Three Essays on Using Economic Evaluations for Scaling Up Early Childhood Education and Development Programs

A Dissertation

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Dedicated

To

My loving parents, Neelam Varshney & Kamal Babu Varshney,

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My dear wife, Aarushi Rastogi

This doctorate is as much yours as it is mine!

Abstract

Despite growing evidence about the significance of Early Childhood Development (ECD) programs, public investment has been relatively low, resulting in slower expansion of evidence-based ECD programs. This dissertation consists of three essays on conducting and using economic evaluation methods to scale up early childhood education and development programs. Specifically, I conduct a benefit-cost analysis of the Chicago Child-Parent Center (CPC) preschool program, with a focus on health outcomes in mid-adulthood. Further, I analyze the costs of implementing the expansion of the CPC program to four districts in the Midwestern US. I discuss the costs required to scale up an evidence-based high-quality preschool program with a focus on estimating the marginal costs of each of the program's six quality elements. Finally, I review the existing economic evaluations of Nurse-Family Partnership Home Visiting programs and suggest two innovative financial mechanisms – Pay for Success (PFS) and Data-Driven Philanthropy that can be used to expand access to home-visiting programs by leveraging public-private partnerships.

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Chapter 1: Introduction

1.1 Introduction

There has been growing evidence about the significance of early childhood development and education, particularly during the first six years of age, in improving long-term life outcomes not only in terms of improved educational outcomes but also physical and socio-emotional development, and economic well-being (Camilli et al., 2010; Duffee et al., 2017; Heckman et al., 2010; van Huizen et al., 2019). However, despite this research, public investment in early childhood interventions remains relatively low, placing the cost burden on the parents of young children, who find it challenging to pay for early childhood programs as they are relatively early in their careers (Davis & Sojourner, 2021). As a result, less than 50% of 3 and 4-year-olds were enrolled in preschool pre-pandemic (McElrath, 2021), with only eight U.S. states and D.C. serving more than 60% of the 4-year-olds through Head Start, state preschool, and special education (Friedman-Krauss et al., 2022). Additionally, despite considerable research demonstrating the positive impacts of home visiting programs, they are currently only able to cater to less than 10% of high-risk mothers across the U.S (NHVRC, 2022).

Ongoing federal and state policy discussions may lead to tremendous increases in access and expenditures in early childhood programs. Notably, in 2022, the U.S. Congress considered the Biden Administration's Build Back Better plan, which would have significantly expanded access to early learning opportunities, including universal preschool subsidies (Romm, 2021). In practice, public funds are limited, so allocating public resources across a wide range of programs that have been found to be effective in serving young children can be challenging.

To address this investment conundrum, policymakers and funders often use economic evaluation methods such as Cost-Benefit Analysis (CBA) to make informed decisions about allocating resources across various programs (Boardman et al., 2017). Cost-benefit analysis is a method of comparing the costs of an intervention to the benefits it generates. When the total expected benefits of a program exceed the total expected costs, it may be beneficial to invest in the program; however, when deciding between comparable programs, the one with a higher benefit-to-cost ratio or the one with the highest net benefit may receive preference. Thus, conducting CBAs of early childhood development and education programs can help promote efficiency in public decisions regarding which programs to fund and how much to invest in them.

In chapters 2 and 3, I leverage a unique opportunity to conduct economic evaluations of an early childhood education (ECE) program at two different stages and scales of its implementation. In 1967, Chicago Public School District started the Child-Parent Center (CPC) program in high-poverty neighborhoods. The CPCs provide comprehensive educational and family support services to children ages 3 to 4 years, with continuing services up to the third grade (Reynolds, 2000). Following the evidence of its impact, the CPC program was expanded in 2012 to four school districts in the midwestern U.S.: Chicago, Evanston, and Normal in Illinois, and St. Paul in Minnesota (referred to as MCPC in this study) (Reynolds, Richardson, et al., 2016). In chapters 2 and 3, I aim to answer the following research questions:

1. Is there a sustained impact of the CPC program on the physical and mental health outcomes through the mid-thirties?
2. If yes, how large are the monetized benefits of improved health relative to the CPC program costs?
3. What are the costs to implement the MCPC expansion program, and how do they compare to the costs of the original CPC program and other preschool programs?
4. What are the implications of this cost analysis for scaling-up preventative programs?

