalopolous, Robins & Garfinkel, 1992; Kimmel, 1998; Averett, Peters & Waldman, 1997;Connelly & Kimmel, 2003; Cleveland, Gunderson & Hyatt, 1996). Presence of older siblings or other adults in the household is likely to influence the decision to use paid childcare but is less likely to influence the price for paid childcare once the household decides to use paid childcare.

A second issue is that in order to identify the price of childcare in the desired entrance age equation there must be some variables that predict childcare prices but have no direct relationship with the entrance age decision. I use state childcare regulations, including child to staff ratio for four year olds, whether family care providers are regulated, and whether state requires any early education training for childcare center providers to identify the price of childcare. State child care regulations have been used by previous studies in order to identify variation in child care prices (Kimmel, 1998; Ribar, 1992; Hotz & Kilburn, 1995; Connelly & Kimmel, 2003; Powell, 2002, 1997). In addition, I also use the state's average hourly wage for childcare workers as an additional instrument for child care prices.

The full results of the sample selection model are reported in Table 3. A number of factors were significantly associated with use of paid childcare. For example, non-whites and disabled children were less likely to use paid childcare. The presence of children 4 years or younger and potential caregivers such as teenagers and other adults in the household reduced the likelihood of using paid childcare. Families with higher education and income were more likely to use paid childcare. Among families that used paid childcare, non-whites tended to pay lower prices compared to whites. Families with higher income and education were more likely to pay a higher price for childcare. However, this finding might in part reflect differences in the quality of child care chosen by high income families and low income families rather than differences in quality-adjusted prices. Families living in states that regulate family care providers and where the child-to-staff ratios are lower were more likely to pay a higher price for childcare. The estimated ❒ was negative and significant, suggesting that childcare prices were observed for families that faced lower prices.

### 5.3. Simulating the Impact of Changes in Entrance Age Policies

In order to examine the impact of changes in entrance age policies on families' childcare needs, I run simulations for three alternate policy scenarios.

1. Schools in all states require children to be at least 5 years old on the first day of school
2. Schools in all state set their minimum entrance age requirement to 54 months (currently the lowest entrance age requirement in the U.S.)

3. All schools with a December or January cutoff date move their cutoff date to September 1st

Since age 5 has historically been used as a standard for judging children's school readiness in the U.S., the first policy examines the impact of a national policy of requiring all children to be at least 5 years of age on the first day of school, instead of states choosing their own cutoff dates. Based on the ECLS-K data, it is estimated that in 1998 about 2.7 million children were in schools with a minimum entrance age lower than 60 months. The second policy lowers the minimum entrance age requirement in all schools across the nation to 54 months, which is currently the lowest minimum entrance age requirement in the U.S. In 1998, only about 1 percent of the schools had a minimum entrance age requirement of 54 months, with the rest requiring children to older than 54 months. This policy alternative will help examine the impact of the policy change in the opposite direction. The third policy considered is one that reflects the current trends in entrance age policies in the U.S., where all states with a December or January cutoff date are drafting legislations to move the cutoff date to September. This policy change will affect 8 states in the U.S. with an estimated kindergarten population of about 900,000 children.

For each of these policy scenarios, I estimate – (a) the number of children forced to stay out of school for an additional year due to the policy change, (b) the demographic composition of these children, and (c) estimated childcare costs that families of affected children will incur.

A. Number of Children Forced Out of School for an Additional Year Due to Changes in Entrance Age Policies

The maximum likelihood estimates of $\hat{\beta}$ and $\hat{\sigma}$ are used to compute the predicted probability of having a desired age of entry below the earliest entrance age implied by current cutoff dates for each child as follows:

$$\hat{P}_i = \Phi[\frac{EA_i - X_i\hat{\beta}}{\hat{\sigma}}] \quad (32)$$

The sum of this probability over all children yields an estimate of the number of children forced to stay out of school due to the current entrance age policy ($N_0$).

$$N_0 = \sum_{i=1}^{n} \hat{P}_i = \sum_{i=1}^{n} \Phi[\frac{EA_i - X_i\hat{\beta}}{\hat{\sigma}}] \quad (33)$$

Under a new policy regime, the earliest age at which each child can enter kindergarten is computed again ($\overset{\square}{EA}_i$). $\overset{\square}{EA}_i$ is used along with the maximum likelihood estimates to compute the predicted probability for each child of having a desired entrance age lower than the earliest entrance age. As before, these probabilities are summed to arrive at the expected number of children that will be forced to stay out of school due to the entrance age policy under the new policy ($N_1$).

(34) $$N_1 = \sum_{i=1}^{n} \tilde{P}_i = \sum_{i=1}^{n} \Phi[\frac{EA_i - X_i\hat{\beta}}{\hat{\sigma}}]$$

The difference between $N_1$ and $N_0$ provides an estimate of the number of additional children that are predicted to be forced to stay out of school due to the policy change. The 95 percent confidence intervals for these estimates are also computed and are reported in results.

B. Demographic Composition of Pre-Kindergartners Affected by Entrance Age Policies

Estimates of key demographics of the children forced to stay out of school, including gender composition, race-ethnicity, parental education, poverty status, and disability status are generated as follows.

Let $X = (X^1, X^2, ..., X^k)$ be the vector of indicator variables representing k demographic groups. The predicted number of out of school children in each of these groups is computed as follows:

(35) $$N_{k\times 1} = X'_{n\times k}.\hat{P}_{n\times 1}$$

where, $N = [N^1, N^2, ..., N^k]$ represents the number of children in each demographic category, and $\hat{P}$ = Predicted probability of being out of school.

## 6. RESULTS

### 6.1. Maximum Likelihood Estimates

The maximum likelihood estimates are reported in Table 4. Predicted childcare prices have a significant negative effect on the desired entrance age into kindergarten. Parents who face higher childcare prices (as reflected by average wage of a child care worker) are more likely to want to send their child to kindergarten at an earlier age. The estimated coefficient implies that a dollar increase in the hourly price of childcare would lower the desired kindergarten entrance age by 0.5 months.[38] The proxy for maternal wage, the average weekly wage for a female between the ages 23-49 years in the state of residence, is also significant and has a negative sign. The estimated coefficient suggests that a dollar increase in hourly wage (13 percent increase) reduces desired entrance age by 0.8 months. Higher female wages raise the opportunity cost of time in maternal care an increase the probability that the mother works. Consequently, mothers reduce time in maternal care by sending the child to school at an earlier age. Therefore, higher female wages reduce the desired entrance age for kindergarten. The presence of toddlers and preschoolers in the household does not appear to be significantly related to desired entrance age. However, the presence of teenagers in the household has a positive effect on the desired entrance age, indicating that teenagers

[38] A dollar increase in the hourly price of childcare is equivalent to a one standard deviation increase in childcare price. Assuming 40 hours/week of childcare is used, this increase translates into a $160 increase in monthly childcare expenses.

may act as potential caregivers, which would reduce the effective price of childcare for these families or reduce the probability that they use paid child care.

Consistent with the previous literature, parents’ desired entrance age for girls is lower compared to boys, and earlier for non-whites compared to whites. Children with a disability as well as those with a low birth weight tend to have a higher desired entrance age. This finding suggests that parents of children who suffer from negative health shocks may try to compensate for such deficiencies by sending their child to school at an older age when they may be able to perform well and fit better with their peers. Children from high-income families were found to be more likely to have a later desired entrance age compared to low-income families. Specifically, families with income in the highest quartile had a desired entrance age that was about 1.5 months higher than that of families with income in the bottom quartile. This may be because high-income families can afford to pay for childcare and may not find free public schooling as attractive as do low-income families. Finally, higher maternal education significantly increased the desired entrance age. Specifically, families where the mother had a bachelor’s degree or higher had a desired entrance age for their child that was almost 1 month higher than the desired entrance age for families where the mother had less than a high school diploma.

These findings suggest that girls, non-whites, and children from low-income and less educated families are more likely to face binding policy constraints since their desired entrance age is relatively early. On the other hand, children with disabilities and low-birth weight are less likely to be constrained by changes in entrance age policies because parents of such children prefer to enter their child in kindergarten at an older age.

### 6.2. Simulations For Number And Characteristics Of Children Affected By Changes In Entrance Age Policies

The simulation results for the current policy scenario and three alternate policy scenarios are reported in Tables 5-8. The estimates are weighted so as to be representative of a kindergarten population of 3.32 million children in the U.S. Table 5 reports the expected number and characteristics of children whose desired entrance age is lesser than or equal to the earliest eligible age under the current policies (subsequently referred to as children for whom policies are binding). It is estimated that the current entrance age cutoff dates are binding for 2.64 million children (79.6 percent of the kindergarten population). While many of these children may be those who preferred to enter kindergarten earlier than when they became eligible, this large percentage also reflects the fact that children can only enter kindergarten once in a year. Of these 2.64 million children, 52 percent are girls, which is 3 percentage points higher than the proportion of girls in the kindergarten population. Blacks, Hispanics and other non-whites comprise 16.4 percent, 20.1 percent and 8 percent of the children facing a binding constraint. Again, these proportions are between 0.8-1.7 percentage points higher than the proportions of these sub-groups in the kindergarten population. Children with mothers who have less than high school education are slightly more prevalent in the constrained population compared to their proportion in the kindergarten population. About 22 percent of the children facing a binding constraint are below the poverty line compared to 20 percent in the kindergarten population. Finally, children with a disability constituted a lower proportion of the constrained population (12.2 percent) compared to the kindergarten population (14.1 percent). Overall, these results reiterate the findings from the maximum likelihood model and imply that if the minimum entrance age for kindergarten is raised, girls, non-whites, children of less educated mothers and poor children will be more likely to be forced to stay out of school for an additional year.

The first policy alternative considered is where all schools set their minimum entrance age requirement on the first day of school to be 60 months (5 years). In 1998, about 2.7 million kindergartners were in schools that had a minimum entrance age requirement below 5 years. More than 50 percent of the children were required to complete 5 years of age between the school's start date and 1 month into the school year. Estimates from Table 1 suggest that about 80 percent of these children already faced binding policy constraints. Moreover, only a fraction among the remaining 20 percent would be affected by the change in cutoff date. In addition, some children previously constrained by the policy will now be able to enter kindergarten an academic year earlier. It is estimated that under the new policy, about 150,000 additional children (4.6 percent of the kindergarten population) will be forced to stay out of school for 1 year (Table 6). Of these, about 42 percent will be girls, 37 percent will be non-whites, and about 18 percent will have mothers with a high school degree or lesser education. Close to 27,000 additional poor children and 26,000 disabled children will be forced to enter school 1 year later.

The second policy alternative considered is where all states lower their minimum entrance age requirement to 54 months (4 years, 6 months) (Table 7). 54 months is currently the lowest minimum entrance age requirement in the U.S. and was the requirement in less than 1 percent of the schools in 1998. It is estimated that the number of children forced to stay out of school for an additional year reduces by 23 percent to about 1.89 million children (57 percent of the kindergarten population). Among those children who will be able to enter school 1 year earlier will be about 340,000 girls, about 253,000 non-whites, and over 370,000 children with mothers with a high school degree or lesser education. In addition, close to 140,000 poor and 120,000 disabled children will be able to enter kindergarten a year earlier.

The final policy alternative considered captures the current trends in entrance age policies. This simulation examines the impact of a change where all states with a December or January cutoff date move their cutoff date to September 1$^{st}$ (Table 8). In

1998, there were 8 states with a cutoff date in December or January. If these eight states moved their cutoff date to September 1st, the estimated number of children facing a binding policy constraint will increase by over 92,000 children to about 2.73 million children (82.3 percent of the kindergarten population). Of these, about 37,000 children will be girls, over 39,000 will be non-whites, and about 41,000 will have mothers with a high school degree or lesser education. An estimated 13,486 additional poor and 14,270 disabled children will be forced to enter school 1 year later.

The simulation results discussed above estimate the overall number of children affected by the policy change across the nation and also provide estimates of children affected in specific sub-populations. However, for service planning purposes policymakers at the state level may be interested in knowing the number and types of children affected in their state as a result of specific policy changes implemented in their state. While the ECLS allows me to generate national estimates, it is not feasible to estimate the number of affected children by each state separately using these data. However, this study and the approach used here may be used by states to motivate statewide data collection efforts that will enable them to generate estimates of child care needs in their state. Perhaps, states could use the ML estimates from this study and 2000 Census data to generate local estimates as a preliminary examination.

### 6.3. Estimates Of The Childcare Cost Burden On Affected Families

Table 9 presents the estimated childcare cost burden incurred by families of children affected by the changes in entrance age policies. These estimates are computed assuming that parents who are forced to keep their child out of school for an additional year continue to utilize the same childcare mode for the additional year. In 1998, about 18 percent of kindergartners did not use any non-maternal childcare, 27 percent used childcare that they did not pay for, and 54 percent used paid childcare in the year prior to entering kindergarten. Those who used paid childcare spent $2,516 on average on childcare in the year prior to kindergarten.

As shown in Table 6, if all schools set their minimum entrance age requirement on the first day of school at 5 years 153,189 additional children who preferred to enter kindergarten will be forced to stay out of school for an additional year. Of these, 30,886 children will be left without any non-maternal childcare for the additional year. The additional childcare cost burden borne by the families who continue to use paid childcare (approximately 81,000 children) is estimated to be approximately $220 million. Under policy 2, where the minimum entrance age requirement is reduced to 4 years and 6 months, close to 750,000 children who wanted to enter kindergarten earlier will be able to enter 1 year earlier. Of these, about 138,000 children will be those who would have used no non-maternal childcare had they remained out of school. The childcare cost savings to those families who would have used paid childcare (approximately 400,000 children) is estimated to be about $1 billion. Finally, if the current trends in entrance age policies continue, where states with December/January cutoff dates move their cutoff dates to September 1st, an additional 92,000 children (10 percent of the kindergarten population in the 8 affected states) who wanted to enter kindergarten will be forced to stay out of school for 1 additional year. Among these, about 19,600 children can be expected to satisfy their demand for child care for the additional year with care provided by the mother. The additional childcare cost burden on families that used paid childcare (approximately 51,000) is estimated to be around $147 million. These costs are substantial as they translate into about $2,863 per child per year.

## 7. CONCLUSIONS AND DISCUSSION

This chapter developed an economic model for parents' kindergarten entrance age decisions and examined the relationship between various social and economic factors and these decisions. The estimates from this model were used to simulate the impact of alternate changes in kindergarten entrance age policies on—(a) the number of children affected by the policy change, (b) the socio-demographic composition of the affected children, and (3) estimated additional childcare cost burden/savings from the policy change.

