

Can Early Childhood Interventions Decrease Inequality of Economic Opportunity?



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This paper considers whether expanding access to center-based early childhood education (ECE) will reduce economic inequality later in life. A strong evidence base indicates that ECE is effective at improving young children's academic skills and human capital development. We review evidence that children from low-income families have lower rates of preschool enrollment than their more affluent peers. Our analysis indicates that increasing enrollments for preschoolers in the year before school entry is likely to be a worthy investment that will yield economic payoffs in the form of increased adult earnings. The benefits of even a moderately effective ECE program are likely to be sufficient to offset the costs of program expansion, and increased enrollment among low-income children may reduce later economic inequality.

Keywords: early childhood education, preschool, economic inequality

Early childhood has emerged as a “frontier” in economic research related to the production of human capital. It is an important stage for the human capital production function, and the only period of childhood and adolescence with relatively little public investment. But, as the frontier metaphor suggests, early childhood is a contested field of research. Some scholars interpret the early childhood intervention evidence as showing promising opportunities for remediating inequities in human capital and thus argue for significant expansions in public investments. Others come to more cautious or even negative conclusions, worrying about the uncertainty in the evidence base regarding the long-term payoffs to early childhood investments that might be made today.

MODELS OF CHILD INVESTMENTS AND DEVELOPMENT

Both human and animal studies point to the critical importance of the earliest years of life to establishing the brain architecture and other biological systems that will shape future cognitive, social, and emotional development, as well as physical and mental health (Blair and Raver 2012; Knudsen et al. 2006). Infants, toddlers, and preschoolers benefit from environments that provide sensitive, responsive caregiving and a variety of language-rich learning opportunities. Research on the malleability (plasticity) of cognitive and language abilities shows these skills to be highly responsive to both positive and negative influences (Fox, Levitt, and Nelson 2010; Shonkoff 2010). Environmental enrichment can promote cognitive

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development, whereas a variety of adverse experiences may shape cognitive development in ways that limit later learning (Shonkoff 2010).

Economic models of human development formalize thinking about the human capital production function, and emphasize how investments and child endowments interact to create a child's stock of human capital. Flavio Cunha and James Heckman (2007) describe a cumulative model of the production of human capital that allows for the possibility of differing childhood investment stages as well as roles for the past effects and future development of both cognitive and socioemotional ("noncognitive") skills. Their model highlights the interactive nature of skill building and investments from families, preschools and schools, and other agents. It posits that human capital accumulation results from *self-productivity*—skills developed in earlier stages bolster the development of skills in later stages—as well as the dynamic complementarity that results from the assumption that skills acquired prior to a given investment increase the productivity of that investment. Taken together, these two principles undergird their hypothesis that skill begets skill.

An important strength of Cunha and Heckman-type models is that they generate clear and testable hypotheses. Although widely described and endorsed, the hypothesis of dynamic complementarity in early childhood currently rests on a thin empirical base. The most direct evidence comes from work by Anna Aizer and Flavio Cunha (2012) who use data from a longitudinal study begun in the 1960s that spans the period surrounding the introduction of Head Start, the largest preschool intervention for low-income children, and finds larger impacts of the program on children with higher scores on a measure of infant cognitive development. However, evidence using more recent data from an experimental evaluation of Head Start does not find that significantly larger gains accrue to students who enter the program with higher skills at program entry (Purtell and Gershoff 2013).

Developmental psychologists, like economists, describe children's development as the result of the dynamic interplay between an in-

dividual child and his or her environment. Recent developmental theory and research on how early environments affect learning and later outcomes have two foci. The first centers on how particular contexts, especially interpersonal relationships and interactions, affect children's acquisition of specific skills. These studies are focused on discovering which types of experiences, on average, lead to learning specific knowledge or skills. They typically generate their estimates by exploiting naturally occurring variation in developmental processes in population-based samples (Sameroff 2010). For example, several studies have documented considerable variability in the amount of speech directed at children by caregivers during the course of a typical day (Hoff 2003; Rowe 2012). In turn, this variability in experience of speech is strongly linked to the child's later language expression and vocabulary (Rowe 2012; Weisleder and Fernald 2013). Similarly, studies of parenting and children's self-regulation point to associations between parents' early support of their children's autonomy with later assessments of children's executive function (Bernier, Carlson, and Whipple 2010).

A second and newer body of developmental resoundments are largely invariant during development, changes in the epigenome—the biochemical system that regulates gene expression—are not. Moreover, the epigenome is found to be particularly responsive to environmental conditions (Champagne and Mashoodh 2009). For example, animal studies have shown that experimental manipulation of the amount and timing of a rat grooming her pups is related to the pups' gene expression and subsequent developmental trajectories (Meaney 2010). Although much of this work began with studies of adverse events and animal models, increasingly such studies are extending to humans. For example, Marilyn Essex and her colleagues (2013) find that early maternal stressors were related to epigenetic changes in their children during adolescence, with implications for their mental health.

Economists' and developmentalists' differing models of development generate contrasting predictions regarding the effects of preschool investments. If focused on the pre-

school period, defined roughly as ages three to five, the Cunha and Heckman model implies that school readiness is a product of the child's cognitive and socioemotional skills on entry into the preschool period plus preschool period investments from parents and possible ECE programs. Their hypothesis of dynamic complementarity implies that impacts of parental and ECE investments on child outcomes will be largest for children who enter the preschool period with the highest levels of cognitive and socioemotional skills. Indeed, this is the very evidence that Aizer and Cunha (2012) provide.

Developmental theories link productivity to the quality of the match between what a program offers and the kinds of developmental supports needed by a child (Blair and Raver 2012). Specifically, "compensatory" models are based on the premise that preschool investments can function effectively as a substitute for, rather than as a complement to, sensitive or enriched home environments (Ramey and Ramey 1998). Thus, children whose skill development may be hindered by economic disadvantage or low-quality home environments are predicted to benefit more from high-quality ECE programs than more advantaged children. In particular, if preschool settings expose children to sensitive caregiving environments, developmental theory would suggest that they would increase children's socioemotional skills most among children with less sensitive parental caregivers. Recent evidence supports these compensatory patterns of association (Watanabe et al. 2011). This compensatory or protective model of high-quality early childhood care and education argues for understanding specific qualities and nature of investments, as they pertain to differing domains of development.