In Chapter 2, I use longitudinal data obtained from a long-running study called Chicago Longitudinal Study (CLS). CLS follows a cohort of 1,539 children, including 989 children who attended the Chicago Child-Parent Center (CPC) program in the 1980s and 550 children from a comparison group that did not. The study sample was last surveyed at age 35-37 to examine the sustained impact of a preschool program on outcomes in mid-adulthood. In this study, I limit the focus to health benefits because while some studies have investigated the impacts of ECE on health outcomes in adolescence, the economic impact on health outcomes in adulthood remains understudied (Englund et al., 2015; Muennig et al., 2009). This is important because the adverse effects of poor health negatively affect the quality of life and state and federal budgets, and if future health benefits are overlooked, the total benefits to society are undercounted.

I use the human capital theoretical framework that views early investments like education and programs to strengthen parental involvement as the inputs which lead to better outputs such as adult health. Previous studies of the CPC program have identified causal pathways through which it impacts adolescent health-related outcomes (Reynolds & Ou, 2016; Topitzes et al., 2009). I use multivariate regressions to estimate the impact of CPC on the reduction in adverse physical and mental health outcomes at age 37, such as the rates of smoking, diabetes, obesity, hypertension, depression, and drug use, while controlling for the child and family socioeconomic characteristics using a rich set of pre-treatment covariates. I use Inverse Probability Weighting (IPW) method to address non-random program assignment and attrition. Here the inverse of estimated probabilities of being assigned to the CPC program and remaining in the sample over time are used as weights. IPW reweights the sample to create a study design that more closely resembles a randomized trial, potentially increasing the internal validity of our study and reducing the concerns about selection and attrition bias (Austin & Stuart, 2015). Additionally, since multiple health outcomes are evaluated in this study, the results are corrected for multiple hypothesis testing (Benjamini & Hochberg, 1995).

I estimate the life-term benefits accrued from avoidance of each of diabetes, smoking, obesity, hypertension, drug use, and depression for the program participants as well as for society by reviewing various studies in the literature. Then I calculate the economic benefits by multiplying the program estimates obtained above with the respective monetary estimate of that outcome (e.g., % reduction in diabetes * savings from diabetes avoidance). The cost of implementing the CPC program is adjusted to present-day values. I calculate the Net Benefit (Program Benefits - Program Costs), and the benefit-cost ratio (Program Benefits/Program Costs) to draw comparisons with investments in other similar programs. Finally, I conduct sensitivity analysis using a range of discount rates and through Monte-Carlo analysis to test the robustness of the results.

This study is significant for many reasons. It is one of the first studies that evaluate the health benefits of an early childhood education program in mid-adulthood. In addition to the range of methodologies employed for robustness checks, this will also be one of the first benefit-cost analysis studies to use multiple hypothesis testing, which is important to ensure that the statistical significance of each outcome is not achieved merely by chance. Evidence of long-term health benefits will better help advocate for resource allocation to preschool programs. The work in this chapter has been published as Varshney et al. (2022).

In Chapter 3, I conduct a cost analysis of the Midwest Expansion of the CPC program as learning about the cost of scaling up proven intervention programs can be of particular significance for their expansion. Few ECE programs in the literature have reported their cost estimates, but among those that have, the cost information is often provided as a summary estimate, which may not be helpful for others that aim to replicate the program (Jones et al., 2019). Estimating the costs of ECE interventions can be challenging due to several factors. A key challenge is calculating the "shadow prices" for inputs not included in annual organizational budgets, such as facilities costs and volunteer contributions. Instructional costs constitute a large part of the ECE program costs, which may vary to a large extent by site and the scale of the program. With an increase in the requirement of skills, as well as the number of educators, cost analyses will need to account for the fact that the wages will need to be raised to staff new instructional sites.

This chapter follows the ‘ingredient-method’ approach defined by Levin et al. (2018), which identifies the program inputs necessary for the program's effective implementation. This includes items that appear in the budget, such as personnel, materials, equipment, and space costs, but also items that may not be explicit such as valuing the time of parents and other volunteers. Data were collected through a review of all budget documents of the program and the school districts where the program is implemented to assess the overhead costs. Relevant estimates from the workforce literature on the elasticity of teacher supply have been incorporated for predicting the costs of a scaled-up universal preschool program. The program’s total costs are then divided by the number of children served to estimate the per-child cost for comparability. Finally, I conduct a sensitivity analysis to incorporate the uncertainties in the costs that represent a variation across settings. These costs are then compared to the cost of the original CPC program and other contemporary ECE programs to discuss the implications for scaling.