The results show that both childcare costs and maternal wages appear to have a significant negative effect on parents' desired entrance age for their child. Higher childcare costs and maternal wage increase the marginal cost of delaying kindergarten entrance and lower the desired kindergarten entrance age. In addition, presence of alternate caregivers in the household, especially teenage children, raises parents' desired entrance age. A number of other family characteristics were found to be important in determining the desired entrance age, such as family income, maternal education, child's gender and disability status.

Findings from the policy simulations suggest that a significant proportion of kindergartners preferred to enter kindergarten early but were required to stay out of school due to the policies. This is evident from the fact that a large majority of parents choose to send their child to kindergarten at the earliest possible age. Under the current policies, the model estimates that about 80 percent of the children preferred to enter kindergarten earlier than when they were eligible. The socio-demographic composition of children facing binding constraints reveals that these children are more likely to be girls, non-whites, and from poor and less educated families. As mentioned earlier in this chapter, non-whites and children from poor and less educated families are also known to have relatively low participation rates in affordable and high-quality prekindergarten programs.

The simulations for the alternate policy scenarios demonstrate that the magnitude of the impact on childcare needs and costs is substantial despite small perturbations to the existing policies. The additional childcare cost burden on parents from the continuation in current trends in entrance age policies is estimated to be $147 million.

These findings suggest that policymakers may need to view entrance age policies and preschool policies as a package. Findings from chapter 2 indicated that poor children who delay entrance experienced faster gains in test scores over time compared to poor children who entered kindergarten at a younger age. However, findings from chapter 3 indicate that these children are more likely to bear huge additional child care costs if minimum entrance age requirement are raised. Estimates from this study can be used to identify sub-populations that are more likely to be affected by these changes and better policies may be designed that help ease the burden of changes in policies on these families.

# CHAPTER 4 – Discussion and Policy Implications

This dissertation examined two key issues related to kindergarten entrance age policies in the U.S. First, it examined the impact of delaying kindergarten entrance age on children's academic performance during the first two years in school. And second, by developing a behavioral model of parents' kindergarten entrance age decisions, it simulated the impact of alternate changes in entrance age policies on the childcare needs of families.

Chapter 2 examined the effects of entering kindergarten at an older age on children's test scores in the beginning of kindergarten and at the end of two years in school. This analysis compared the test scores of children in the same-grade with different entrance ages (these children also differ in their chronological age, by definition). The rationale for focusing on same-grade comparisons is that students are now expected to demonstrate proficiency in their classes and on tests at the end of each grade level, regardless of how old they are. This continues all the way through high school, and many states are requiring students to pass exit exams to graduate, regardless of their age. In addition, with the passing of the No Child Left Behind Act of 2001, there is significant emphasis on assessing students' performance starting in early grades, making same-grade comparisons increasingly relevant in the current environment.

Chapter 2 also compared test score gains between grades across children of different entrance ages. By examining gains instead of levels, this approach controlled for initial differences in achievement that exist between children of different entrance ages, which may be related to differences in their chronological age. Therefore, this approach estimates whether the age at which a child enters kindergarten affects the value added (in terms of test scores) from schooling.

Findings from chapter 2 indicate that entering kindergarten at an older age is associated with a significant increase in math, reading and general knowledge test scores at the beginning of kindergarten. This initial advantage is found to remain sizeable after two years in school. While it is no surprise that older children performed better on standardized tests compared to younger children at the beginning of kindergarten, this study found significant effects of delaying kindergarten entrance on test score gains among poor and disabled children. The effect of delaying entrance was small for these children when they entered school, but grew significantly over the first two years in school implying that poor and disabled children who entered kindergarten at an older age learnt at a faster rate over time compared to poor and disabled children who entered at a younger age. The entrance age effect for children from higher income families was initially larger than the effect for poor children, but among children from higher income families older and younger entrants experienced similar gains in test scores over time.

The finding that the entrance age effect for poor children at the beginning of kindergarten is significantly smaller than that for children from high-income families suggests that how children spend their time before they enter school may play an important role in their ability to succeed in school. For example, children from high socioeconomic status (SES) families may enroll in high quality preschool programs when they delay their entrance into kindergarten, whereas those from low SES families may not have access to such programs in the additional year out of school. In fact, children from low SES families are known to have significantly lower participation rates in public or private early childhood programs compared to children from high SES families (Blank et al., 1999). These differences in pre-kindergarten experiences across children from different socioeconomic groups may explain some of the achievement differences at the beginning of kindergarten.

There is considerable evidence suggesting that participation in high-quality early childhood programs has positive effects on achievement, test scores, high school graduation rates, and earnings, as well as long term negative effects on criminal activity and welfare use (Currie, 2001; Karoly et al., 1998; Cost, Quality and Outcomes Study, 1995). In particular, these studies have found that participation in early childhood programs has the greatest payoff for the most disadvantaged children. Therefore, participation of disadvantaged children, such as the poor and disabled, in developmentally appropriate preschool programs may reduce these achievement differences.

Another finding that is particularly interesting is that the gains for poor and disabled children who entered at an older age were similar to the gains for the non-poor and non-disabled children. This finding suggests that delaying kindergarten entrance may be especially beneficial for poor and disabled children since it would make them learn as fast as the rest of the children. This leads us to the question as to why these children would benefit differentially. One possibility may be that in order for children to learn from schooling, they need to have a certain set of skills or a minimum level of maturity. Young, disadvantaged children may lack these skills and maturity in large part due to the lack of an enriching pre-kindergarten environment, which prevents them from learning as fast as the other children (younger and older entrants from advantaged families who have had richer pre-kindergarten experiences). The benefit of an extra year of age may compensate for the lack of a rich pre-kindergarten experience by giving these children the maturity and experiences needed to learn from schooling like the rest of the children.

However, Chapter 3 showed that these benefits to children come with a significant price tag. It developed an economic model of parents' kindergarten entrance age decisions to help understand how various social and economic factors influence these decisions. Factors such as child care costs and mother's wages were found to be important considerations in families' entrance age decisions. Delaying a child's entrance would mean additional child care costs for the extra year out of school and/or lost wages for parents who provide child care for their children themselves. Families facing higher childcare costs and maternal wages were found to be more likely to want to send their child to kindergarten at an earlier age since public schooling is free. A number of other individual and family characteristics, such as gender, disability status, and presence of alternate caregivers, were found to exert an important influence on entrance age decisions.

The results from this model were used to simulate the effect of alternate changes in kindergarten entrance age policies on the number and types of children most likely to be forced to stay out of school for an additional year. The socio-demographic composition of children affected by the policy changes revealed that these children were more likely to be girls, non-whites, and from poor and less educated families. One policy change considered in chapter 3 was the continuation of recent trends in entrance age policies, where states with December cutoff dates moved their cutoff dates to September. Simulations of the impact of such a policy change revealed that between 73,000 to 111,000 additional children will be forced to stay out of school for an extra year and their families will have to look for childcare arrangements for them for that extra year. If parents continue to use the same childcare mode during that additional year as they did in the previous year then it is estimated that close to 20,000 children will continue to use child care provided by the mother. The additional childcare cost burden on families that will use paid childcare is estimated to be close to $147 million. This number is significant considering that this policy change affected only 8 states in the country and translates into about $2800 per child per year of additional costs.

Findings from chapters 2 and 3 have important implications for children from low SES families. Low SES children are more likely to be affected by a rise in the minimum entrance age for kindergarten since their parents are more likely to send them to kindergarten at an earlier age. In addition, delayed entrance has a positive effect on their test scores levels at the beginning of kindergarten and a positive effect on their test scores gains during the first two years in school. While these findings suggest that the recent trends in entrance age policies may be beneficial for these children in terms of their academic success in the early school years, other factors merit consideration. First, findings from chapter 3 suggest that these benefits in the short run come at a significant cost to families, such as additional child care costs. In addition, families that continue to provide child care for their children will incur costs in the form of forgone wages due to reduced or no labor force participation. As discussed later, some of these costs may be offset by other benefits in the long run, such as higher earnings of their children. Second, apart from its impact on academic achievement, delaying kindergarten entrance may also affect other outcomes of children such as their social and behavioral development in school, grade retention, and dropout rates. For example, children that are much older compared to their classmates may be subjected to peer harassment or bullying in school, which may lead to behavior problems. On the other hand, children who are very young when they enter kindergarten may not have the maturity or social skills needed to succeed in school. While this study does not examine these outcomes, future research must also examine the effect of entrance age on such outcomes.

Third, it is important to examine the long-term benefits and costs from delaying kindergarten entrance faced by the society at large. For example, one may compare the present value of lifetime earnings (and other outcomes) (net of costs) if a child entered kindergarten at age 5 to the present value of her lifetime earnings if she entered kindergarten at age 6. The impact of kindergarten entrance age on lifetime earnings may be realized in a number of ways. Those who delay kindergarten entrance may also enter the labor market a year later. On the other hand, delayed kindergarten entrance may result in higher test scores at high school graduation, which may provide better labor market opportunities in the form of higher wages. Although achievement differences due to delayed kindergarten entrance may diminish a little in later grades as children grow older and receive exposure to common instruction and environments, there is some evidence that early academic success is a predictor of later outcomes (Hutchison, Prosser & Wedge, 1979; Connolly, Micklewright & Nickell, 1992; Robertson & Symons, 1996; Harmon & Walker, 1998; Currie & Thomas, 1999). For example, Currie and Thomas (1999) find that test scores at age 7 were very strong predictors of future test scores, educational attainment and labor market outcomes at ages 23 and 33 years. In particular, men and women in the lowest quartile of the reading test score distribution had wages 20 percent lower at age 33 than those who scored in the highest quartile. Higher earnings later in adulthood may offset some of the private costs incurred by families during the additional year out of school.

In addition to effects on earnings, delaying kindergarten entrance age could potentially affect educational attainment of children and may even extend the working lives of individuals. For example, Angrist and Kruger (1991) find that children who entered kindergarten at an older age completed 1 less year of schooling due to the presence of compulsory education laws. On the other hand, children who enter kindergarten at an older age are also less likely to be retained in grades, which may reduce the public costs of educating these children (Eide and Showalter, 2001).

Finally, even if we knew all the long term benefits and costs of entering kindergarten at an older age, it is important to examine this policy option together with other policies that are trying to achieve the common goal of increasing children's readiness to learn. One policy option often cited as an important lever to increase children's readiness for school is to increase children's participation in developmentally appropriate early childhood programs. Some targeted early childhood intervention programs have been shown to be cost-effective, especially for disadvantaged children (Karoly et al 1998). Increased participation of at-risk children in high quality early childhood programs may be achieved through programs such as head start or provision of child care subsidies and tax credits to low income parents. Another policy option may be to allow parents to make informed decisions about their child's entrance into school. Parents of poor and disabled children may not know of the benefits that come to their child from delaying entrance. This may be achieved by providing parents with more information about research findings related to entrance age and children's development and success in school and by having schools and teachers in the community work with parents in deciding what is most appropriate for their child.

To summarize, this study finds that policies that delay kindergarten entrance have significant short-term benefits as well as costs for children, especially those from disadvantaged families. While it is unclear right now whether the benefits of delaying kindergarten entrance outweigh the costs in the long-run, what this study suggests is that states and districts ought to view entrance age policies, pre-school program policies and child care subsidy policies as a package so as to ease the burden of changes in entrance age policies on disadvantaged families affected by the change. A broader policy analysis that evaluates the optimal mix of these policies would be important for future research to pursue.

## APPENDIX A

### A. Seemingly Unrelated Regression (SUR) Model

The SUR model for a system of three equations can be written as follows:[39]

$$Y_i = X_i\beta_i + \varepsilon_i, \quad i = 1,2,3 \qquad \text{(i)}$$

where

$$\varepsilon = [\varepsilon_1', \varepsilon_2', \varepsilon_3']'$$

and

$$E[\varepsilon] = 0$$
$$E[\varepsilon\varepsilon'] = V$$

It is assumed that disturbances are uncorrelated across observations. Therefore,

$$E[\varepsilon_{it}\varepsilon_{js}] = \sigma_{ij}, \quad \text{if } t = s \text{ and 0 otherwise}$$

The variance-covariance structure of the error is therefore

$$E[\varepsilon_i\varepsilon_j'] = \sigma_{ij}I_T \quad \text{where T = total number of observations}$$

or

$$E[\varepsilon\varepsilon'] = V = \begin{bmatrix} \sigma_{11}I & \sigma_{12}I & \sigma_{13}I \\ \sigma_{21}I & \sigma_{22}I & \sigma_{23}I \\ \sigma_{31}I & \sigma_{32}I & \sigma_{33}I \end{bmatrix} \qquad \text{(ii)}$$

Each equation in (i) is by itself a classical linear regression. However, since the errors across equations are correlated as described by (ii), the parameters of the system

[39] The description of the SUR model is based on the description in Greene (2000).

($\beta_{1,}\beta_{2,}\beta_3$) can be estimated more efficiently compared to equation-by-equation OLS by using the Generalized Least Squares (GLS) Estimator.[40] The GLS estimator is

$$\hat{\beta}_{GLS} = [X'V^{-1}X]^{-1}X'V^{-1}Y \qquad \text{(iii)}$$

The system is estimated using Feasible Generalized Least Squares (FGLS) where the elements of V are estimated using the least squares residuals from equation-by-equation OLS.

**B. Three Stage Least Squares Estimator (3SLS)**

When there are endogenous regressors present in X, the estimates from the SUR model in the previous section will be inconsistent. Consistent estimates of the parameters of the system of equations in (i) may be obtained using the 3SLS estimator.[41] 3SLS estimation uses an instrumental variables approach to produce consistent estimates and GLS to account for the correlation structure in the disturbances across the equations. 3SLS can be thought of as producing estimates from a three-step process:

Stage 1: Instrumented (or predicted) values for kindergarten entrance age are developed from a regression of entrance age on all exogenous variables in the model,

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40 If all variables in X are identical across equations then there is no gain in efficiency from GLS (Greene 2000). However, in the model described in this paper the variables in X are not all identical and therefore the GLS estimates are more efficient.

41 The discussion of 3SLS estimation is based on the discussions in Greene (2000) and STATA Version 7 Reference Manual (under "reg3").

including the three instruments. The instruments are critical for the consistency of the estimates. The predicted values for entrance age are estimated from

$$\hat{x} = Z(Z'Z)^{-1} Z'x \qquad \text{(iv)}$$

where x = entrance age, and Z = all exogenous variables in the system, including instruments.

Stage 2: Consistent estimates for the covariance matrix of the equation disturbances are obtained. These estimates are based on the residuals from a two-stage least squares estimation of each structural equation.