WHICH EARLY SKILLS MATTER FOR HUMAN CAPITAL ACCUMULATION?

If early childhood programs seek to build skills that will generate lasting changes in adults' human capital, which skills should they target? Economists tend to lump IQ and achievement into a cognitive category and everything else into a noncognitive or soft-skills category. This

is unhelpful for a variety of reasons. First, the cognitive category mixes general cognitive ability with concrete academic skills such as literacy and numeracy. Although scores on tests of cognitive ability and achievement tend to be highly correlated, the conceptual difference between cognitive ability as a relatively stable trait and the concrete achievement skills that develop in response to schooling and other human capital investments, including ECE, is an important one. Second, noncognitive skills such as the ability to sustain attention when performing tasks, plan ahead, and control emotions involve many of the same elements of brain circuitry as learning concrete skills, and are therefore inherently cognitive. Third, conceptualizing and measuring distinct components of noncognitive skills might be important for understanding why ECE and other human capital investments affect so many outcomes in the long run.

Our recent review classifies competencies into four groups: achievement, attention, externalizing behavior problems, and mental health (Duncan and Magnuson 2011). Attention refers to the ability to control impulses and focus on tasks (see, for example, Raver 2004). Externalizing behavior refers to a cluster of related behavioral problems that include antisocial behavior, conduct disorders, and more general aggression (Campbell, Shaw, and Gilliom 2000). Mental health constructs include anxiety and depression as well as somatic complaints and withdrawn behavior (Bongers et al. 2003). All of these skills and behaviors might both respond to ECE investments and contribute to subsequent educational attainment, skill development, and labor market participation.

The evidence base on how early skills link to later earnings in adulthood is thin. Longitudinal datasets that have collected multiple domains of early childhood data and followed subjects through adulthood are rare, and often made up of convenience samples. In addition, drawing causal conclusions from these nonexperimental studies is difficult because of confounding characteristics and contexts and the likely bidirectional nature of developmental processes. Nevertheless, analysis of the British

cohort studies and recent data from U.S. studies suggest that early achievement skills directly predict later earnings (Chetty et al. 2011; Currie and Thomas 1999).

More evidence is found linking early skills to later childhood and adolescent outcomes. Data from several large studies of young children find that when a constellation of skills and behavior are taken into account and differences in family background are held constant, early achievement skills (reading and math) best predict achievement later in childhood, followed by attention skills (sometimes measured by the lack of attention and hyperactivity) (Duncan et al. 2007). Somewhat surprising is that early problem behavior such as aggression or even prosocial behaviors did not predict later achievement (Grimm et al. 2010).

A somewhat different picture of the role of early behavior is found, however, if the outcomes considered are educational attainment, later criminal activity, and earnings, rather than achievement skills. In the case of high school graduation, as would be expected, concrete achievement skills play an important role. However, early problem behavior, and more specifically persistent antisocial behavior during middle childhood, also predicts high school completion, college attendance, and years of educational attainment (Magnuson et al., forthcoming). Follow-up evaluations of high-quality early childhood interventions that had sizable impacts on multiple developmental domains also suggest the importance of early skills and behavior for long-term criminal activity and higher earnings (Heckman, Pinto, and Savelyev 2013).

Decisions about which skills to make the target of early childhood education efforts should be guided not only by which skills are important for later outcomes, but also be guided by where socioeconomic status (SES) differences in development are largest. The data are very clear on this point. Differences in development between more and less advantaged children are found early in life, recent data pointing to differences by poverty status as early as nine months of age (Halle et al. 2009). By school entry, family SES much more sharply differentiates children's early achievement skills than their early behavior. Table 1

provides data from the Early Childhood Longitudinal Study Kindergarten Cohorts of 1998 and 2010. Twelve years apart, the studies collected similar data from nationally representative samples of U.S. children and thus provide a useful comparison. They include one-on-one achievement skill assessments, as well as teacher and parent surveys, first gathered in the fall of the kindergarten year. These data provide a snapshot of skills and behavior that children have at the start of formal schooling.

In table 1, we provide two estimates of the differences across groups of children. The first *unadjusted* estimates describe mean differences for all children, and the second estimates from teacher fixed-effect models, which are based on the comparison of children within the same kindergarten classrooms. This second strategy provides an indication of how these differences are manifest among children sitting in the same schools and classrooms.

Disparities in children's skills are evident along a number of demographic dimensions in both the unadjusted and teacher fixed-effect estimates. Girls outperform boys in reading and are reported by teachers to be better behaved. White children outperform African American and Hispanic children in terms of reading and math and are rated as having better approaches to learning. Yet, the magnitude of these differences is dwarfed by those related to family SES (as measured by a composite of parental education and family income). Figure 1 shows differences in these early school entry skills by SES quintiles. The lowest SES quintile corresponds to an average family income of about \$15,500 (in 1998) and the highest to incomes over \$100,000 (in 1998). The differences between children in the top SES quintile and the bottom quintile are large. The difference in math and reading skills was 1.2 to 1.3 standard deviations for reading and math in 1998, and only slightly less in 2010. It is also notable from the fixed effects columns that differences of nearly these magnitudes are found among children in the same classroom.

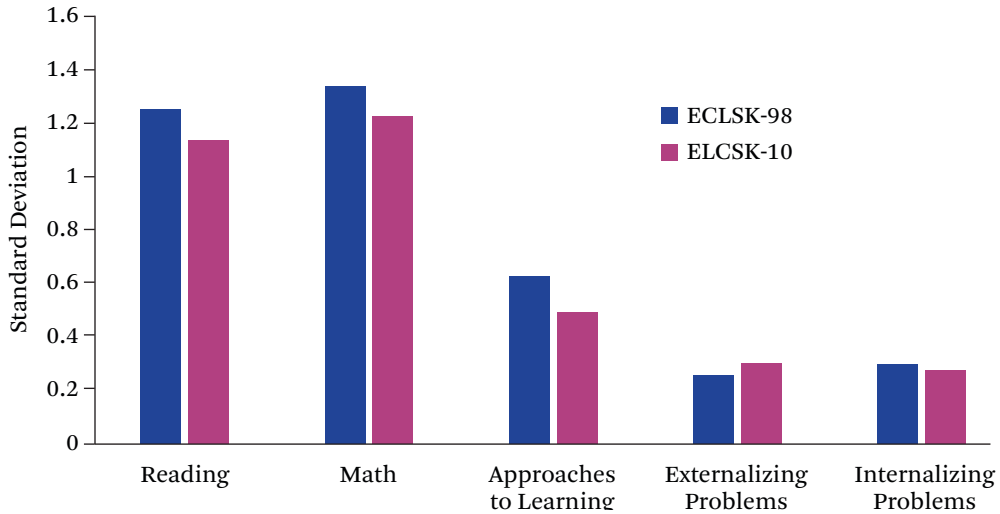
Turning to children's attention skills, as measured by their teachers' response to questions forming the "approaches to learning" scale, bottom-to-top quintile differences across the SES spectrum are about half the size of