The MCPC program has six major components: effective learning, parent involvement, collaborative leadership, aligned curriculum across grades, continuity and stability, and teacher professional development (Reynolds, Richardson, et al., 2021). I also estimate the marginal costs for each of these quality elements, which will help identify the differences between the costs of other preschool programs in the US and the components they offer.

This study is significant because it evaluates the economic costs of expanding a tested ECE program at a larger scale. These estimates will provide a more realistic indication of resources that need to be allocated in the current circumstances. This cost analysis will open a pathway to conduct future studies on cost-effectiveness analysis and cost-benefit analysis of the MCPC program. Finally, as one of the first cost analyses of an ECE program to estimate the marginal cost of each program element, this research can contribute to discussions of best practices.

In Chapter 4, I analyze the economic evaluations of home visiting programs to identify several innovative financing mechanisms through which funding for effective home-visiting programs like the Nurse-Family Partnership can be expanded. Research has shown that nurse home visiting, where trained nurses and paraprofessionals provide comprehensive education and support to expectant mothers from disadvantaged backgrounds, can be instrumental in addressing disparities in early childhood development (Duffee et al., 2017; Michalopoulos et al., 2017).

In this chapter, I first highlight different approaches to conducting cost-benefit analysis and then discuss two newer approaches to financial investment that rely on economic evaluation methods – Pay for Success (PFS) or Social Impact Bonds (SIBs) and Data-Driven Philanthropy. PFS is a type of financing mechanism where private investors provide funding for a social program, and the government pays back the investors based on the program's success in achieving pre-determined outcomes solely in terms of government cost savings (e.g., reduced welfare expenditure). Data-driven philanthropy involves using data and evidence to guide philanthropic investments and maximize impact in terms of the benefits received by low-income community members (e.g., increased employment or earnings).

These approaches can supplement scarce public funds and help increase the reach and impact of home visiting programs while providing a financial return for private sector investors willing to invest in programs with a strong track record of success. I show that the economic benefits of the NFP program are so large that even after restricting the benefits to one set of stakeholders – the government or the program participants- the benefits outweigh the program costs, making it a viable candidate for funding through these approaches. Finally, I suggest that these approaches can help integrate concerns about equity into benefit-cost analysis and help target resources to communities most in need.

Chapter 2: Early Education and Adult Health: Age 37 Impacts and Economic Benefits of the Child-Parent Center Preschool Program

2.1 Introduction

Evidence continues to accumulate on the significance of early childhood education in improving children's long-term development and well-being. Studies in neuroscience, education, and social science indicate that improvements in early education can have meaningful impacts on the lives of children (Camilli et al., 2010; Heckman, 2008; McCoy et al., 2017; Reynolds & Temple, 2019; Shonkoff, 2010) as well as for taxpayers and society-at-large (Belfield et al., 2021; Cannon et al., 2018; Heckman et al., 2010; Reynolds et al., 2002; van Huizen et al., 2019). However, despite this research, the level of public investments in early childhood education has been relatively low, leaving parents to shoulder the heaviest financial burden in a phase of life when they are less able to afford it (Council of Economic Advisers, 2016).

Some states in the U.S. fund preschool, but on average, among all 4-year-olds across the United States, before the pandemic only a third were enrolled in state preschool programs, and the states spend only a little over $5,000 per child in preschool as compared to over $12,000 per year in elementary and secondary school (Barnett et al., 2015; US Census Bureau, 2017). Good-quality early care and education are expensive, with the average full-time childcare costs exceeding the average cost of in-state college tuition in the United States (Schulte & Durana, 2016). Thus, conducting rigorous benefit-cost analysis to assess the magnitude of benefits relative to costs of early childhood programs can be of great importance to ongoing discussions of how much public resources to devote to these programs.

While a few notable studies have investigated impacts on health outcomes in adolescence and adulthood, the majority of the cost-benefit research so far has focused on outcomes such as educational attainment, earnings, and involvement in criminal activity (Heckman et al., 2010;

Reynolds et al., 2002; Reynolds, Temple, White, et al., 2011). The economic impact of early childhood education on health outcomes in adulthood remains understudied, despite the adverse effects of poor health on state and federal budgets and the quality of life. Previous studies of the Chicago Child-Parent Center (CPC) program have identified pathways through which early education programs can impact the health-related outcomes through adulthood (Reynolds & Ou, 2016; Topitzes et al., 2009). To the extent that future health benefits of early childhood programs are overlooked in economic evaluations, the total benefits to society are undercounted.