Stage 3: A GLS-type estimation is performed using the covariance matrix estimated in the second stage and with the instrumented values in place of the kindergarten entrance age variable. The 3SLS estimator is:

$$\hat{\beta}_{3SLS} = [\hat{X}'V^{-1}\hat{X}]^{-1}\hat{X}'V^{-1}Y \qquad \text{(v)}$$

where $\hat{X}$ includes all exogenous regressors (except instruments) and the predicted entrance age from stage 1.

## APPENDIX B

First Stage Regression Estimates

| Variables | Coefficient | Standard Error |
|---|---|---|
| Instruments | | |
| (1) # of days between 5th birthday and cutoff date | -0.025 | 0.000 |
| (2) Min entrance age required on 1st day of school | 0.773 | 0.018 |
| (3) Whether school's upper age requirement>6 | 0.087 | 0.058 |
| Female | -0.428 | 0.048 |
| Black | -0.282 | 0.091 |
| Hispanic | -0.051 | 0.089 |
| Rest | -0.212 | 0.090 |
| Disabled | 0.549 | 0.073 |
| Below poverty line | 0.052 | 0.071 |
| # of siblings in household | 0.101 | 0.022 |
| # of adults in household | -0.083 | 0.037 |
| Mother's Education | | |
| HS degree | 0.040 | 0.085 |
| Some college | 0.015 | 0.093 |
| BA or more | 0.089 | 0.097 |
| Primary language not English | -0.106 | 0.094 |
| School size | | |
| 0-149 students | -0.128 | 0.113 |
| 150-299 students | -0.045 | 0.076 |
| 300-499 students | 0.052 | 0.064 |
| 750 and above | 0.035 | 0.074 |
| % Minority in school | | |
| 10 to less than 25 | -0.185 | 0.072 |
| 25 to less than 50 | -0.221 | 0.079 |
| 50 to less than75 | -0.351 | 0.097 |
| 75 or more | -0.668 | 0.093 |
| Private school | 0.057 | 0.068 |
| North east | -0.388 | 0.081 |
| Mid west | 0.561 | 0.080 |
| South | 0.149 | 0.074 |
| Time in school in fall K | -0.084 | 0.046 |
| Time in school in spring K | -0.085 | 0.046 |
| Time in school in spring G1 | -0.038 | 0.042 |
| Constant | 26.613 | 1.467 |
| Adjusted R-squared | 0.5377 | |
| F-test for joint significance of instruments | F(3, 13702)= 4726.71 | Prob > F = 0.0000 |
| Partial R-squared of excluded instruments | 0.5086 | |

## FIGURES

**Figure 1:**
**Relationship Between Mean Entrance Age and Number of Days Between Child's 5th Birthday and School Cutoff Date**