Table 1. Gaps in Children's Academic and Behavior Skills in the Fall of Kindergarten

	Reading		Math		Approaches to Learning		Externalizing Behavior		Lack of Internalizing Behavior	
	Unadj.	Teacher FE	Unadj.	Teacher FE	Unadj.	Teacher FE	Unadj.	Teacher FE	Unadj.	Teacher FE
ECLSK-10										
Boys/girls	0.11	0.11	-0.03	-0.03	0.43	0.44	0.42	0.42	0.07	0.06
Black/white	0.30	0.23	0.57	0.36	0.25	0.32	0.29	0.29	0.08	0.06
Hispanic/white	0.52	0.31	0.64	0.35	0.12	0.12	0.02	0.10	0.01	-0.02
SES: 1st quintile/5th quintile	1.14	0.95	1.23	0.87	0.50	0.72	0.30	0.39	0.28	0.39
SES: 1st quintile/3rd quintile	0.52	0.39	0.61	0.39	0.25	0.22	0.12	0.09	0.15	0.16
SES: 3rd quintile/5th quintile	0.62	0.49	0.62	0.43	0.26	0.34	0.17	0.16	0.13	0.12
ECLSK-98										
Boys/girls	0.17	0.15	0.03	0.01	0.40	0.39	0.41	0.39	0.06	0.05
Black/white	0.43	0.30	0.62	0.40	0.36	0.30	0.31	0.28	0.06	0.04
Hispanic/white	0.53	0.29	0.77	0.36	0.22	0.14	-0.01	-0.07	0.05	0.03
SES: 1st quintile/5th quintile	1.26	0.85	1.34	0.85	0.63	0.63	0.26	0.17	0.30	0.31
SES: 1st quintile/3rd quintile	0.59	0.45	0.72	0.46	0.36	0.35	0.14	0.08	0.21	0.23
SES: 3rd quintile/5th quintile	0.67	0.47	0.62	0.40	0.27	0.27	0.12	0.13	0.09	0.08

Source: Authors' calculations.

Notes: In this table, all positive numbers represent gaps in reference to the advantaged group indicated on the right-hand side of the first column. Unadj. refers to unadjusted comparisons across groups and Teacher FE provides estimates from teacher fixed effect models in which children are compared to other children in the same classroom. Negative numbers indicate that the left-hand group has better scores, on average. For both externalizing and internalizing behaviors, a positive gap indicates better behavior (less externalizing and internalizing) for the advantaged group. Approaches to Learning is the ECLS-K measure of attention and school engagement. Calculations done by Sharon Wolf, National Poverty Postdoctoral Fellow at UW-Madison, Institute for Research on Poverty.

Figure 1. Differences in School Readiness by Family Socioeconomic Status

Source: Authors' calculations.

Notes: The graph shows standard deviation differences in skills and behavior for children in the lowest income quintile and the highest SES quintile based on estimates in table 1. ECLSK refers to the Early Childhood Longitudinal Study Kindergarten Cohort studies, which were fielded in 1998 and 2010. Approaches to Learning is the ECLS-K measure of attention and school engagement.

concrete achievement skills, though still sizable—about 0.60 standard deviations in 1998 and 0.50 standard deviations in 2010. For externalizing and internalizing behaviors, although SES differences are apparent, they are a quarter of the size of the SES-related reading and math skill gaps. All in all, SES-based differences in concrete achievement skills are by far the largest.

It might be hoped that schools would be able to ameliorate some of the skill and behavior differences across the SES spectrum. For the 1998 cohort, the ECLS-K study followed the same children over the course of elementary school and into middle school. For reading and math skills, the magnitude of the gaps in standardized scores are largely similar over time—the gaps in eighth grade are of a magnitude similar to those in kindergarten. For teacher reports of problem behaviors, despite no evident change over time for internalizing behaviors, the gap in externalizing behavior over the course of elementary school is increasing (Magnuson, Waldfogel, and Washbrook 2012).

Turning to other national data to explore

SES differences in adult outcomes, Duncan and Magnuson (2011) report that, compared with children in the top SES quintile, children in the lowest SES quintile subsequently have arrest rates 15 percentage points higher, high school completion rates 31 percentage points lower, and college attendance rates 40 percentage points lower. In sum, large SES-related differences in early skills and moderate differences in aspects of behavior forecast later disparities in schooling and criminal involvement that have important implications for youth's experiences in the labor market.

CURRENT PRESCHOOL INVESTMENTS

The large and enduring SES differences in early skills, as well as their consequences for later learning, have not gone unnoticed by educators and policymakers. Indeed these differences helped motivate the creation of Head Start, the expansion of state and local prekindergarten programs, and most recently President Obama's proposed expansion of enrollment in high-quality early learning programs. Despite advocates' and critics' focus on the findings from just a handful of programs, it is

important to understand that preschool comprises a very heterogeneous set of programs, many of which have been evaluated and studied over time.

The rubric of *preschool* includes three broad types of programs serving children two years prior to kindergarten (ages three to five): private preschool programs (which may be publicly paid for with child-care subsidies), Head Start, and prekindergarten programs supported by state and local education funds. About 75 percent of U.S. children attended a center-based preschool program the year before kindergarten and just over half attended a center-based program the year before that (at age three) (Federal Interagency Forum on Child and Family Statistics 2011).

Despite the similarities among preschool programs, some differ in important ways from others. The oldest, largest, and best known federally funded preschool program is Head Start. Conceived as part of the Johnson administration's War on Poverty, Head Start has served more than thirty-one million children since its inception in 1965 (Head Start 2013). Federal guidelines require that at least 90 percent of the families served in each Head Start program be poor (incomes below the federal poverty threshold), and that 10 percent of children served by Head Start have developmental disabilities.