Through this study, we wish to examine the following research questions:

1. Is there a sustained impact of the Chicago Child-Parent Center (CPC) preschool program on the physical and mental health outcomes through the mid-thirties?
2. How large are the monetized benefits of improved health relative to program costs?

In our cost-benefit analyses, we follow the standards expected for conducting and reporting economic evaluations for preventive interventions (Crowley et al., 2018) and specifically early childhood interventions (Karoly, 2012). We estimate the impact of the program on each outcome and use recommended methods in statistical inference for multiple comparisons to adjust p-values. We carefully define the health outcomes of interest to avoid the double-counting of benefits and then perform sensitivity analysis including Monte-Carlo analysis and use a range of discount rates to test the robustness of our results. Moreover, our analysis differs from prior CPC work in two major ways. First, this report only examines the preschool component of CPC while the two prior studies also assessed school-age services from 1st to 3rd grade and the extended (preschool to 3rd grade) program for 4 to 6 years versus fewer years. In the present study, however, the estimates for preschool impacts are adjusted for participation in the school-age program for which both groups were eligible. Analyzing all program contrasts was beyond the scope of the present study. Second, we only examine impacts for physical and mental health outcomes, not all domains of well-being as the prior studies did. Such a study, which is now underway, would have greatly increased the length and complexity of the report.

2.2 Literature Review

One reason for the underinvestment in good quality early education programs may be that while many studies report strong effects, the evidence is not entirely positive. Some well-publicized research shows that the early gains especially in terms of test scores that are evident in kindergarten may not be discernible by second or third grade. Two notable examples employing random assignment include the U.S. Department of Health and Human Services (HHS)'s Head Start Impact Study and the Tennessee Pre-Kindergarten (VPK) Program. In the Head Start Impact Study, families were randomly assigned an offer for enrollment in Head Start a federally-funded preschool program for children in low-income families. While the first report from the study in 2005 found small but improved effects on cognitive skills, the subsequent report in 2010 found that the effects had mostly faded out by the end of first grade and there was no impact on test scores by the end of third grade (Bauer, 2019; Puma et al., 2005, 2010, 2012). Subsequent researchers have reanalyzed these data to incorporate significant heterogeneity in the counterfactual care settings available to study participants and found sizeable effects of Head Start participation for children who would otherwise have not attended preschool (Feller et al., 2016; Kline & Walters, 2016).

In the evaluation of the Tennessee Pre-Kindergarten (VPK) Program, Lipsey, Farran, and Durkin (2018) found that while the program had what Kraft (2020) describes as a large impact (effect size >0.25) on achievement measures in pre-k, none of these effects of the program on children's academic achievement and behavior persisted through the third grade. Some evidence indicates that the VPK program participants ended up performing worse than the comparison group on Mathematics (effect size: -0.23) and Science (ES: -0.20) scores in third grade. The authors did note that the quality score of the VPK program (4.15) was below the average of other state pre-k programs (4.35) when measured using the Early Childhood Environmental Rating System-Revised (ECERS-R). Subsequent research by other researchers found that the VPK participants who had attended high-quality elementary schools with high-quality teachers had significant gains in math and language lasting through third grade (Pearman et al., 2020).

While there have been numerous studies on the benefits of early intervention, only a subset of these studies has looked at the long-term impacts of early childhood education in later adulthood, well beyond high-school graduation. In this paper, we limit our focus to studies that have evaluated the impact of an ECE program beyond 20 years. Further, we review the studies that investigate the long-term impact on health outcomes or have conducted cost-benefit analyses that may or may not include benefits accruing to improved health outcomes.