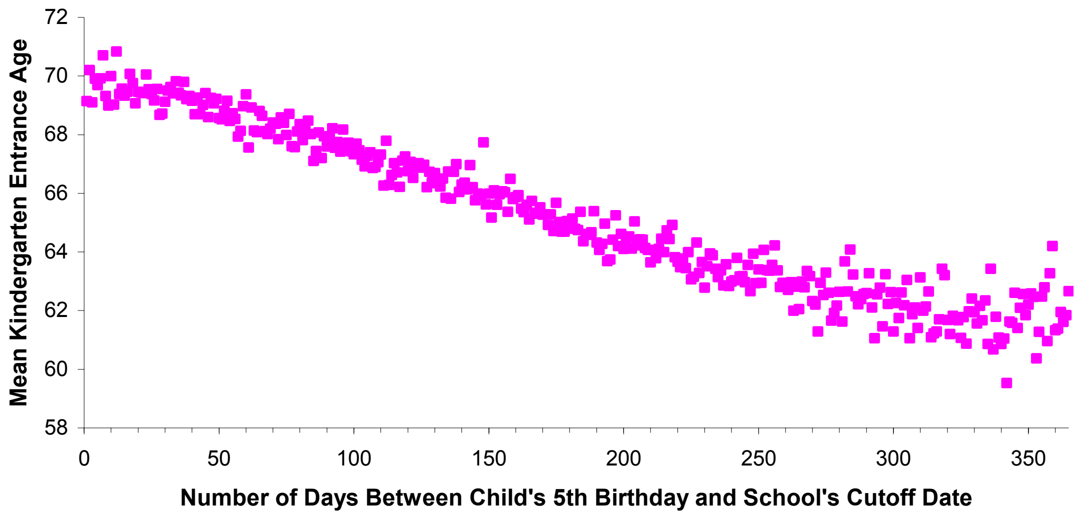



**Figure 2:**
**Relationship Between Mean Entrance Age and Minimum Entrance Age Requirement**

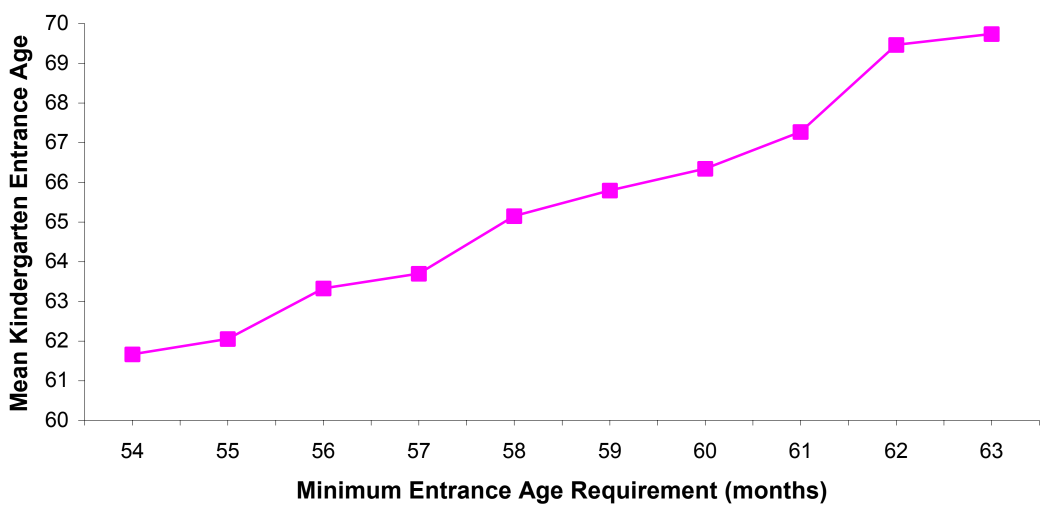


**Figure 3:**
**Relationship Between Math IRT Scale Scores and Kindergarten Entrance Age**

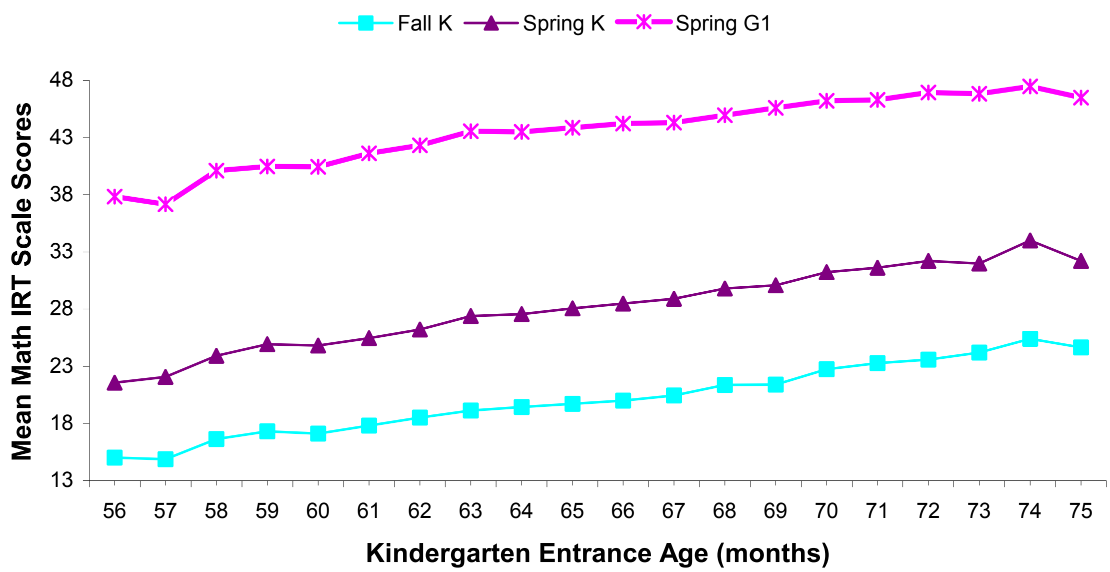



**Figure 4:**
**Relationship Between Reading IRT Scale Scores and Kindergarten Entrance Age**

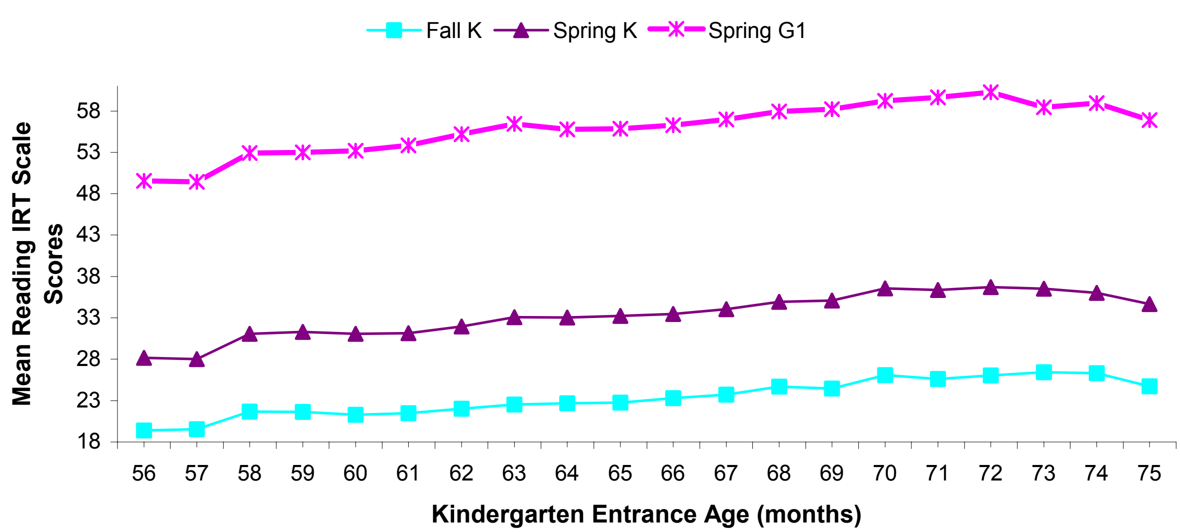


**Figure 5:**
**Relationship Between General Knowledge IRT Scale Scores and Kindergarten Entrance Age**

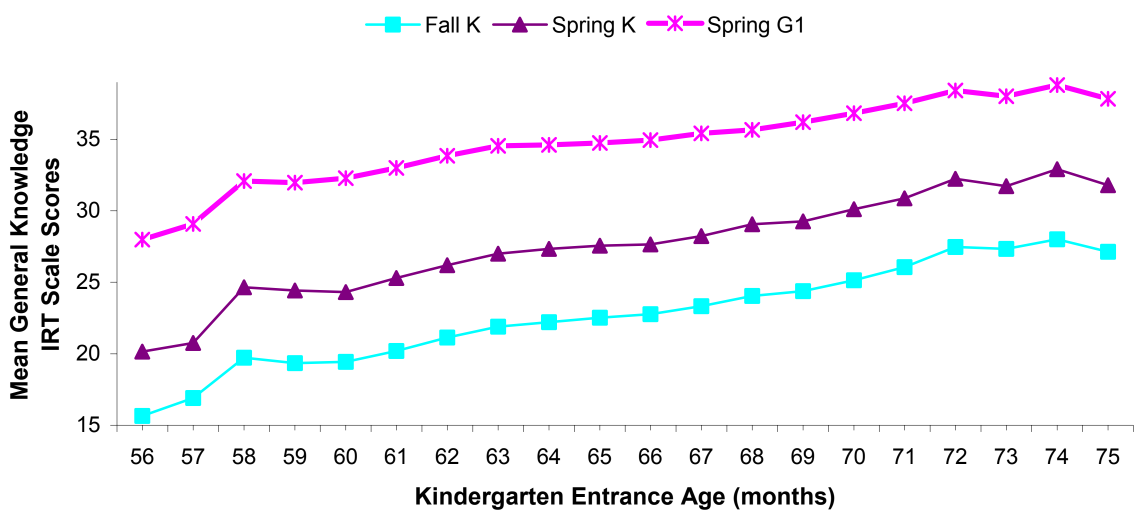



**Figure 6:**
**Effect of a 1-Year Delay in Kindergarten Entrance Age on Math Achievement**

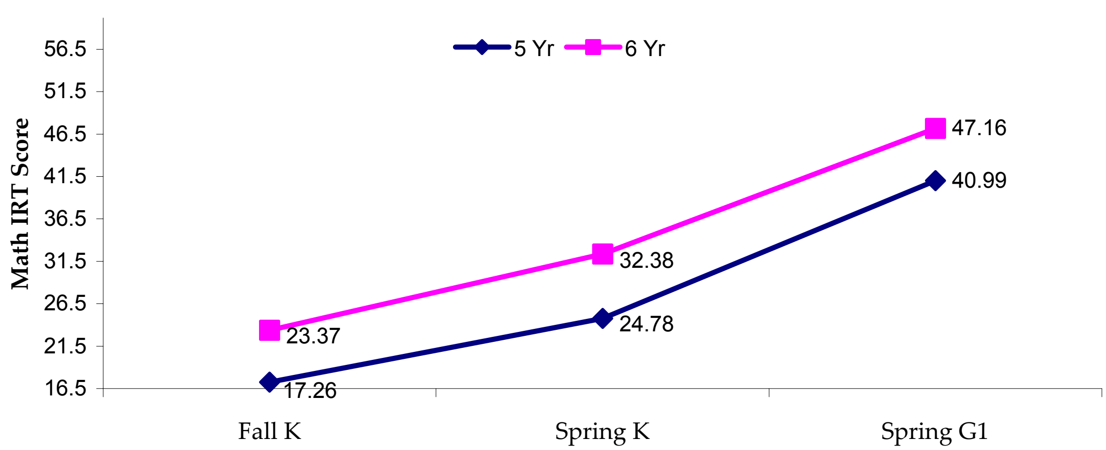


**Figure 7:**
**Effect of a 1-Year Delay in Kindergarten Entrance Age on Reading Achievement**

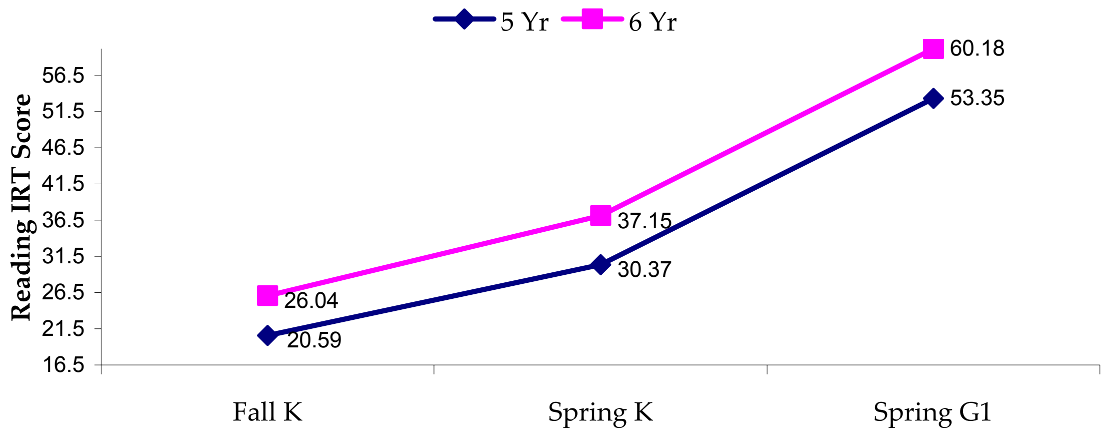
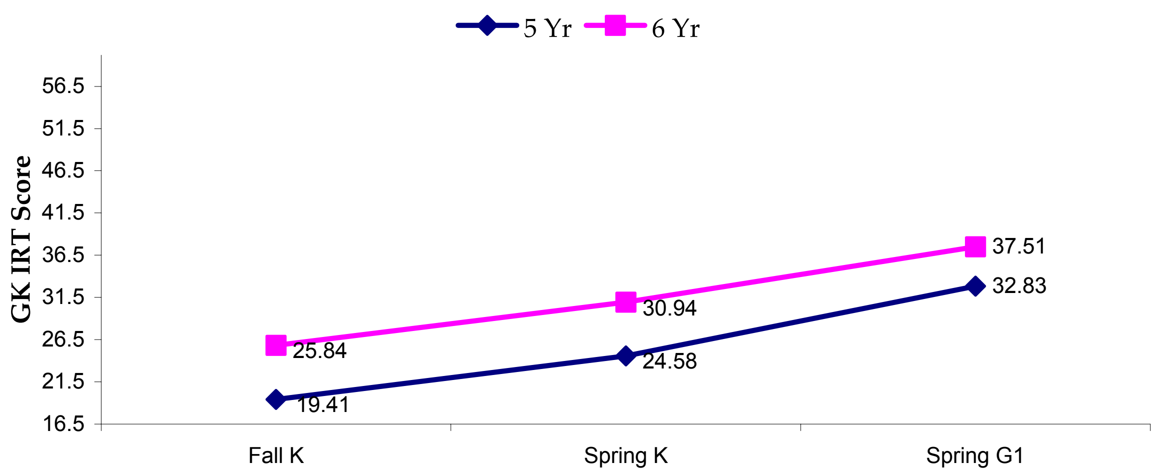



**Figure 8:**
**Effect of a 1-Year Delay in Kindergarten Entrance Age on General Knowledge Achievement**



## TABLES

### Table 1a: Comparison of Baseline (Fall K) Characteristics of Attritors and Non-Attritors

| | Non-Attritors | Attritors |
|---|---|---|
| Math IRT Score | 19.44 (0.16) * | 18.01 (0.19) |
| Reading IRT Score | 22.29 (0.17) * | 21.05 (0.24) |
| GK IRT Score | 22.43 (0.20) * | 20.88 (0.20) |
| K Entrance Age | 64.93 (0.08) | 64.71 (0.11) |
| Female | 0.49 (0.00) | 0.49 (0.01) |
| White | 0.59 (0.02) * | 0.52 (0.02) |
| Black | 0.15 (0.01) | 0.19 (0.01) |
| Hispanic | 0.19 (0.01) | 0.22 (0.02) |
| Other | 0.07 (0.01) | 0.07 (0.01) |
| Disabled | 0.13 (0.00) | 0.14 (0.01) |
| Below poverty line | 0.19 (0.01) | 0.18 (0.01) |
| Number of siblings in household | 1.43 (0.02) | 1.35 (0.02) |
| Number of adults in household | 2.03 (0.01) | 2.00 (0.01) |
| Mother's edu.- less than high school (HS) | 0.13 (0.01) | 0.16 (0.01) |
| Mother's edu.- HS graduate | 0.39 (0.01) * | 0.45 (0.01) |
| Mother's edu.- some college | 0.25 (0.01) | 0.23 (0.01) |
| Mother's edu.- BA or higher | 0.22 (0.01) * | 0.16 (0.01) |
| Primary language not English | 0.11 (0.01) | 0.11 (0.01) |
| Private school | 0.14 (0.01) | 0.17 (0.01) |
| Northeast | 0.18 (0.01) | 0.16 (0.01) |
| Midwest | 0.24 (0.01) | 0.21 (0.02) |
| South | 0.36 (0.01) | 0.35 (0.02) |
| West | 0.21 (0.01) * | 0.27 (0.01) |
| Number of observations | 14,622 | 4,042 |

Note: Standard errors are reported in the parentheses. The estimates reported are computed using fall kindergarten data and are weighted.
* Significantly different from mean for attritors at the 5 % level.

## Table 1b: Descriptive Statistics, by Kindergarten Entrance Age

| Variable | < 5 years | 5-5.5 years | >5.5 years |
|---|---|---|---|
| Math IRT Score (Fall K) | 16.52(5.79) | 18.89(6.54) | 22.00(7.88) |
| Math IRT Score (Spring K) | 23.87(7.8) | 26.95(8.23) | 30.43(9.08) |
| Math IRT Score (Spring G1) | 39.51(9.45) | 42.88(9.01) | 45.49(8.6) |
| Reading IRT Score (Fall K) | 21.12(7.34) | 22.35(7.98) | 24.93(9.65) |
| Reading IRT Score (Spring K) | 30.39(10.2) | 32.50(10.39) | 35.34(11.46) |
| Reading IRT Score (Spring G1) | 52.02(14.47) | 55.30(13.56) | 58.27(13.36) |
| GK IRT Score (Fall K) | 18.71(6.57) | 21.54(7.11) | 24.85(7.59) |
| GK IRT Score (Spring K) | 23.44(7.43) | 26.57(7.45) | 29.72(7.72) |
| GK IRT Score (Spring G1) | 31.09(7.78) | 34.07(7.35) | 36.45(7.15) |
| Kindergarten entrance age (months) | 58.05(1.16) | 63.15(1.98) | 69.48(2.25) |
| Time in school (Fall K) | 2.28(0.62) | 2.18(0.54) | 2.15(0.51) |
| Time in school (Spring K) | 8.41(0.74) | 8.30(0.6) | 8.26(0.52) |
| Time in school (Spring G1) | 20.48(0.78) | 20.31(0.64) | 20.25(0.59) |
| Female | 0.52(0.5) | 0.51(0.5) | 0.48(0.5) |
| Male | 0.48(0.5) | 0.49(0.5) | 0.52(0.5) |
| White | 0.46(0.5) | 0.57(0.5) | 0.63(0.48) |
| Black | 0.15(0.36) | 0.14(0.35) | 0.13(0.34) |
| Hispanic | 0.24(0.43) | 0.18(0.38) | 0.15(0.35) |
| Other | 0.15(0.36) | 0.11(0.31) | 0.09(0.29) |
| Disabled | 0.10(0.3) | 0.11(0.32) | 0.15(0.35) |
| Below poverty line | 0.21(0.4) | 0.18(0.39) | 0.18(0.39) |
| Number of siblings in household | 1.27(1.07) | 1.41(1.11) | 1.48(1.13) |
| Number of adults in household | 2.09(0.67) | 2.04(0.67) | 2.01(0.63) |
| Mother's education: less than high school | 0.16(0.37) | 0.12(0.32) | 0.12(0.32) |
| Mother's education: high school degree | 0.37(0.48) | 0.38(0.49) | 0.38(0.49) |
| Mother's education: some college | 0.24(0.43) | 0.26(0.44) | 0.26(0.44) |
| Mother's education: BA or higher | 0.23(0.42) | 0.23(0.42) | 0.25(0.43) |
| Primary language not English | 0.18(0.39) | 0.12(0.32) | 0.10(0.3) |
| School size: 0-149 students | 0.08(0.27) | 0.06(0.23) | 0.06(0.24) |
| School size: 150-299 students | 0.16(0.36) | 0.19(0.39) | 0.20(0.4) |
| School size: 300-499 students | 0.23(0.42) | 0.28(0.45) | 0.29(0.45) |
| School size: 500-699students | 0.31(0.46) | 0.31(0.46) | 0.29(0.45) |
| School size: 750 and above students | 0.23(0.42) | 0.17(0.37) | 0.16(0.36) |
| Percent Minority in school: less than 10 | 0.22(0.41) | 0.34(0.47) | 0.38(0.49) |
| Percent Minority in school: 10 to less than 25 | 0.15(0.36) | 0.18(0.38) | 0.19(0.39) |
| Percent Minority in school: 25 to less than 50 | 0.14(0.35) | 0.15(0.36) | 0.17(0.37) |
| Percent Minority in school: 50 to less than 75 | 0.15(0.35) | 0.10(0.3) | 0.08(0.28) |
| Percent Minority in school: 75 or more | 0.34(0.47) | 0.23(0.42) | 0.18(0.38) |
| Private school | 0.20(0.4) | 0.20(0.4) | 0.21(0.41) |
| Northeast | 0.28(0.45) | 0.20(0.4) | 0.16(0.36) |
| Midwest | 0.10(0.3) | 0.24(0.43) | 0.32(0.47) |
| South | 0.21(0.41) | 0.33(0.47) | 0.35(0.48) |
| West | 0.41(0.49) | 0.24(0.43) | 0.18(0.38) |

Note: Figures in parentheses are standard deviations

**Table 2a: Distribution of Birth Month**

| Birth Month | Percent of Sample |
|---|---|
| Jan | 7.76 |
| Feb | 8.04 |
| Mar | 8.58 |
| Apr | 8.20 |
| May | 8.75 |
| Jun | 8.74 |
| Jul | 8.68 |
| Aug | 8.79 |
| Sep | 8.56 |
| Oct | 8.18 |
| Nov | 7.58 |
| Dec | 8.13 |

## Table 2b: Descriptive Statistics, by Number of Days Between 5th Birthday and Cutoff Date (Instrument 1)

| | 1-90 days | 91-182 days | 183-274 days | 275-365 days |
|---|---|---|---|---|
| Female | 0.5(0.5) | 0.5(0.5) | 0.5(0.5) | 0.49(0.5) |
| White | 0.58(0.49) | 0.58(0.49) | 0.59(0.49) | 0.59(0.49) |
| Black | 0.13(0.34) | 0.15(0.36) | 0.14(0.34) | 0.14(0.35) |
| Hispanic | 0.18(0.38) | 0.17(0.37) | 0.17(0.38) | 0.17(0.38) |
| Other | 0.11(0.31) | 0.11(0.31) | 0.1(0.3) | 0.1(0.3) |
| Disabled | 0.13(0.33) | 0.13(0.34) | 0.12(0.33) | 0.12(0.33) |
| Below poverty line | 0.19(0.39) | 0.19(0.39) | 0.18(0.38) | 0.18(0.38) |
| Number of siblings in household | 1.44(1.12) | 1.43(1.13) | 1.44(1.14) | 1.38(1.07) |
| Number of adults in household | 2.03(0.65) | 2.04(0.68) | 2.04(0.66) | 2.03(0.63) |
| Mother's education: less than high school | 0.13(0.34) | 0.12(0.32) | 0.11(0.32) | 0.12(0.33) |
| Mother's education: high school degree | 0.39(0.49) | 0.39(0.49) | 0.38(0.48) | 0.37(0.48) |
| Mother's education: some college | 0.25(0.43) | 0.26(0.44) | 0.27(0.44) | 0.26(0.44) |
| Mother's education: BA or higher | 0.23(0.42) | 0.23(0.42) | 0.24(0.43) | 0.25(0.43) |
| Primary language not English | 0.13(0.33) | 0.12(0.32) | 0.11(0.32) | 0.11(0.31) |
| School size: 0-149 students | 0.06(0.25) | 0.06(0.23) | 0.06(0.23) | 0.06(0.24) |
| School size: 150-299 students | 0.18(0.39) | 0.18(0.38) | 0.2(0.4) | 0.2(0.4) |
| School size: 300-499 students | 0.28(0.45) | 0.27(0.45) | 0.29(0.45) | 0.28(0.45) |
| School size: 500-699students | 0.3(0.46) | 0.31(0.46) | 0.3(0.46) | 0.3(0.46) |
| School size: 750 and above students | 0.17(0.38) | 0.17(0.38) | 0.16(0.36) | 0.16(0.37) |
| Percent Minority in school: less than 10 | 0.34(0.47) | 0.33(0.47) | 0.36(0.48) | 0.35(0.48) |
| Percent Minority in school: 10 to less than 25 | 0.19(0.39) | 0.18(0.39) | 0.18(0.38) | 0.18(0.38) |
| Percent Minority in school: 25 to less than 50 | 0.16(0.37) | 0.16(0.37) | 0.15(0.36) | 0.16(0.36) |
| Percent Minority in school: 50 to less than 75 | 0.1(0.29) | 0.1(0.3) | 0.1(0.3) | 0.1(0.3) |
| Percent Minority in school: 75 or more | 0.22(0.41) | 0.23(0.42) | 0.21(0.41) | 0.21(0.41) |
| Private school | 0.2(0.4) | 0.19(0.39) | 0.21(0.41) | 0.21(0.41) |
| Northeast | 0.16(0.37) | 0.19(0.39) | 0.2(0.4) | 0.19(0.39) |
| Midwest | 0.26(0.44) | 0.26(0.44) | 0.27(0.44) | 0.26(0.44) |
| South | 0.34(0.48) | 0.33(0.47) | 0.3(0.46) | 0.33(0.47) |
| West | 0.23(0.42) | 0.22(0.41) | 0.24(0.42) | 0.22(0.42) |

Note: Figures in parentheses are standard deviations.