Head Start's 2013 federal budget was just under \$7.6 billion, and funds were distributed to 1,591 local private and public nonprofit grantees serving just over nine hundred thousand children. Nearly half of Head Start programs provide full-week, full-time center care (Hamm 2006). Head Start programs are designed to enhance the development of economically disadvantaged children using a holistic approach, including the provision of educational services, parenting education, and providing families support to achieve parents' educational and employment goals. Head Start also provides services to identify health concerns and increase access to a full range of health care services including dental and mental health care (Puma et al. 2005). All Head Start centers are required to adopt a "whole-child" curriculum. A high priority is placed on parents' involvement in their children's educa-

tion and the local administration of Head Start programs.

Public prekindergarten (pre-K) programs are a second form of publicly provided preschool and funded by states or local school districts. Funding and enrollment in state pre-K programs have increased dramatically over the past several years. As of 2012 to 2013, forty states (including the District of Columbia) had pre-K initiatives serving approximately 28 percent of four-year-olds and 4 percent of three-year-olds (Barnett et al. 2013). Most pre-K programs are targeted to low-income children (thirty-one state programs have income eligibility requirements); however, a small but growing number of states either offer, or are currently considering funding, universal access for all four-year-olds and, in some cases, three-year-olds (Barnett et al. 2013). Pre-K initiatives are intended to complement, rather than supplant, existing sources of ECE funding such as Head Start.

State prekindergarten programs vary substantially in terms of funding levels, program design, and quality. A majority of pre-K programs are either part time or have locally determined hours. Some programs offer an extensive set of support services, such as transportation and health screenings and referrals, others very few of these kinds of services. Most states use a mixed service delivery system that provides pre-K programming in schools as well as community-based settings, by contracting with privately run preschools and federally funded Head Start programs. Approximately one-third of children receiving pre-K services in 2011 were served outside public schools (Barnett et al. 2013).

Despite expansions in Head Start and pre-K programs, a large proportion of children still attend a private preschool the year before they enter kindergarten. These programs are typically licensed or regulated by states as child-care providers, and include both for-profit and not-for-profit entities. Steven Barnett and Milagros Nores's (2012) analysis of the National Higher Education Survey data finds, as would be expected, that participation in private preschool is most common among higher-income families, who are less likely to qualify for public programs.

META-ANALYSIS OF SHORT-TERM PRESCHOOL PROGRAM EFFECTS

What do we know about how children's preschool attendance affects their school readiness?

Despite the hundreds of evaluation studies of early childhood education programs that have been published over the past fifty years, only a handful of programs have been prominently discussed in policy circles by advocates and critics: Perry Preschool, the Abecedarian program, Head Start, and more recently some state and local prekindergarten programs. These programs provide a selective view of the impact of early education programs. Given the range of diverse programs that children experience, attention to the broader set of impacts and averages across programs seem most relevant and important. In a collaborative research project, we have focused on evaluations of preschool programs conducted over the course of the last half-century that used strong experimental or quasi-experimental methods and provided impact estimates for cognitive or achievement-related outcomes.¹

Figure 2 shows the distribution of eighty-four program-average treatment effect sizes for cognitive and achievement outcomes, measured at the end of each program's treatment period, by the calendar year in which the program began. Reflecting their approximate contributions to weighted results, bubble sizes are proportional to the inverse of the squared standard error of the estimated program impact. The figure differentiates between evaluations of Head Start and other ECE programs and also includes a weighted regression line of effect size by calendar year.

Taken as a whole, the simple average effect size for early childhood education on cognitive and achievement scores was 0.28 standard deviations at the end of the program treatment periods, an amount equal to nearly half of race differences in the kindergarten achievement gap found in the Early Childhood Longitudinal

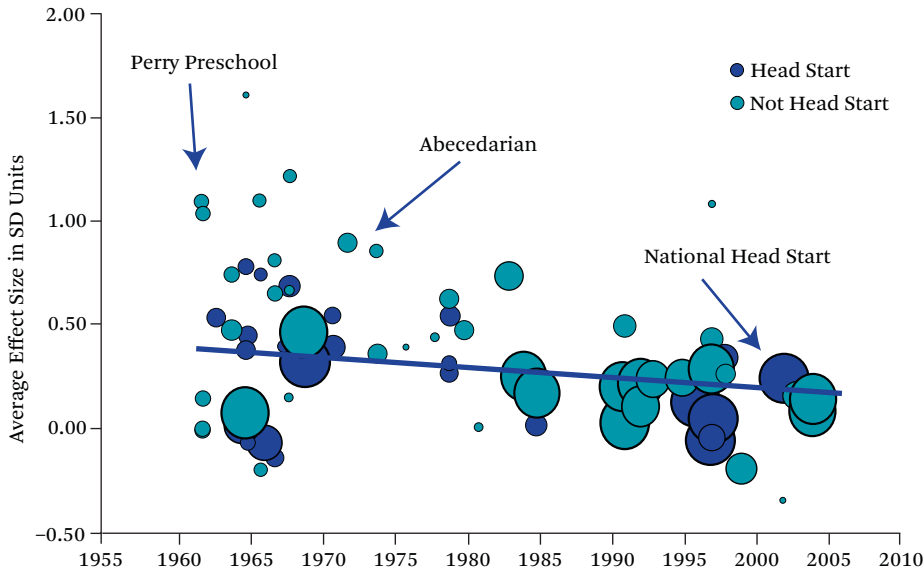
Program, Kindergarten (ECLS-K) data, but less than a quarter of the top-to-bottom quintile SES-related gaps (see table 1). However, as can be seen from figure 2, average effect sizes vary substantially and studies with the largest effect sizes tended to have the fewest subjects. When weighted by the inverse of the squared standard errors of the estimates, the average drops to 0.23 standard deviations (Leak et al. 2014).