## Table 3: State Kindergarten Entrance Age Policies, 1998

| State | State Cutoff Date to Complete 5 Years of Age | Age at which Child Must be in Kindergarten |
|---|---|---|
| Alabama | 1-Sep | 7 |
| Alaska | 15-Aug | 7 |
| Arizona | 1-Sep | 6 |
| Arkansas | 15-Sep | 5 |
| California | 2-Dec | 6 |
| Colorado | LEA Option | 7 |
| Connecticut | 1-Jan | 7 |
| Delaware | 31-Aug | 5 |
| District Of Columbia | 31-Dec | 5 |
| Florida | 1-Sep | 6 |
| Georgia | 1-Sep | 7 |
| Hawaii | 31-Dec | 6 |
| Idaho | 1-Sep | 7 |
| Illinois | 1-Sep | 7 |
| Indiana | 1-Jun | 7 |
| Iowa | 15-Sep | 6 |
| Kansas | 31-Aug | 7 |
| Kentucky | 1-Oct | 6 |
| Louisiana | 30-Sep | 6 |
| Maine | 15-Oct | 7 |
| Maryland | 31-Dec | 5 |
| Massachusetts | LEA Option | 6 |
| Michigan | 1-Dec | 6 |
| Minnesota | 1-Sep | 7 |
| Mississippi | 1-Sep | 6 |
| Missouri | 1-Aug | 7 |
| Montana | 10-Sep | 7 |
| Nebraska | 15-Oct | 7 |
| Nevada | 30-Sep | 7 |
| New Hampshire | LEA Option | 6 |
| New Jersey | LEA Option | 6 |
| New Mexico | 1-Sep | 5 |
| New York | 1-Dec | 6 |
| North Carolina | 16-Oct | 7 |
| North Dakota | 31-Aug | 7 |
| Ohio | 30-Sep | 6 |
| Oklahoma | 1-Sep | 5 |
| Oregon | 1-Sep | 7 |
| Pennsylvania | LEA Option | 8 |
| Rhode Island | 31-Dec | 6 |
| South Carolina | 1-Sep | 5 |

## Table 3: State Kindergarten Entrance Age Policies, 1998 (Contd.)

| State | State Cutoff Date to Complete 5 Years of Age | Age at which Child Must be in Kindergarten |
|---|---|---|
| South Dakota | 1-Sep | 6 |
| Tennessee | 30-Sep | 6 |
| Texas | 1-Sep | 6 |
| Utah | 2-Sep | 6 |
| Vermont | 1-Jan | 7 |
| Virginia | 30-Sep | 5 |
| Washington | 31-Aug | 8 |
| West Virginia | 1-Sep | 6 |
| Wisconsin | 1-Sep | 6 |
| Wyoming | 15-Sep | 6 |

Source: State Departments of Education, CCSSO Policies and Practices Survey, 1998. Council of Chief State School Officers, State Education Assessment Center, Washington, DC.

**Table 4: OLS and IV Estimates for Math Achievement [a]**

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | Fall K | Spring K | Spring G1 | Fall K | Spring K | Spring G1 |
| K Entrance Age (months) | 0.453** | 0.508** | 0.406** † | 0.510** | 0.633** | 0.514** |
| | (0.013) | (0.016) | (0.017) | (0.018) | (0.022) | (0.024) |
| Time in school (months)[b] | 1.197** | 0.977** | 0.864** | 1.193** | 0.990** | 0.882** |
| | (0.064) | (0.067) | (0.079) | (0.064) | (0.067) | (0.079) |
| Female | 0.039 | -0.113 | -0.378** | 0.064 | -0.064 | -0.329* |
| | (0.104) | (0.128) | (0.136) | (0.104) | (0.129) | (0.136) |
| Race[c] | | | | | | |
| Black | -2.011** | -3.475** | -4.147** | -1.960** | -3.373** | -4.050** |
| | (0.194) | (0.240) | (0.254) | (0.196) | (0.242) | (0.256) |
| Hispanic | -2.239** | -2.685** | -2.268** | -2.212** | -2.650** | -2.230** |
| | (0.191) | (0.236) | (0.250) | (0.192) | (0.237) | (0.250) |
| Other | -0.504** | -0.534* | -1.226** | -0.474* | -0.483* | -1.185** |
| | (0.194) | (0.240) | (0.254) | (0.195) | (0.240) | (0.254) |
| Disabled | -2.064** | -2.562** | -2.856** | -2.096** | -2.640** | -2.909** |
| | (0.158) | (0.195) | (0.207) | (0.159) | (0.196) | (0.207) |
| Below poverty | -1.591** | -1.895** | -2.092** | -1.595** | -1.903** | -2.087** |
| | (0.154) | (0.190) | (0.201) | (0.154) | (0.191) | (0.201) |
| Number of siblings in household | -0.233** | -0.196** | -0.059 | -0.241** | -0.218** | -0.078 |
| | (0.048) | (0.059) | (0.063) | (0.048) | (0.059) | (0.063) |
| Number of adults in household | 0.039 | 0.111 | 0.002 | 0.048 | 0.129 | 0.019 |
| | (0.081) | (0.099) | (0.105) | (0.081) | (0.100) | (0.105) |
| Mother's education[d] | | | | | | |
| High school degree | 1.421** | 1.919** | 2.238** | 1.419** | 1.910** | 2.232** |
| | (0.185) | (0.228) | (0.241) | (0.185) | (0.228) | (0.241) |
| Some college | 2.964** | 3.789** | 4.265** | 2.973** | 3.808** | 4.286** |
| | (0.201) | (0.248) | (0.262) | (0.201) | (0.248) | (0.262) |
| Bachelor's degree or more | 5.715** | 6.737** | 6.786** | 5.734** | 6.760** | 6.824** |
| | (0.211) | (0.260) | (0.275) | (0.211) | (0.261) | (0.276) |
| Primary language spoken at home not English | -0.498* | -0.668** | 0.301 | -0.509* | -0.675** | 0.303 |
| | (0.204) | (0.251) | (0.266) | (0.204) | (0.252) | (0.267) |
| School size[e] | | | | | | |
| 0-149 students | -0.244 | -0.116 | -0.780* | -0.254 | -0.117 | -0.748* |
| | (0.243) | (0.299) | (0.317) | (0.245) | (0.303) | (0.320) |
| 150-299 students | -0.600** | -0.177 | -0.575** | -0.629** | -0.224 | -0.607** |
| | (0.164) | (0.202) | (0.213) | (0.164) | (0.203) | (0.214) |
| 300-499 students | 0.070 | 0.106 | 0.178 | 0.053 | 0.060 | 0.133 |
| | (0.138) | (0.170) | (0.180) | (0.138) | (0.171) | (0.181) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 750 and above | 0.429** | 0.593** | 0.569** | 0.425** | 0.581** | 0.558** |
| | (0.160) | (0.197) | (0.209) | (0.160) | (0.198) | (0.209) |
| Percent minority in school[f] | | | | | | |
| 10 to less than 25 | 0.728** | 0.580** | 0.295 | 0.672** | 0.508** | 0.231 |
| | (0.155) | (0.191) | (0.202) | (0.156) | (0.192) | (0.203) |
| 25 to less than 50 | 0.265 | 0.442* | 0.161 | 0.239 | 0.398 | 0.113 |
| | (0.171) | (0.211) | (0.223) | (0.172) | (0.212) | (0.224) |
| 50 to less than75 | -0.867** | -0.682** | -1.106** | -0.864** | -0.659* | -1.097** |
| | (0.210) | (0.259) | (0.275) | (0.211) | (0.261) | (0.276) |
| 75 or more | -0.767** | -0.651** | -1.458** | -0.756** | -0.610* | -1.440** |
| | (0.199) | (0.245) | (0.260) | (0.200) | (0.247) | (0.262) |
| Private school | 2.123** | 2.240** | 1.334** | 2.109** | 2.256** | 1.374** |
| | (0.146) | (0.180) | (0.191) | (0.147) | (0.182) | (0.192) |
| Region[g] | | | | | | |
| North east | -0.061 | -0.695** | -0.622** | -0.070 | -0.702** | -0.628** |
| | (0.173) | (0.214) | (0.226) | (0.174) | (0.215) | (0.227) |
| Mid-west | -0.599** | -0.567** | -0.374 | -0.716** | -0.808** | -0.576** |
| | (0.165) | (0.204) | (0.216) | (0.167) | (0.207) | (0.218) |
| South | -0.577** | -0.186 | 0.235 | -0.636** | -0.309 | 0.131 |
| | (0.153) | (0.189) | (0.200) | (0.154) | (0.190) | (0.201) |
| Constant | -13.330** | -14.788** | -1.657 | -16.938** | -22.955** | -8.966** |
| | (0.910) | (1.252) | (2.019) | (1.235) | (1.631) | (2.329) |
| R-squared | 0.30 | 0.27 | 0.23 | 0.30 | 0.27 | 0.23 |
| Observations | 13788 | 13788 | 13788 | 13723 | 13723 | 13723 |

Note: Figures in parentheses are standard errors. Significance levels: * 0.05 level, ** 0.01 level.

[a] OLS estimates are generated from a SUR model; IV estimates are generated from a 3SLS estimation of the system of equations (1)-(3).

[b] Time in school measures the time in months between the assessment date and the school start date.

[c] Omitted race category is—white.

[d] Omitted category for mother's education is—less than high school.

[e] Omitted category for school size is—500-749 students.

[f] Omitted category for percent minority in school is—less than 10 percent.

[g] Omitted category for region is—west.

[†] Difference between Fall K estimate and Spring G1 estimate is statistically significant at 5% level.

## Table 5: OLS and IV Estimates for Reading Achievement [a]

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | Fall K | Spring K | Spring G1 | Fall K | Spring K | Spring G1 |
| K Entrance Age (months) | 0.387** | 0.450** | 0.459** † | 0.455** | 0.565** | 0.570** † |
| | (0.017) | (0.022) | (0.027) | (0.024) | (0.031) | (0.038) |
| Time in school (months)[b] | 2.117** | 1.306** | 1.218** | 2.114** | 1.306** | 1.255** |
| | (0.082) | (0.087) | (0.127) | (0.082) | (0.087) | (0.127) |
| Female | 1.431** | 2.109** | 2.638** | 1.447** | 2.139** | 2.666** |
| | (0.136) | (0.173) | (0.214) | (0.136) | (0.174) | (0.215) |
| Race[c] | | | | | | |
| Black | -0.921** | -2.304** | -2.842** | -0.908** | -2.343** | -2.747** |
| | (0.251) | (0.320) | (0.395) | (0.252) | (0.322) | (0.398) |
| Hispanic | -1.551** | -1.533** | -1.524** | -1.517** | -1.517** | -1.478** |
| | (0.249) | (0.318) | (0.393) | (0.249) | (0.318) | (0.393) |
| Other | 0.191 | 0.601 | 0.081 | 0.233 | 0.640* | 0.128 |
| | (0.252) | (0.321) | (0.397) | (0.252) | (0.321) | (0.397) |
| Disabled | -2.030** | -2.969** | -4.201** | -2.073** | -3.041** | -4.279** |
| | (0.204) | (0.260) | (0.322) | (0.205) | (0.261) | (0.323) |
| Below poverty | -1.798** | -2.366** | -4.006** | -1.803** | -2.365** | -4.021** |
| | (0.209) | (0.266) | (0.329) | (0.208) | (0.266) | (0.329) |
| Number of siblings in household | -0.716** | -0.741** | -0.575** | -0.723** | -0.750** | -0.578** |
| | (0.063) | (0.081) | (0.100) | (0.063) | (0.081) | (0.100) |
| Number of adults in household | 0.183 | 0.305* | 0.502** | 0.193 | 0.316* | 0.514** |
| | (0.108) | (0.138) | (0.171) | (0.108) | (0.138) | (0.171) |
| Mother's education[d] | | | | | | |
| High school degree | 1.793** | 2.685** | 4.125** | 1.794** | 2.695** | 4.132** |
| | (0.256) | (0.327) | (0.404) | (0.256) | (0.326) | (0.404) |
| Some college | 3.598** | 4.822** | 6.741** | 3.606** | 4.855** | 6.802** |
| | (0.273) | (0.348) | (0.430) | (0.273) | (0.348) | (0.430) |
| Bachelor's degree or more | 6.986** | 8.439** | 10.628** | 7.004** | 8.475** | 10.710** |
| | (0.285) | (0.363) | (0.450) | (0.285) | (0.363) | (0.450) |
| Primary language spoken at home not English | -0.299 | 0.311 | 1.498** | -0.377 | 0.233 | 1.487** |
| | (0.294) | (0.375) | (0.465) | (0.294) | (0.375) | (0.465) |
| School size[e] | | | | | | |
| 0-149 students | -0.107 | 0.079 | -1.264** | -0.118 | 0.148 | -1.138* |
| | (0.310) | (0.395) | (0.489) | (0.312) | (0.398) | (0.493) |
| 150-299 students | -0.864** | -0.205 | -0.506 | -0.879** | -0.212 | -0.515 |
| | (0.211) | (0.269) | (0.333) | (0.212) | (0.270) | (0.334) |
| 300-499 students | 0.013 | 0.456* | 0.184 | 0.000 | 0.452* | 0.137 |
| | (0.179) | (0.228) | (0.282) | (0.179) | (0.228) | (0.282) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 750 and above | 0.717** | 1.231** | 0.879* | 0.713** | 1.237** | 0.860* |
| | (0.216) | (0.276) | (0.341) | (0.216) | (0.275) | (0.341) |
| Percent minority in school[f] | | | | | | |
| 10 to less than 25 | 1.018** | 0.707** | 0.469 | 0.980** | 0.640* | 0.340 |
| | (0.197) | (0.252) | (0.311) | (0.198) | (0.253) | (0.313) |
| 25 to less than 50 | 0.779** | 1.088** | 0.269 | 0.770** | 1.086** | 0.174 |
| | (0.219) | (0.280) | (0.346) | (0.220) | (0.280) | (0.346) |
| 50 to less than75 | -0.438 | 0.059 | -1.723** | -0.403 | 0.137 | -1.745** |
| | (0.273) | (0.349) | (0.431) | (0.274) | (0.349) | (0.432) |
| 75 or more | -0.536* | 0.009 | -2.549** | -0.484 | 0.131 | -2.564** |
| | (0.260) | (0.332) | (0.411) | (0.262) | (0.334) | (0.413) |
| Private school | 2.605** | 2.822** | 2.641** | 2.577** | 2.760** | 2.724** |
| | (0.187) | (0.239) | (0.295) | (0.188) | (0.240) | (0.296) |
| Region[g] | | | | | | |
| North east | 0.084 | -0.840** | -0.951** | 0.076 | -0.832** | -0.937** |
| | (0.228) | (0.291) | (0.359) | (0.228) | (0.291) | (0.359) |
| Mid-west | -1.039** | -1.461** | -1.900** | -1.159** | -1.673** | -2.118** |
| | (0.216) | (0.276) | (0.341) | (0.218) | (0.278) | (0.344) |
| South | -0.433* | -0.039 | -0.562 | -0.491* | -0.148 | -0.639* |
| | (0.204) | (0.261) | (0.322) | (0.205) | (0.261) | (0.323) |
| Constant | -9.470** | -11.085** | -3.065 | -13.820** | -18.522** | -11.022** |
| | (1.196) | (1.682) | (3.230) | (1.638) | (2.213) | (3.735) |
| R-squared | 0.22 | 0.18 | 0.19 | 0.22 | 0.18 | 0.19 |
| Observations | 13051 | 13051 | 13051 | 12986 | 12986 | 12986 |

Note: Figures in parentheses are standard errors. Significance levels: * 0.05 level, ** 0.01 level.

[a] OLS estimates are generated from a SUR model; IV estimates are generated from a 3SLS estimation of the system of equations (1)-(3).

[b] Time in school measures the time in months between the assessment date and the school start date.

[c] Omitted race category is—white.

[d] Omitted category for mother's education is—less than high school.

[e] Omitted category for school size is—500-749 students.

[f] Omitted category for percent minority in school is—less than 10 percent.

[g] Omitted category for region is—west.

[†] Difference between Fall K estimate and Spring G1 estimate is statistically significant at 5% level.

## Table 6: OLS and IV Estimates for General Knowledge Achievement [a]

| | OLS | | | IV | | |
|---|---|---|---|---|---|---|
| | Fall K | Spring K | Spring G1 | Fall K | Spring K | Spring G1 |
| K Entrance Age (months) | 0.489** | 0.465** | 0.330** † | 0.535** | 0.530** | 0.390** † |
| | (0.013) | (0.013) | (0.013) | (0.018) | (0.019) | (0.018) |
| Time in school (months)[b] | 0.845** | 0.397** | 0.416** | 0.842** | 0.403** | 0.423** |
| | (0.062) | (0.055) | (0.055) | (0.062) | (0.055) | (0.056) |
| Female | -0.255* | -0.359** | -0.742** | -0.248* | -0.337** | -0.726** |
| | (0.104) | (0.107) | (0.101) | (0.104) | (0.107) | (0.102) |
| Race[c] | | | | | | |
| Black | -3.866** | -4.216** | -3.678** | -3.766** | -4.081** | -3.569** |
| | (0.191) | (0.197) | (0.187) | (0.193) | (0.198) | (0.189) |
| Hispanic | -1.820** | -1.717** | -1.409** | -1.787** | -1.661** | -1.366** |
| | (0.190) | (0.195) | (0.186) | (0.191) | (0.196) | (0.187) |
| Other | -2.605** | -2.521** | -1.826** | -2.557** | -2.455** | -1.772** |
| | (0.192) | (0.198) | (0.188) | (0.193) | (0.198) | (0.188) |
| Disabled | -2.116** | -2.528** | -2.185** | -2.156** | -2.582** | -2.240** |
| | (0.156) | (0.161) | (0.153) | (0.157) | (0.161) | (0.154) |
| Below poverty | -1.754** | -1.809** | -2.072** | -1.764** | -1.817** | -2.076** |
| | (0.159) | (0.164) | (0.156) | (0.160) | (0.164) | (0.156) |
| Number of siblings in household | -0.434** | -0.450** | -0.392** | -0.443** | -0.463** | -0.402** |
| | (0.048) | (0.050) | (0.047) | (0.049) | (0.050) | (0.047) |
| Number of adults in household | 0.231** | 0.294** | 0.338** | 0.243** | 0.309** | 0.352** |
| | (0.083) | (0.085) | (0.081) | (0.083) | (0.085) | (0.081) |
| Mother's education[d] | | | | | | |
| High school degree | 1.456** | 1.386** | 1.613** | 1.457** | 1.403** | 1.628** |
| | (0.196) | (0.201) | (0.191) | (0.196) | (0.201) | (0.191) |
| Some college | 3.010** | 3.280** | 3.453** | 3.020** | 3.303** | 3.481** |
| | (0.208) | (0.214) | (0.204) | (0.209) | (0.214) | (0.204) |
| Bachelor's degree or more | 5.808** | 6.009** | 5.453** | 5.815** | 6.025** | 5.470** |
| | (0.218) | (0.224) | (0.213) | (0.218) | (0.224) | (0.213) |
| Primary language spoken at home not English | -3.347** | -2.954** | -1.976** | -3.369** | -2.967** | -1.996** |
| | (0.225) | (0.231) | (0.220) | (0.225) | (0.231) | (0.220) |
| School size[e] | | | | | | |
| 0-149 students | -0.106 | -0.034 | 0.318 | -0.178 | -0.089 | 0.262 |
| | (0.237) | (0.243) | (0.231) | (0.239) | (0.245) | (0.234) |
| 150-299 students | -0.498** | -0.126 | 0.123 | -0.541** | -0.197 | 0.075 |
| | (0.161) | (0.166) | (0.158) | (0.162) | (0.166) | (0.158) |
| 300-499 students | -0.072 | 0.016 | 0.082 | -0.106 | -0.029 | 0.043 |
| | (0.137) | (0.140) | (0.134) | (0.137) | (0.141) | (0.134) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 750 and above | -0.061 | 0.184 | 0.212 | -0.082 | 0.152 | 0.187 |
| | (0.165) | (0.170) | (0.161) | (0.165) | (0.170) | (0.162) |
| Percent minority in school[f] | | | | | | |
| 10 to less than 25 | 0.364* | 0.505** | 0.426** | 0.324* | 0.439** | 0.382** |
| | (0.151) | (0.155) | (0.147) | (0.152) | (0.156) | (0.148) |
| 25 to less than 50 | -0.247 | -0.181 | -0.476** | -0.284 | -0.239 | -0.519** |
| | (0.168) | (0.172) | (0.164) | (0.168) | (0.173) | (0.164) |
| 50 to less than75 | -1.132** | -0.894** | -1.054** | -1.148** | -0.926** | -1.070** |
| | (0.209) | (0.214) | (0.204) | (0.210) | (0.215) | (0.205) |
| 75 or more | -2.292** | -2.652** | -2.911** | -2.319** | -2.699** | -2.938** |
| | (0.199) | (0.204) | (0.194) | (0.200) | (0.206) | (0.196) |
| Private school | 1.420** | 1.081** | 0.752** | 1.441** | 1.108** | 0.780** |
| | (0.143) | (0.147) | (0.139) | (0.144) | (0.148) | (0.140) |
| Region[g] | | | | | | |
| North east | 0.277 | 0.079 | -0.325 | 0.260 | 0.057 | -0.343* |
| | (0.174) | (0.179) | (0.170) | (0.174) | (0.179) | (0.170) |
| Mid-west | -0.671** | -0.385* | -0.108 | -0.762** | -0.519** | -0.224 |
| | (0.165) | (0.170) | (0.161) | (0.167) | (0.171) | (0.163) |
| South | -0.909** | -0.811** | -0.412** | -0.941** | -0.854** | -0.457** |
| | (0.156) | (0.160) | (0.153) | (0.157) | (0.161) | (0.153) |
| Constant | -11.025** | -6.015** | 4.877** | -13.989** | -10.202** | 0.871 |
| | (0.915) | (1.041) | (1.452) | (1.254) | (1.369) | (1.700) |
| R-squared | 0.38 | 0.38 | 0.35 | 0.38 | 0.38 | 0.35 |
| Observations | 13008 | 13008 | 13008 | 12944 | 12944 | 12944 |

Note: Figures in parentheses are standard errors. Significance levels: * 0.05 level, ** 0.01 level.

[a] OLS estimates are generated from a SUR model; IV estimates are generated from a 3SLS estimation of the system of equations (1)-(3).

[b] Time in school measures the time in months between the assessment date and the school start date.

[c] Omitted race category is—white.

[d] Omitted category for mother's education is—less than high school.

[e] Omitted category for school size is—500-749 students.

[f] Omitted category for percent minority in school is—less than 10 percent.

[g] Omitted category for region is—west.

[†] Difference between Fall K estimate and Spring G1 estimate is statistically significant at 5% level.

## Table 7: Effect of a 1-Year Delay in Kindergarten Entrance on Academic Achievement, by Poverty Status

| | Fall Kindergarten | Spring Grade 1 | $H_0$: $\delta$ (Fall K) = $\delta$ (Spring G1)[a] |
|---|---|---|---|
| **Math** | | | |
| Below poverty line | 4.692 ** | 7.092 ** | 0.000 |
| | (0.36) | (0.636) | |
| On or above poverty line | 6.528 ** | 5.964 ** | 0.031 |
| | (0.264) | (0.324) | |
| $H_0$: $\delta$(below pov.) = $\delta$(above pov.)[b] | 0.000 | 0.114 | |
| **Reading** | | | |
| Below poverty line | 3.204 ** | 6.144 ** | 0.001 |
| | (0.468) | (1.032) | |
| On or above poverty line | 5.976 ** | 7.044 ** | 0.009 |
| | (0.336) | (0.504) | |
| $H_0$: $\delta$(below pov.) = $\delta$(above pov.)[b] | 0.000 | 0.433 | |
| **General Knowledge** | | | |
| Below poverty line | 4.632 ** | 4.524 ** | 0.794 |
| | (0.432) | (0.528) | |
| On or above poverty line | 6.852 ** | 4.728 ** | 0.000 |
| | (0.252) | (0.24) | |
| $H_0$: $\delta$(below pov.) = $\delta$(above pov.)[b] | 0.000 | 0.725 | |

Note: Estimates reported here show the IV estimates of the effect of delaying kindergarten entrance by one year. Standard errors are reported in parentheses. Significance levels: * 0.05 level, ** 0.01 level.

[a,b] Figures reported are p-values for a two tailed test at 5% level of significance.

## Table 8: Effect of a 1-Year Delay in Kindergarten Entrance on Academic Achievement, by Disability Status

| | Fall Kindergarten | Spring Grade 1 | $H_0$: $\delta$ (Fall K) = $\delta$ (Spring G1)[a] |
|---|---|---|---|
| **Math** | | | |
| Disabled | 4.632 ** | 6.228 ** | 0.033 |
| | (0.648) | (0.972) | |
| Not disabled | 6.3 ** | 6.168 ** | 0.565 |
| | (0.228) | (0.30) | |
| $H_0$: $\delta$(disabled) = $\delta$(not disabled)[b] | 0.015 | 0.953 | |
| **Reading** | | | |
| Disabled | 3.072 ** | 6.42 ** | 0.004 |
| | (0.804) | (1.44) | |
| Not disabled | 5.76 ** | 6.912 ** | 0.003 |
| | (0.312) | (0.48) | |
| $H_0$: $\delta$(disabled) = $\delta$(not disabled)[b] | 0.002 | 0.746 | |
| **General Knowledge** | | | |
| Disabled | 5.208 ** | 4.2 ** | 0.067 |
| | (0.72) | (0.744) | |
| Not disabled | 6.588 ** | 4.764 ** | 0.000 |
| | (0.228) | (0.228) | |
| $H_0$: $\delta$(disabled) = $\delta$(not disabled)[b] | 0.068 | 0.469 | |

Note: Estimates reported here show the IV estimates of the effect of delaying kindergarten entrance by one year. Standard errors are reported in parentheses. Significance levels: * 0.05 level, ** 0.01 level.

[a,b] Figures reported are p-values for a two tailed test at 5% level of significance.

## Table 9: Effect of a 1-Year Delay in Kindergarten Entrance on Academic Achievement, by Gender

| | Fall Kindergarten | Spring Grade 1 | $H_0$: ♌ (Fall K) = ♌ (Spring G1)[a] |
|---|---|---|---|
| **Math** | | | |
| Female | 6.024 ** | 5.928 ** | 0.756 |
| | (0.276) | (0.372) | |
| Male | 6.192 ** | 6.384 ** | 0.581 |
| | (0.336) | (0.444) | |
| $H_0$: ♌(male) = ♌(female)[b] | 0.699 | 0.431 | |
| **Reading** | | | |
| Female | 6.156 ** | 6.204 ** | 0.929 |
| | (0.384) | (0.6) | |
| Male | 4.716 ** | 7.452 ** | 0.000 |
| | (0.432) | (0.696) | |
| $H_0$: ♌(male) = ♌(female)[b] | 0.013 | 0.175 | |
| **General Knowledge** | | | |
| Female | 6.444 ** | 4.392 ** | 0.000 |
| | (0.288) | (0.3) | |
| Male | 6.396 ** | 4.992 ** | 0.000 |
| | (0.336) | (0.324) | |
| $H_0$: ♌(male) = ♌(female)[b] | 0.914 | 0.175 | |

Note: Estimates reported here show the IV estimates of the effect of delaying kindergarten entrance by one year. Standard errors are reported in parentheses. Significance levels: * 0.05 level, ** 0.01 level.

[a,b] Figures reported are p-values for a two tailed test at 5% level of significance.