STUDIES OF PRESCHOOL'S LONG-TERM EFFECTS

What do we know about the long-term effects of these programs? A key motivation for investing in early childhood education programs is that they will generate important long-term benefits. Indeed, any discussion of preschool's potential to equalize opportunity and mitigate economic inequality hinges on these programs' long-term effects on low-income children's later education, employment, and earnings. The evidence is fairly clear on two issues. First is that short-term impacts on achievement skills dissipate over time. Estimates from our meta-analysis suggest that for each year after program impact on average the effects decline by 0.02 standard deviations (Leak et al. 2014). That suggests that if the average program impact at the end of the program was 0.23 standard deviations, the treatment effect would be entirely gone ten years after the program ended. However, we also find support for the conclusion that impacts decline more quickly in the years right after program completion than in later years. Our results align with those of other researchers who have sought to answer similar questions (Aos et al. 2004).

Despite the frequent convergence between preschool attendees and comparison-group children's IQ scores or achievement skills, studies that have followed early education participants beyond adolescence typically find a range of substantial program impacts on measures of young adult and adult human capital,

1. Programs selected for our analysis had both treatment and control comparison groups, included at least ten participants in each condition, incurred less than 50 percent attrition, and measured children's outcomes close to end of their programs. Studies had to have used random assignment or a rigorous quasi-experimental design that established baseline equivalence of groups.

Figure 2. Average Cognitive and Achievement Skill Impact at the End of Program Treatment

Source: Authors' compilation.

including increases in educational attainment, reductions in criminal activity, and greater earnings (Currie and Almond 2011). Studying the long-term effects of large, public programs, primarily Head Start, has required different methods than have been used for model demonstration programs, because of the dearth of experimental studies with long-term follow-ups (Garces, Thomas, and Currie 2002; Johnson and Jackson 2015; Ludwig and Miller 2007). Head Start is the most examined public program because of its large size and scope. Long-term studies of Head Start have used a variety of econometric methods to construct appropriate comparison groups for preschool attendees, with particular concern that the same level of disadvantage is found among preschool attendees and non-attendees. For example, Eliana Garces and her colleagues' (2002) find in their sibling fixed-effect study using data from the Panel Study of Income Dynamics that among white children, attending Head Start was linked with additional 22 percentage points higher rates of high school graduation and 19 percentage points higher rates of college attendance. Among African American children, attending Head Start was linked with

lower likelihoods of being charged or convicted of a crime (12 percentage points lower). Similarly, David Deming (2009) finds that Head Start is associated with a 0.23 standard deviation increase in this adult outcome index (a mix of education, employment and parental outcomes). Although the pattern of results from the long-term studies is consistent in term of positive effects on human capital, that these studies lack measures other than early achievement test scores means that the processes that produce these long-term effects are essentially a "black box."

An evaluation study of the Chicago Child Parent Centers (CPC) provides the only longitudinal evaluation of a large, public program other than Head Start (Reynolds and Temple 1998). It follows a cohort of children who attended the Chicago Public School prekindergarten program and a matched comparison group. Age twenty-eight results showed positive impacts on participants' educational attainment and income, and negative impacts on their criminal involvement, substance and drug abuse. Arthur Reynolds, Judy Temple, and Suh-Ruu Ou's (2010) efforts to understand the early foundation of the program's later ef-

fects on occupational prestige and reduced crime and depressive symptoms produced a complex mediation model. Their work points to substantial roles of children's cognitive skills, school support, and family support. In contrast, program impacts on social adjustment and motivation made far smaller contributions to these adult outcomes.

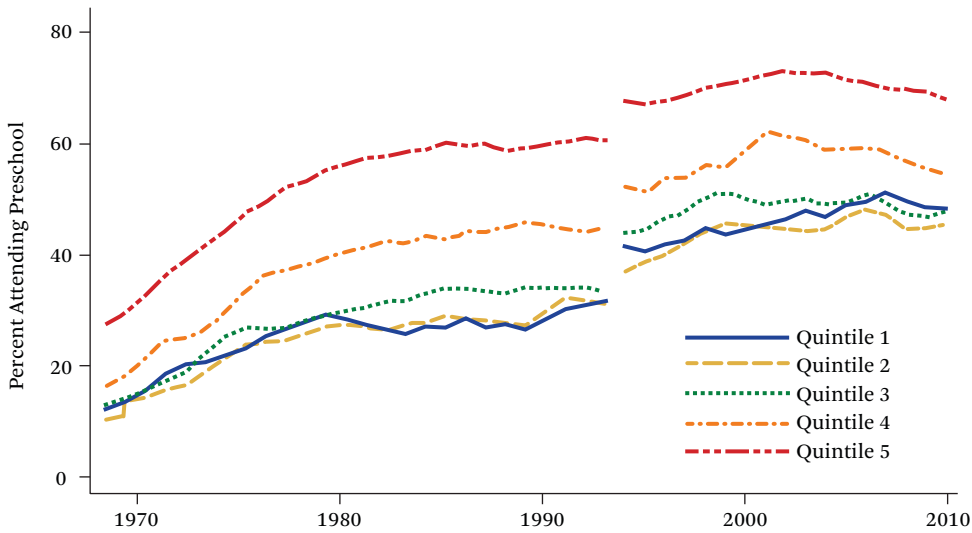
Studies of small, exemplary demonstration programs also yield a pattern of significant long-term improvement in a variety of human capital production dimensions. In addition, these studies typically have a richer range of measures at program completion, offering the opportunity to better understand how early education programs generate these long-term effects. Yet, what emerges from these studies is puzzling. James Heckman and his colleagues (2010) argue that the Perry Preschool program had its most important effects not on children's academic skills, but on their character. Indeed, reductions in criminal activity in adulthood for male participants were the largest contribution to the program's positive long-term effects, and appear to have been most closely linked to changes in children's earlier behavior. The importance of behavior may constitute a significant part of the economic case for Perry Preschool, but it does not appear to generalize more broadly to other preschool studies.

Abecedarian—an intensive, high-quality early education program that began in the first year of life and lasted through school entry—demonstrated positive effects on adult human capital outcomes, but both the range of outcomes affected and the possible explanatory pathways appear to differ in important ways from those found among Perry Preschool attendees. For example, by age twenty-eight, children who attended the Abecedarian program were more likely to be college graduates than the control group and to have substantially higher earnings, though these did not rise to the level of statistical significance (Campbell et al. 2012). However, there was no apparent treatment difference in measures of criminal conviction, which may have been foreshadowed by early study findings that indicated no reductions in problem behavior for program participants (Clarke and Campbell 1998).