**Table 10: State Kindergarten Entrance Cutoff Dates, 1998**

| State | Number of States | Cutoff Date |
|---|---|---|
| Indiana | 1 | 1-Jun |
| Puerto Rico, Missouri | 1 | 1-Aug |
| Alaska | 1 | 15-Aug |
| Delaware, Kansas, North Dakota, Washington | 4 | 31-Aug |
| Alabama, American Samoa, Arizona, Florida, Georgia, Idaho, Illinois, Minnesota, Mississippi, New Mexico, Oklahoma, Oregon, South Carolina, South Dakota, Texas, West Virginia, Wisconsin | 16 | 1-Sep |
| Utah | 1 | 2-Sep |
| Montana | 1 | 10-Sep |
| Arkansas, Iowa, Wyoming | 3 | 15-Sep |
| Louisiana, Nevada, Ohio, Tennessee, Virginia | 5 | 30-Sep |
| Kentucky | 1 | 1-Oct |
| Maine, Nebraska | 2 | 15-Oct |
| North Carolina | 1 | 16-Oct |
| Michigan, New York | 2 | 1-Dec |
| California | 1 | 2-Dec |
| Hawaii, Maryland, Rhode Island | 3 | 31-Dec |
| Connecticut, Vermont | 2 | 1-Jan |
| Colorado, Massachusetts, New Hampshire, New Jersey, Pennsylvania | 5 | LEA Option |

Note: LEA option implies that in these states the local education agency sets it own policy.
Source: State Departments of Education, Council of Chief State School Officers Policies and Practices Survey, 1998

**Table 11: State Policies for Age at which Children Must be in Kindergarten, 1998**

| State | Number of States | Age at which children must be in kindergarten |
|---|---|---|
| Arkansas, Delaware, DC, Maryland, New Mexico, Oklahoma, South Carolina, Virginia | 8 | 5 |
| Arizona, California, Florida, Hawaii, Iowa, Kentucky, Louisiana, Massachusetts, Michigan, Mississippi, New Hampshire, New Jersey, New York, Ohio, Rhode Island, South Dakota, Tennessee, Texas, Utah, West Virginia, Wisconsin, Wyoming | 22 | 6 |
| Alabama, Alaska, Colorado, Connecticut, Georgia, Idaho, Illinois, Indiana, Kansas, Maine, Minnesota, Missouri, Montana, Nebraska, Nevada, North Carolina, North Dakota, Oregon, Vermont | 19 | 7 |
| Pennsylvania, Washington | 2 | 8 |

Source: State Departments of Education, Council of Chief State School Officers Policies and Practices Survey, 1998

## Table 12: Descriptive Statistics

| | Mean | Standard Deviation |
|---|---|---|
| Kindergarten entrance age (months) | 65.116 | 4.144 |
| Female | 0.496 | 0.500 |
| Black | 0.136 | 0.343 |
| Hispanic | 0.173 | 0.379 |
| Other | 0.104 | 0.305 |
| Disabled | 0.135 | 0.342 |
| Birth weight (pounds) | 7.382 | 1.306 |
| Income quartile 1 | 0.247 | 0.431 |
| Income quartile 2 | 0.250 | 0.433 |
| Income quartile 3 | 0.273 | 0.446 |
| Income quartile 4 | 0.230 | 0.421 |
| Mother's Education: Less than high school | 0.123 | 0.328 |
| Mother's Education: High school diploma | 0.360 | 0.480 |
| Mother's Education: Some college | 0.270 | 0.444 |
| Mother's Education: Bachelor's degree or more | 0.247 | 0.431 |
| Whether father works full-time | 0.714 | 0.452 |
| Whether father works part-time | 0.028 | 0.166 |
| No father present in household | 0.218 | 0.413 |
| kid0-1 years present in household | 0.147 | 0.354 |
| kid2-4 years present in household | 0.349 | 0.477 |
| kid13-19 years present in household | 0.163 | 0.370 |
| Number of persons 20 years and older | 1.984 | 0.627 |
| Whether state offers tax credits to parents for childcare expenses | 0.335 | 0.472 |
| Whether state requires any in-service or pre-service early education training for childcare center providers | 0.930 | 0.255 |
| Whether state regulates family day care providers | 0.159 | 0.366 |
| Child-to-staff ratio required in childcare centers for 4 year olds | 12.492 | 4.348 |
| West | 0.235 | 0.424 |
| Northeast | 0.188 | 0.391 |
| Midwest | 0.261 | 0.439 |
| South | 0.315 | 0.465 |
| State average hourly wage for childcare worker | 7.611 | 0.875 |
| State average weekly wage for female 23-49 years | 493.702 | 53.667 |
| Predicted hourly price of childcare | 3.167 | 1.040 |
| Proportion using non-maternal childcare | 0.817 | 0.387 |
| Proportion using paid childcare | 0.559 | 0.496 |

## Table 13: Sample Selection Model for Childcare Prices

| | Use Paid Childcare | | Price Per Hour of Childcare | |
|---|---|---|---|---|
| | Estimate | Robust Standard Error | Estimate | Robust Standard Error |
| Female | 0.024 | (0.023) | -0.156 | (0.092) |
| Black | -0.319** | (0.040) | -0.654** | (0.166) |
| Hispanic | -0.210** | (0.035) | -0.382** | (0.140) |
| Other | -0.403** | (0.043) | -0.176 | (0.158) |
| Disabled | -0.116** | (0.032) | -0.240 | (0.125) |
| Birth weight (pounds) | 0.018* | (0.009) | 0.030 | (0.031) |
| Income quartile 2 | 0.266** | (0.034) | 0.370** | (0.132) |
| Income quartile 3 | 0.687** | (0.037) | 0.417** | (0.127) |
| Income quartile 4 | 0.995** | (0.043) | 1.228** | (0.185) |
| High School Diploma | 0.442** | (0.039) | 0.287 | (0.166) |
| Some College | 0.739** | (0.041) | 0.388* | (0.184) |
| Bachelor's Degree or more | 0.907** | (0.047) | 0.804** | (0.200) |
| Kid 0-1 years present | -0.154** | (0.031) | -0.055 | (0.130) |
| Kid 2-4 years present | -0.143** | (0.024) | -0.176* | (0.086) |
| State's average hourly wage for a childcare worker | | | 0.481** | (0.161) |
| Whether state requires any pre- or in-service early education training for childcare center providers | | | -0.001 | (0.278) |
| Whether state regulates family care providers | | | 0.492** | (0.191) |
| Child-to-staff ratio in childcare centers for 4 year olds | | | -0.047** | (0.017) |
| Whether state offers tax credits to parents for childcare expenses | 0.041 | (0.031) | -0.235* | (0.112) |
| Northeast | 0.042 | (0.043) | -0.132 | (0.224) |
| Midwest | 0.160** | (0.039) | -0.477 | (0.264) |
| South | -0.039 | (0.038) | -0.344 | (0.342) |
| Whether mom has health problems limiting work at job or business | -0.337** | (0.053) | | |
| Whether father works full-time | 0.246** | (0.060) | | |
| Whether father works part-time | 0.229** | (0.089) | | |
| No father present in household | 0.340** | (0.063) | | |
| Kid 13-19 years present | -0.289** | (0.032) | | |
| Number of persons 20 years & above | -0.091** | (0.021) | | |
| Constant | -0.894** | (0.108) | -0.419 | (1.374) |
| Rho | | | -0.041 | (0.009) |
| Sigma | | | 4.210 | (0.586) |
| Observations | 15,547 | | 15,547 | |
| Wald test of indep. eqns. (rho = 0): chi2(1) = 21.95 Prob > chi2 = 0.0000 | | | | |

Note: Standard errors in parentheses. * Significant at 5%, ** Significant at 1%.

## Table 14: Maximum Likelihood Estimates for Desired Entrance Age

| Dependent Variable: Desired Kindergarten Entrance Age | Estimate | Robust Standard Errors |
|---|---|---|
| Hourly price of childcare (predicted) | -0.503* | (0.229) |
| State average female weekly wage | -0.017** | (0.003) |
| Female | -2.315** | (0.230) |
| Black | -3.714** | (0.511) |
| Hispanic | -1.986** | (0.421) |
| Other | -3.065** | (0.527) |
| Disabled | 2.074** | (0.346) |
| Birth weight (pounds) | -0.375** | (0.087) |
| Income quartile 2 | 0.321 | (0.383) |
| Income quartile 3 | 1.453** | (0.403) |
| Income quartile 4 | 1.549** | (0.538) |
| Kid 0-1 yrs present | -0.472 | (0.349) |
| Kid 2-4 yrs present | -0.239 | (0.233) |
| Kid 13-19 yrs present | 0.953** | (0.318) |
| Number of persons 20 yrs & above | -0.510* | (0.253) |
| High School Diploma | -0.011 | (0.453) |
| Some College | 0.054 | (0.470) |
| Bachelor's Degree or more | 0.990* | (0.498) |
| Whether father works full-time | -0.131 | (0.611) |
| Whether father works part-time | -0.137 | (0.897) |
| No father present in household | -0.685 | (0.681) |
| Constant | 73.930** | (1.654) |
| Sigma | 5.543** | (0.231) |
| Observations | 15,547 | |

Note: * Significant at 5%, ** Significant at 1%

### Table 15: Estimated Number and Characteristics of Children With Desired Entrance Age Lesser than or Equal to Earliest Eligible Age (Baseline)

| Total Population = 3,316,884 | Number of children who are forced to enter school 1 year later | 95% Confidence Interval | | % of Constrained Population | % of Kindergarten Population |
|---|---|---|---|---|---|
| Total | 2,639,355 | 2,532,425 | 2,746,284 | 100.0% | 79.6% |
| Girls | 1,371,373 | 1,316,773 | 1,425,974 | 52.0% | 49.0% |
| Racial-Ethnic Composition | | | | | |
| Black | 431,980 | 358,572 | 505,388 | 16.4% | 14.7% |
| Hispanic | 530,208 | 466,486 | 593,930 | 20.1% | 18.9% |
| Other | 207,648 | 153,589 | 261,707 | 7.9% | 7.2% |
| Maternal Education | | | | | |
| Less than high school | 371,430 | 336,550 | 406,309 | 14.1% | 13.5% |
| High school diploma | 993,864 | 935,989 | 1,051,739 | 37.7% | 37.0% |
| Below poverty line | 568,275 | 500,637 | 635,914 | 21.5% | 20.2% |
| Disabled | 323,840 | 302,550 | 345,129 | 12.3% | 14.1% |

### Table 16: Simulation Results for Policy 1 – All States Set Minimum Entrance Age Requirement at 5 Years

| Total Population = 3,316,884 | Number of additional children forced to enter school 1 year later | 95% Confidence Interval | |
|---|---|---|---|
| Total | 153,189 | 129,435 | 176,945 |
| Girls | 64,761 | 54,448 | 75,072 |
| Racial-Ethnic Composition | | | |
| Black | 15,523 | 11,137 | 19,909 |
| Hispanic | 30,380 | 25,755 | 35,005 |
| Other | 10,601 | 5,532 | 15,669 |
| Maternal Education | | | |
| Less than high school | 21,657 | 17,752 | 25,561 |
| High school diploma | 50,923 | 41,873 | 59,974 |
| Below poverty line | 26,819 | 21,840 | 31,798 |
| Disabled | 25,876 | 20,514 | 31,238 |

## Table 17: Simulation Results for Policy 2 – All States Lower Minimum Entrance Age Requirement to 4 Years, 6 Months

| Total Population = 3,316,884 | Number of children able to enter school 1 year early | 95% Confidence Interval | |
|---|---|---|---|
| Total | 748,092 | 788,908 | 707,275 |
| Girls | 342,488 | 361,300 | 323,676 |
| Racial-Ethnic Composition | | | |
| Black | 92,661 | 110,985 | 74,336 |
| Hispanic | 115,541 | 133,357 | 97,725 |
| Other | 44,567 | 58,298 | 30,837 |
| Maternal Education | | | |
| Less than high school | 93,045 | 104,484 | 81,607 |
| High school diploma | 281,371 | 303,729 | 259,014 |
| Below poverty line | 139,018 | 156,230 | 121,806 |
| Disabled | 123,613 | 135,679 | 111,547 |

## Table 18: Simulation Results for Policy 3 – All States With December/January Cutoffs Move Cutoff Date to September 1

| Total Population = 3,316,884 | Number of additional children forced to enter school 1 year later | 95% Confidence Interval | |
|---|---|---|---|
| Total | 92,009 | 72,994 | 111,025 |
| Girls | 37,362 | 29,224 | 45,500 |
| Racial-Ethnic Composition | | | |
| Black | 7,594 | 4,896 | 10,291 |
| Hispanic | 23,386 | 19,589 | 27,182 |
| Other | 8,350 | 3,719 | 12,982 |
| Maternal Education | | | |
| Less than high school | 12,901 | 10,138 | 15,663 |
| High school diploma | 28,450 | 21,626 | 35,274 |
| Below poverty line | 13,486 | 10,472 | 16,499 |
| Disabled | 14,270 | 10,649 | 17,890 |

**Table 19: Estimated Childcare Cost Burden/Savings (Millions of dollars)**

| | Policy | Expected number of additional children forced to stay out of school for an 1 year | Expected number of children without non-maternal childcare | Expected cost of continuing current paid childcare arrangement |
|---|---|---|---|---|
| 1 | All states set minimum entrance age requirement at 5 years | 153,189 | 30,886 | $220 |
| 2 | All states reduce their minimum entrance age requirement to 4 years, 6 months | -748,092 | -137,917 | -$1010 |
| 3 | All states with December/January cutoff dates move cutoff date to September 1st | 92,009 | 19,595 | $147 |

Note: These estimates are computed assuming all parents affected by the policy change continue to use the same childcare mode.

# BIBLIOGRAPHY


Adams, Gina and Rohacek, Monica (2002). "Childcare and Welfare Reform." Brookings Institution. Welfare and Beyond Policy Brief No. 14 (February). Washington DC. < http://www.brook.edu/dybdocroot/wrb/publications/pb/pb14.pdf>

Angrist, J.D., Krueger, Alan B. (1991). Does Compulsory School Attendance Affect Schooling and Earnings? *The Quarterly Journal of Economics,* CVI(4): 979-1014.

Averett, S.L., Peters, E., Waldman, D.M. (1997). "Tax Credits, Labor Supply and Child Care." *The Review of Economics and Statistics*. 79(1):125-35.

Becker, Gary (1981). A Treatise on the Family. Harvard University Press: Cambridge MA.

Bickel, D., Zigmond, M., Strayhorn, J. (1991). Chronological age and entrance to first grade: Effects on elementary school success. *Early Childhood Research Quarterly,* 6(2): 10-117.

Bisanz, J., Dunn, M., Morrison, F.J. (1995). Effects of age and schooling on the acquisition of elementary quantitative skills. *Developmental Psychology*, 31(2): 221-236.

Blank, Helen and Nicole Oxendine Poersch. (2000). "State Developments in Child Care and Early Education 1999." Children's Defense Fund. February 2000.

Blank, Helen, Schulman, K., and Danielle Ewen (1999). *Seeds of Success: State Prekindergarten Initiatives 1998-1999*. Children's Defense Fund. Washington DC.

Blau, David M., and Robins, Philip K. (1988). "Childcare Costs and Family Labor Supply." *Research in Economics and Statistics* 70(3): 374-81.

Blau. Francine D., and Grossberg, Adam J. (1992). "Maternal Labor Supply and Children's Cognitive Development." *The Review of Economics and Statistics* Vol.74, Issue 3 (August): 474-481.

Boettger, M.A. (1994). Does an extra year (junior first grade) enhance academic ability and self-concept on academic ability? (Publication No. ED 376981). Michigan: U.S. Department of Education. Office of Research and Improvement.

Bollen, Kenneth A. (1989). *Structural Equations With Latent Variables*. New York: Chris Wiley & Sons.

Bracey, G.W. (1989). Age and achievement. *Phi Delta Kappan*, 70:732.

Breznitz, Z. & Teltsch, T. (1989). The effect of school entrance age on academic achievement and social-emotional adjustment of children: Follow-up study on fourth graders. *Psychology in the Schools*, 26: 62-68.

Byrd, R., Weitzman, M., & Auinger, P. (1997). Increased behavior problems associated with delayed school entry and delayed school progress. *Pediatrics*, 100: 664-661.

Cahan, S., & Davis, D. (1987). A between-grade-levels approach to the investigation of the absolute effects of schooling on achievement. *American Education Research Journal*, 24: 1-12.

Cameron, M., & Wilson, B. (1990). The effects of chronological age, gender, and delay of entry on academic achievement and retention: Implications for academic redshirting. *Psychology in the Schools*, 27: 260-263.

Carnegie Foundation for the Advancement of Teaching. (1991). National Survey of Kindergarten Teachers. Menlo Park, CA.

Casper, L.M. (1995). What Does it Cost to Mind Our Preschoolers? U.S. Bureau of the Census, Current Population Reports, P70-52: Washington, DC.

Cleveland, G., Gunderson, M., Hyatt, D. (1996). "Child Care Costs and the Employment Decision of Women: Canadian Evidence." *The Canadian Journal of Economics*. 29(1): 132-151.

Connelly, R., Kimmel, J. (2003). "The Effect of Child Care Costs on the Employment and Welfare Recipiency of Single Mothers." *Southern Economic Journal*. 69(3): 498-519.

Connelly, Rachel. (1992). "The Effects of Childcare Costs on Married Women's Labor Force Participation." *The Review of Economics and Statistics* Vol.74 No.1 (February): 83-90.

Connolly, S., Micklewright, J., & Nickell, S. (1992). The occupational success of young men who left school at sixteen. *Oxford Economic Papers*, 44: 460-479.

Cosden M., Zimmer J., & Tuss P. (1993). The impact of age, sex, and ethnicity on kindergarten entry and retention decisions. *Educational Evaluation and Policy Analysis*, Vol 15. No. 2 pp. 209-222.

Cost, Quality and Child Outcomes Study Team (1995). Cost, Quality and Child Outcomes in Childcare Centers: Public Report. Center for Research on Economic and Social Policy, Department of Economics, University of Colorado, Denver.

Council of Chief State School Officers (1998). Key State Education Policies on K-12 Education. Council of Chief State School Officers, State Departments of Education, Washington D.C.

Council of Chief State School Officers (2000). Key State Education Policies on K-12 Education: 2000. Council of Chief State School Officers, State Departments of Education, Washington D.C.

Crnic, K., & Lamberty G. (1994, April). Reconsidering school readiness: Conceptual and applied perspectives. Early Education and Development 5(2), 99-105. Available online: http://readyweb.crc.uiuc.edu/library/1994/crnic1.html

Crosser, S. (1991). Summer birth date children: Kindergarten entrance age and academic achievement. *Journal of Educational Research*, 84: 140-146.

Currie, J., & Thomas, D. (1999). Early test scores, socioeconomic status and future outcomes. National Bureau of Economic Research Working Paper # 6943.

Currie, Janet (Spring 2001). "Early Childhood Education Programs." Journal of Economic Perspectives Volume 15 Number 2: 213-238.

Davis, B.G, Trimble, C.S., & Vincent, D.R. (1980). Does age of entrance affect school achievement. *Elementary School Journal,* 80(3): 133-143.

De Cos, Patricia L. (1997). Readiness for Kindergarten: What Does it Mean? California Research Bureau, California State Library, CRB-97-014.

Deaton, A. (1997). The analysis of household surveys: A microeconometric approach to development policy. The World Bank. Washington, DC.

DeMeis, J.L., & Stearns, E.S. (1992). Relationship of School Entrance Age to Academic and Social Performance. *Journal of Educational Research,* 86(1): 20-27.

Diamond, Grace H. (1983). The Birthdate Effect – A Maturational Effect. *Journal of Learning Disabilities,* 16:161-164.

Dietz, C., & Wilson, B. (1985). Beginning school age and achievement. *Psychology in the Schools*, 22, 93-94.

DiPasquale, G.W., Moule, A.D., & Flewelling, R.W. (1980). The Birthdate effect. *Journal of Learning Disabilities,* 13(5): 234-248.

Eide, Eric R., & Showalter, M.H. (2001). The effect of grade retention on educational and labor market outcomes. *Economics of Education Review,* 20: 563-576.

Elkind D. (1987). Miseducation. New York: Knopf.

Evans, W.N., & Ringel, J.S. Can higher cigarette taxes improve birth outcomes? *Journal of Public Economics*, 1999;72: 135–154.

Federal Interagency Forum on Child and Family Statistics. America's Children: Key National Indicators of Well-Being, 2001. Federal Interagency Forum on Child and Family Statistics, Washington, DC: U.S. Government Printing Office.

Gelbach, Jonah B. (2002). "Public Schooling for Young Children and Maternal Labor Supply." American Economic Review March: 307-322.

Goldman, D.P., Bhattacharya, J., McCaffery, D.F., Duan, N., Leibowitz, A.A., Joyce, G.F., & Morton, S.C. (2001). Effect of insurance on mortality in an HIV-positive population in care. *Journal of American Statistical Association*, Vol 96 No 455: pp. 883-894

Graue, M.E., & DiPerna, J. (2000). Redshirting and early retention: who gets the "gift of time" and what are its outcomes? *American Educational Research Journal*, Vol. 37 No. 2. pp. 509-534.

Gredler, G.R. (1984). Transition classes: A viable alternative for the at-risk child? *Psychology in the Schools*, 21: 463-470.

Greene, William H. (2000). Econometric Analysis. Fourth Edition. Prentice Hall, Upper Saddle River, NJ.

Grissmer, D., & Flanagan, A. (2000). U.S. Department of Education. National Center for Education Statistics. Analytic Issues in the Assessment of Student Achievement, NCES 2000-050 by David W. Grissmer and J. Michael Ross. Washington, DC: 2000.

Harmon, C. & Walker, I. (1998). Selective schooling and the returns to the quantity and quality of education. Dublin: Department of Economics, University College Dublin.

Hausman, J.A. (1978). Specification tests in econometrics. *Econometrica,* 46: 1251-1271.

Hotz, V. Joseph, and Kilburn, M. Rebecca. (1995). "Regulating Childcare: Effects on Childcare Prices and Demand." RAND, Labor and Population Program Working Paper Series: 95-03.

Huntington E. (1938). Season of birth: Its relation to human abilities. New York: John Wiley.

Hutchison, D., Prosser, H., & Wedge, P. (1979). The prediction of educational failure. *Educational Studies*, 5(1).

Jones, M., & Mandeville, K. (1990). The effect of age at school entry on reading achievement scores among South Carolina students. *Remedial and Special Education*, 11: 56-62.

Karoly, Lynn et al. (1998). Investing in our Children: What we Know and Don't Know About the Costs and Benefits of Early Childhood Interventions. Santa Monica: RAND.

Kennedy, J. (1975). "Kindergarten and First Grade Minimum Entrance Age Policies". Arlington, VA: Educational Research Service, 2.

Kimmel, J. (1998). "Child Care Costs and Barriers to Employment for Single and Married Mothers." The Review of Economics and Statistics. 80(2):287-99.

Kinard, E.M., & Reinherz, H. (1986), "Birthdate Effects on School Performance and Adjustment: A Longitudinal Study," *Journal of Educational Research,* 79(6): 366-372.

Kundert, D., May, D., & Brent, D. (1995). A comparison of students who delay kindergarten entry and those who are retained in grades K-5. *Psychology in the Schools*, 32: 202-209.

Langer, P., Kalk, J.M., & Searls, D.T. (1984). Age of admission and trends in achievement: A comparison of blacks and Caucasians. *American Educational research Journal,* 21(1): 61-78.

Leibowitz, Arleen, Klerman, Jacob A., and Waite, Linda J. (1992). "Employment of New Mothers and Childcare Choices: Differences by Children's Age." Journal of Human Resources 27(1): 112-33.

Leinhardt, G. (1980). Transition rooms: Promoting maturation or reducing education? *Journal of Educational Psychology*, 72: 55-61.

Lord, F.M. (1980). Applications of Item Response Theory to practical testing problems. Hillsdale, NJ: Lawrence Erlbaum Publishers.

Maddala, G.S. (1986). Limited-Dependent and Qualitative Variables in Econometrics, Cambridge University Press, Cambridge.

Maddux, C.D. (1980). First grade entry age in a sample of children labeled learning disabled. *Learning Disability Quarterly,* 3: 79-83.

May, D., Kundert, D., & Brent, D. (1995). Does delayed school entry reduce later grade retentions and use of special education services? *Remedial and Special Education*, 16: 288-294.

Mayer, S.E., & Knutson, D. (1998). Does age at enrollment in first grade affect children's cognitive test scores? Working Paper. Northwestern University-University of Chicago. Joint Center for Poverty Research.

Mayer, S.E., & Knutson, D. (1999). Does the timing of school affect learning? in S. E. Mayer and P.E. Peterson (eds) Earning and Learning: How Schools Matter. Brookings Institution Press. Washington DC. Russell Sage Foundation. New York NY.

McArthur, E.K. and Bianchi, S.M. (1993). "Characteristics of Children Who are Behind in School." Alexandria, VA: American Statistical Association, 1993 Proceedings of the Social Statistics Section.

McClelland, M., Morrison, F., & Holmes, D. (2000). Children at risk for early academic problems: The role of learning related social skills. *Early Childhood Research Quarterly,* 7: 155-174.

Mehaffie, Kelley E., McCall, Robert E. (2002). "Kindergarten Readiness: An Overview of Issues and Assessment." Special Report. University of Pittsburg Office of Child Development. University Center for Social and Urban Research.

Michalopolous, C., Robins, Phillip K., Irwin Garfinkel. (1992). "A Structural Model of Labor Supply and Child Care Demand." The Journal of Human Resources. 27(1): 166-203.

Morrison, F.J., Griffith, E.M., & Alberts, D.M. (1997). Nature-nurture in the classroom: Entrance age, school readiness, and learning in children. *Developmental Psychology*, 33(2): 254-262.

Morrison, F.J., Smith, L., & Dow-Ehrensberger, M. (1995). Education and cognitive development: A Natural Experiment. *Developmental Psychology*, 31(5): 789-799.

National Center for Education Statistics (1993). Public School Kindergarten Teacher's Views on Children's Readiness for School. Publication No. NCES 93410. Washington, DC: National Center for Education Statistics.

National Center for Education Statistics (1999). ECLS-K Base Year Data Files and Codebook. National Center for Educational Statistics. Washington DC.

National Education Goals Panel (1999). The National Education Goals Report: Building a Nation of Learners, 1999. Washington DC: U.S. Government Printing Office.

Powell, Lisa M. (1997). "The Impact of Child Care Costs on the Labour Supply of Married Mothers: Evidence from Canada." The Canadian Journal of Economics. 30(3):106-128.

Powell, Lisa M. (2002). "Joint Labor Supply and Childcare Choice Decisions of Married Mothers." The Journal of Human Resources. 37(1):106-128.

Ribar, D. (1992). "Childcare and the Labor Supply of Married Women: Reduced Form Evidence." Journal of Human Resources, Winter.

Robertson, D., & Symons, J. (1996). Do peer groups matter? Peer group versus schooling effects on academic achievement. London: Center for Economic Performance, London School of Economics, Working Paper # 311.

Saluja, G., Scott-Little, C., Clifford, R.M. (2000). "Readiness for School: A Survey of State Policies and Definitions." Early Childhood Research and Practice. 2(2). Retrieved July 3, 2003, from ecrp.uiuc.edu/v2n2/saluja.html.

Schulman, Karen. (2000). The High Cost of Childcare Puts Quality Care Out of Reach for Many Families. Children's Defense Fund, Issue Brief.

Seigel, G. and Loman, A. (1991). Child Care and AFDC Recipients in Illinois. Illinois: Illinois Department of Public Aid.

Shepard, L.A., & Smith, M.L. (1986). Synthesis of Research on School Readiness and Kindergarten. *Educational Leadership,* 44(3): 78-86.

Shepard, L.A., Taylor, G.A., Kagan, S. L. (1996). "Trends in Early Childhood Assessment Policies and Practices. Unpublished Manuscript.

Spitzer, Sue, et al. (1995). School entrance age, social acceptance, and self perception in kindergarten and 1st grade. *Early Childhood Research Quarterly*, 10(4): 433-450.

StataCorp (2001). Stata Statistical Software: Release 7.0. College Station, TX: Stata Corporation.

Stipek, D., & Byler, P. (2001). Academic achievement and social behaviors associated with age of entry into kindergarten. *Journal of Applied Developmental Psychology*, 22: 175-189.

Stipek, Deborah (2002). At What Age Should Children Enter Kindergarten? A Question for Policy Makers and Parents. *Social Policy Report*, Society for Research in Child Development. Volume XVI No. 2.

Sweetland, J., & De Simone, P. (1987). Age of entry, sex, and academic achievement in elementary school children. *Psychology in the Schools*, 234: 406-412.

U.S. Department of Education. National Center for Education Statistics (1997). The Elementary School Performance and Adjustment if Children Who Enter Kindergarten Late or Repeat Kindergarten: Findings from National Surveys. NCES 98-097, by Nicholas Zill, Laura Spencer Loomis, and Jerry West. Washington DC.

Uphoff, J.K., & Gilmore, J. (1985). Pupil age at school entrance: How many are ready for success. *Educational Leadership*, 43: 86-90.

Wang, L., & Johnstone W. (1997). Evaluation of pre-first grade. Paper presented at the annual meeting of the American Educational Research Association, Chicago.

Warren, C.W., & Tyler, C. (1979). Social status and season of birth: A study of a metropolitan area in southeastern United States. *Social Biology*, 26: 275-288.

West, J. (1993). Readiness for Kindergarten: Parent and teacher beliefs. Statistics in Brief. NCES 93-257. Washington, DC: U.S. Department of Education, National Center for Education Statistics, Office of Educational Research and Improvement.

Zill, N., Loomis, L., & West, J. (1997). The elementary school performance and adjustment of children who enter kindergarten late or repeat kindergarten: Findings from national surveys. (NCES 98-097). U.S. Department of Education. Washington, DC: U.S. Government Printing Office.