Taken together, these studies support the argument that the implementation of these programs several decades ago may have important effects on later human capital accumulation. Studies suggest that a variety of programs, with differing designs and emphasis, have important long-term effects. Beyond that general conclusion, the specific mechanisms behind these impacts remain unclear, and likely differ depending on the program and outcome being considered. Yet, that studies show that the possible positive human capital-generating outcomes are multiple and diverse, as are the pathways by which preschool may produce these outcomes, should be reassuring to policymakers. Efforts to increase children's participation in a range of programs of reasonably high quality are likely to yield long-term effects, even if the specific pathways are diverse or not fully understood, and even if programs' boosts to achievement do not persist. However, if policy goals are broader than increasing access to quality programs—for example, increasing the magnitude of long-term effects—then it would seem that more information about the potential pathways and mechanisms by which early skills and behaviors turn into longer-term outcomes is needed. Specifically, we need to know which skills and program design features to improve in order to yield larger long-term effects, and efforts that would boost early academic skills might differ from those that might more directly target socioemotional skills, behavior, or self-regulation.

COSTS OF EXPANDING PRESCHOOL ACCESS

Recent trends have suggested that through the late 1990s rates of preschool attendance were climbing among all SES groups, although rates of attendance continue to lag for lower-income children. In figure 3, we present enrollment trends for three- and four-year-olds from 1968 to 2010 using nationally representative data from the October Current Population Survey and dividing families into five groups based on income quintiles. Enrollment in preschool has grown for three- and four-year-olds from all income groups over time, but rates are consistently higher for the top two income groups than for the middle and lower two (figure 3).

Figure 3. Children Enrolled in Preschool, Three- and Four-Year-Olds

Source: Authors' calculations.

Notes: Data are taken from the October CPS, and represent three-year moving averages. The break in 1994 is due to a change in the wording of the question. Quintile 1 refers to lowest and quintile 5 to the highest income families.

Looking more closely at the year before children enter school, recent estimates indicate that about 75 percent of children have attended a preschool-like program. As would be expected, ECE participation is higher among the top income quintiles, nearly 90 percent, and lower among the three bottom quintiles, 64 percent to 69 percent (Barnett and Nores 2012).

Public investments have clearly played a role in boosting enrollment among low-income children. The cost of early education programs is typically expensive, with the median state average cost of full-time private preschool (center-based care) at about \$8,000 per year (ChildCare Aware 2011). Without public investments to offset the price, the expense of private preschools is often prohibitive for many low-income and even middle-income families. Although expansions have no doubt been important to boosting preschool enrollments for low-income children, they have not been generous enough for all low-income children to benefit (Magnuson, Meyers, and Waldfogel 2007).

Other demographic groups have comparatively low levels of preschool enrollment—Hispanic children and children of immigrants. No doubt part of the lower rates of enrollment can be attributed to these groups' lower incomes, but African American children, in contrast, are if anything more likely than comparable white children to be enrolled in school- or center-based care (Magnuson, Lahaie, and Waldfogel 2006; Magnuson and Waldfogel 2005). Indeed, both language barriers and cultural factors are also likely influences that play a role in the lower levels of enrollment among Hispanic children and children of immigrants (Takaniishi 2004). Rural communities with their transportation impediments are a final, and often overlooked dimension of under-enrollment. Indeed, less than half of four-year-olds in rural communities attend preschool, compared with nearly 80 percent of their urban or suburban peers (Nores and Barnett 2014).

Could we reach near universal enrollment in prekindergarten or preschool programs? The answer is almost certainly yes. In a relatively short period of time, kindergarten was

introduced and became universal. Other countries, most notably France, have near universal attendance in public programs, even among immigrant minorities. What would it cost to do this in the United States? There are roughly four million four-year-olds, three-quarters of whom attend some form of preschool already. The cost of providing public education per child could range from \$5,000 for half-day programs to about \$10,000 for full-day programs.² Currently four-year olds are evenly divided between part- and full-day programs (Barnett and Nores 2012), and providing this mix of hours seems important to serving the needs and desires of parents. If we assume that those who are not currently attending would have the same distribution across full- and part-time programs, this yields an average cost of \$7,500 per newly attending child. With these assumptions, the added cost for reaching 100 percent enrollment would be \$7.5 billion (\$7,500 for one million four-year-olds).

But, of course, we cannot devise a policy that would pay only for those children whose parents did not otherwise enroll in them. When public programs are available, some children whose parents are currently paying for care will shift to a publicly provided program (Cascio and Schanzenbach 2013). If the public program paid costs for all four-year-olds, the price tag would be \$30 billion (\$7,500 for four million four-year-olds). More than \$5.12 billion is already being spent on state pre-kindergarten and \$8.5 billion on Head Start, therefore the marginal new public investment would amount to \$16.35 billion for a mix of full- and part-day program slots. We expect that once the cost of child-care subsidies was taken into account, this price would fall by possibly \$1 billion. It is also certain that, as is the case for public education, some proportion of families would prefer to pay for a private preschool than participate in public programs. If a similar proportion chose private preschools as choose private K–12 schools (10 percent), that would suggest a total price tag of \$27 billion

and a marginal public investment of \$13.35 billion.

A key question, however, is whether the public investment should be attempting to offset the costs for all families, or only those in lower-income families. With limited public resources, there are compelling reasons to focus on providing access for low-income families, rather than offsetting costs for more affluent families. Low-income families are less able to purchase ECE on their own and ECE impacts may be larger for children reared in low-income families than for those from higher-income families (Duncan and Sojourner 2013; Gormley, Phillips, and Gayer 2008). For these reasons, it is worth considering residence in low-income communities or low family income (or a combination of similar characteristics) as the basis for categorical eligibility. In particular, the bottom three income quintiles (60 percent) all share similarly low rates of enrollment, compared with the upper two income quintiles (figure 3). Combined, roughly 52 percent of these income groups are either not enrolled or enrolled in private programs (Barnett and Nores 2012). Thus, the cost for publicly providing for all these children who are currently not enrolled in publicly funded programs would require new public investments on the order of \$9.36 billion (\$7,500 per child for 1.248 million children). This amounts to a little more than currently being spent on Head Start, and a little less than twice what is being spent on state pre-K programs.

Quantifying the costs of expanding preschool access is important not only in terms of approximating how much more public money would be needed to increase enrollments, but also because it is a necessary step in considering whether such efforts would generate more social benefits than costs. Cost-benefit perspective offers an accounting of whether spending for a program yields societal benefits. Although one might endorse a policy or program that redistributes educational or economic opportunity because it produces

2. These price points are meant to reflect the real costs of providing high-quality programs. But \$10,000 is less than the average per pupil cost for K–12 schooling and Perry Preschool. It is a midpoint between the costs of the recently studied Tulsa Pre-K program (\$4,403 for part-day and \$8,803 for full-day) and the Boston preschool program (\$12,000 for full-day).

outcomes that generate the desired benefit, regardless of cost. Given the many ways in which such outcomes could be achieved as well as the tight budgets and strong arguments for fiscal austerity, cost-benefit comparisons provide one way to consider and compare the economic efficiency of programs and policies.

WHAT ARE THE LIKELY BENEFITS OF INCREASING PRESCHOOL ENROLLMENT?

Documenting the economic benefits of preschool participation is an important part of a cost-benefit comparison. These efforts are obviously most complete and useful when children are followed by researchers well into their adulthood and many types of outcome data are collected. By and large, studies of this type are based on expensive program models in operation decades ago. We adopt an alternative approach in which we ask what magnitude of test score impacts, expressed in standard deviation units, would a pre-K program expansion need to generate long-term benefits that exceed program costs. We believe that this approach is instructive because the field knows more about the magnitude of impacts generated by the existing variety of program models than it does about specific benefits accrued much later in life for the vast majority of these models. Our effort is thus an exercise that seeks to roughly consider whether a public investment in preschool might also be economically productive. Of course, for any specific program model, a more careful and detailed full accounting of costs and benefits would yield a more precise estimate of the benefits, costs and the implied internal rate of return (the discount rate applied to future benefits that would yield a \$0 present value cost).

Research efforts to quantify the benefits of early childhood education are accumulating. We adopt methods used by Timothy Bartik, William Gormley, and Shirley Adelstein (2012) to project benefits for the Tulsa pre-K program.

A first needed piece of information is the association between end-of-kindergarten test scores and adult earnings. We use estimates from Raj Chetty and his colleagues' (2011) analysis of the Tennessee Star experiment, which finds that at the end of kindergarten a 1 percentile increase in test scores is associated with approximately 0.5 percent increase in adult earnings. Bartik and his colleagues (2012) compare predicted earnings impacts based on Chetty and his colleagues' (2011) estimates to measured earnings impacts for available long-term follow-up studies, and find that prediction model seems to do reasonably well thus indicating that this approach seems to provide a good approximation for the effects of test scores at the end of a preschool program.³

Second, we need to know likely earnings of future cohorts. In prior work, we have used the 2013 March Current Population Survey data to estimate the present value of lifetime earnings for adult high school graduates and adults with some college (ages twenty to sixty-five, including zero earnings for nonworkers, we think a reasonable group for this exercise) (Magnuson, Brooks-Gunn, and Waldfogel 2014). Predicting lifetime earnings requires numerous assumptions. Here, we offer a low and high estimate of lifetime earnings. For the low estimate, we assume no wage growth over time, and 3 percent discount to age five; the resulting present value of lifetime earnings for workers with a high school degree or some college is about \$382,392.

Now suppose we assume an expenditure of \$7,500 per child to fund a fifty-fifty mix of part-day and full-day program expansion. How much of a program impact, expressed as a fraction of a kindergarten test score standard deviation, would the ECE program expansion need to generate more benefits than costs? At \$7,500 per child, the preschool investment would represent 2 percent of lifetime earnings, suggesting that the program would need to result in an on average 4 percentile point in-

3. For example, based on the prediction model earnings would increase by about 16 percent, 10 percent, and 8 percent for Perry Preschool, Abecedarian, and the CPC, respectively. The actual earnings effects in these programs were 19 percent, 14 percent, and 7 percent. However, it is unclear whether these associations would hold when moving from a small-scale intervention to a large-scale intervention, in which the entire distribution shifted upward.

crease in test scores (given the 0.5 percent association between test score percentile and earnings). Translating from test score percentiles to effect sizes suggests that this would be an effect size of 0.095 standard deviations for someone who was at the 50th percentile, but closer to 0.15 standard deviation effect size for those scoring at just the 25th (or 75th) test score percentile.

For the high estimate of lifetime earnings, we assume that earnings make up 80 percent of total compensation (the remainder consisting of fringe benefits such as health insurance and retirement contributions), wages grow by 1 percent wage per year, but that the discount rate to age five is still 3 percent. This results in a much larger estimate of lifetime earnings—\$681,544. Under these assumptions, \$7,500 amounts to just 1.1 percent of earnings. Based on the Chetty (Chetty et al. 2011) estimates, this suggests that impacts of just 2.5 percentile points are needed to equalize costs and these earnings benefits. This translates into an effect size of 0.035 standard deviations at the 50th percentile and of a 0.07 standard deviation effect size for 25th (or 75th) percentile test scores. These projections should be interpreted as rough approximations, and with the appropriate warning that any projection into the future involves significant uncertainty. Yet, most effect sizes shown in figure 2 are comfortably above those levels.

Taken together, these admittedly rough benefit estimates seem to suggest that even if expansions to preschool programs yield relatively small effect sizes in improvements in academic skills, the spending and expected returns are likely in the very least to break even, and to bring increased income and economic opportunity. As has been found in long-term evaluations and in recent projections, a program that yields substantial impacts on academic skills will have earnings benefits that well exceed the program costs (Heckman et al. 2010).

Even if program impacts on later earnings were the only benefit to be considered, the exercise indicates that increasing enrollments in preschool programs is likely to be a wise investment. Earnings represent only a proportion of total ECE benefits. In the benefit-cost evalua-

tions of model preschool programs earnings have amounted to from one-third to one-half of estimated program benefits in prior cost-benefit studies. Reductions in spending for special education, grade repetition, child protection services, public welfare benefits, and crime are important documented benefits, with large payoffs (Barnett and Masse 2007; Heckman et al. 2010; Temple and Reynolds 2007). Yet, each study has identified in a slightly different set of non-earnings benefits. In Perry Preschool, a large category was reductions in crime. For CPC, both reductions in crime and reductions in participation in the child welfare system were important. For Abecedarian, benefits were counted from increased maternal employment early in life and later improvements in the children's adult health. All of this suggests that estimating the specifics of likely benefits is hard to do without long-term data, and requires a careful understanding of the populations that will be served by expanded funding and the specifics of the programs being funded. Nonetheless, if prior studies are a useful guide, then other benefits are likely to amount to an important return on the investment.

If the focus of policy attention is on improving inequality in economic fortunes, then it is important that our calculations of increased earnings do not differentiate between the magnitudes of earnings gains for children from differing economic backgrounds. The extent to which both short- and long-term program impacts differ by family background along a number of relevant demographic characteristics is not fully understood. Some evidence suggests that effect sizes might be slightly larger for children from more disadvantaged backgrounds, but the differences are often relatively small and not always significantly different (Burchinal et al. 2015). Thus, although preschool may increase later economic productivity, it is likely to do so for all participating children. It is therefore likely to result in a modest reduction in the inequality of economic opportunity between disadvantaged and affluent children, the magnitude of the reduction contingent on the extent to which policies close the gap in preschool enrollment rates between low-income and higher-income children.

WHAT OTHER TYPES OF INVESTMENTS SHOULD BE CONSIDERED?

Low-income children's preschool enrollment in the year prior to kindergarten is only one margin for improving young children's development and building human capital. Several other types of investments need greater development, evaluation, and policy attention. First, improving the effectiveness of preschool instruction may be an important way to improve children's skills. Increasingly, evidence suggests that one of the most important opportunities to increase children's learning is by selecting good curricula and supporting teachers as they implement it. Curricula and related professional development that are intensive, focused, developmentally appropriate, and sequential can have especially positive impacts on early childhood instruction and on children's learning (Burchinal et al. 2015).

A comparative evaluation of preschool curricula was conducted by the Preschool Curriculum Evaluation Research initiative. The impact of fourteen curricula implemented in early childhood classrooms serving primarily low-income children was assessed using experimental methods (PCERC 2008). Unfortunately, inference from the individual studies was weakened by their cluster design and small sample sizes, which generated low statistical power for analyzing impacts. During the pre-K year, eight of the fourteen curricula had a positive impact on teacher instruction, but only two had statistically significantly positive effects on child outcomes (effect sizes of 0.32 to 0.96 standard deviations). A recent reanalysis of these data by Duncan and his colleagues (2014), which pools across curricula based on their content in order to better detect significant small to moderate effects, concludes that content-specific curricula focused on literacy and math are better able to promote academic skills, compared with more general whole-child curricula.

The Building Blocks math program illustrates a recently developed content-specific curriculum. Developed by Julie Sarama and Douglas Clements (2004), the curriculum includes large- and small-group instruction focused on teaching math skills in a focused and sequential manner, and hands-on and com-

puter activities that promote children's active involvement in solving problems and explaining their solutions. An experimental evaluation found that the curriculum resulted in large improvements in children's math knowledge when compared with a different math curriculum (effect size of 0.47 standard deviations) and a business-as-usual control group (effect size of 1.07 standard deviations) (Clements and Sarama 2008).

An example of a public preschool program that has taken seriously the need to identify exemplary curricula and implement them well is the Boston Pre-Kindergarten Program. The program developed their curriculum by integrating proven literacy, math, and social skills interventions. The academic component combined two curricula, Building Blocks for math instruction and Opening the World of Learning for language and literacy. Extensive teacher training and coaching was provided. The rigorous evaluation indicated large impacts on vocabulary, math, and reading (effect sizes of 0.45 to 0.62) and somewhat smaller impacts on executive functions (effect sizes of 0.21 to 0.28) (Duncan and Murnane 2013; Weiland and Yoshikawa 2013).

While evidence is accumulating, much more research related to preschool curriculum development, implementation, and evaluation is needed. This work is critical, but not easy for several reasons. First, the costs associated with successful implementation are not negligible, often requiring substantial investments in materials and teacher training time. Second, there are often nonpecuniary obstacles to overcome. In general, the early childhood education workforce often works long hours for low salaries, which often results in workers with low levels of education and high rates of job turnover. Sometimes, these circumstances can make implementation challenging, especially in community-based settings. Finally, the associated research costs are often quite high because multisite experimental evaluations that include individual child assessments are expensive.

All the discussion of preschool leaves out infants and toddlers. These earliest years of life are also an important period of development and warrant greater policy and programmatic attention. The developmentally appropriate

model early learning programs for preschoolers cannot be simply extended downward for younger children at the same cost for the same effect. Some model home visiting programs and parenting programs for mothers of infants have also demonstrated the potential to have important impacts on children's trajectories, with potential implications for human capital accumulation (Olds, Sadler, and Kitzman 2007). Yet, at this time what is needed most are continued efforts to innovate and evaluate the feasibility and effectiveness of theoretically informed interventions for very young children.

CONCLUSIONS

Development during early childhood is an important foundation for human capital development, and has substantial long-term links to economic earnings and opportunity later in life. The accumulated evidence suggests multiple aspects of early skills—achievement, behavior, and mental health—if improved early in life can improve children's life chances. Moreover, evidence is accumulating that attending good quality preschools for a year or two results in long-lasting improvements in educational attainment and earnings, even when short-term improvements in concrete achievement skills fade during the elementary school years. The process by which these changes occur, however, seem to vary depending on the populations being served and the emphasis of the programs. Taken together, this argues for the importance of early childhood investments as a way to increase economic opportunity.

Currently, about 25 percent of children do not attend preschool before they enter kindergarten. Because low-income children are least likely to be enrolled compared with higher-income children, and because income gaps in early development forecast lower levels of human capital accumulation, improving attendance should be a first priority for policy. Efforts to expand enrollment will also need to consider other potential barriers such as language and program location. We estimate the costs of providing publicly funded preschool, a mix of part- and full-day programs, for all children in the bottom three income quintiles. We estimate that this would cost an additional \$9.6 billion.

Our consideration of the potential benefits finds that programs that have relatively small effects on children's achievement are projected to "break even" (our low estimate of income, which is more conservative, would require a 0.09 to 0.15 standard deviation impact on achievement to do so). Prior studies of preschool programs that produce larger end of program effects on achievement have been shown to yield larger returns on investments than we project. Although all efforts to forecast years in the future involve uncertainty, we read the evidence to point toward the importance of increased investments in public preschool programs. Other targets for investment include improving learning through research-based preschool curricula and programs for infants and toddlers.

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