2.2.1 Long-Term Evaluations of Major Early Childhood Programs on Non-Health Outcomes

The long-term effects of various early childhood education programs have been evaluated by multiple researchers using a variety of research designs. Estimates of the long-term effects of the Head Start program, which is a nationally offered federally funded preschool program for poor children in the US, tend to come from studies that leverage historical regional differences in program availability to estimate effects by comparing participants in national surveys who were more or less likely to have participated. Carneiro and Ginja (2014), Barr and Gibbs (2019), and

Bailey, Timpe, and Sun (2021) are examples of studies that find significant effects of Head Start on educational attainment and crime. Additionally, sibling comparison studies have found that children who attended Head Start were significantly more likely to complete high school by approximately nine percentage points (Deming, 2009; Garces et al., 2002), and attend college by six to twelve percentage points (Bauer & Schanzenbach, 2016; Deming, 2009). These findings, however, should be interpreted with caution since these studies rely on retrospective reports of participation from data sets whose original purpose was not to assess the effects of Head Start. Prospective longitudinal cohorts studies of early childhood programs provide more interpretable estimates of impact given that participation and implementation is measured fully in real time.

More direct evidence of other early childhood programs comes from several longitudinal studies employing randomized trials or strong non-experimental study designs that follow participants into adulthood. Three early childhood education programs have been extensively evaluated by following a cohort of program and comparison group children over more than three decades – the HighScope Perry Preschool Program[1] (PPP), the Abecedarian Project[2] (ABC), and the Child Parent-Center Program[3] (CPC). Although the three programs differ in their scale of operation, location and time of the offering, target population, and programming, evidence of

[1] The Perry preschool program was conducted from 1962-1967 at the Perry Elementary School in Ypsilanti, Michigan. It was a two-year program spanning 35 weeks in a year, offered for 2 and a half hours for five days a week for Black children considered to be at risk of school failure due to poverty. The study involved random assignment of 123 participants into the program (58 children), while the control group (65 children) was not offered any alternative programming (Schweinhart & Weikart, 1997).

[2] The Carolina Abecedarian Project (ABC) was offered from 1972 to 1977 in Chapel Hill, North Carolina. It was a five-year program spanning 50 weeks in a year, offered for eight hours a day for five days a week. The project randomized 111 infants into the program group (57 children) that received the comprehensive program, or the control group (54 children) that received only nutritional supplements and parental counseling (Campbell et al., 2002).

[3] The Chicago Longitudinal Study (CLS) tracks a cohort of 1,539 children who attended early childhood programs in Chicago, Illinois in 1983-1984. The intervention group (989 children) received the Child-Parent Center (CPC) program for 35 weeks for 2 years, 2 and a half hours a day for five days a week, with school-age services during first to third grades. An appropriate comparison group (550 children) was created by matching on the age of kindergarten entry and demographic characteristics. About a fourth of the comparison group was enrolled in Head Start (Reynolds et al., 2001).

improved outcomes in later-life associated with early education intervention are found in studies of each of these programs, including but not limited to higher high school graduation rates, adult employment, earnings, and lower involvement in criminal activities (Campbell et al., 2012; García et al., 2020; Heckman & Karapakula, 2021; Reynolds et al., 2018; Schweinhart, 2013).

2.2.2 Study of Health Outcomes of Early Childhood Programs

Evaluations of the Head Start program have found the program to be associated with increased access to preventative health services (Currie & Thomas, 1995), improved measure of self-reported health status (Deming, 2009), lower incidence of depression (Bauer & Schanzenbach, 2016), lower incidence of behavioral problems, and reduction in obesity among adolescents (Carneiro & Ginja, 2014). Englund and others (2015) investigated the effects of early childhood education on adult health (age 21) using data from the longitudinal studies of the PPP, ABC, and CPC programs. They measured outcomes such as alcohol, tobacco, and drug use, two or more indicators of these health-compromising behaviors, and depressive symptoms. The study found significant differences in outcomes for drug use (ABC, CPC), tobacco use (CPC), depressive symptoms (CPC), and on two or more indicators of health-compromising behaviors (CPC, PPP).

In the age-37 follow-up study of PPP, Muennig and colleagues (2009) found statistically significant improvements in the health status of program participants. However, the observed differences in rates of self-reported medical conditions as diabetes, hypertension, obesity, asthma, and arthritis were either not significantly different or in the opposite direction of that expected. In a further follow-up at age 55, Heckman and Karapakula (2021) found health effects of the program in form of lower excessive cholesterol and lesser likelihood of being bedridden for males, and lower rates of diabetes and substance abuse among the females, as compared to the control group.

Muennig and others (2011), in their age-21 follow-up study of the Abecedarian program, found that the program participants had improved health outcomes (consisting of depression index, health problems, and hospitalizations), and reduced chances of behavioral risk factors. Interestingly, a later study at age 30 by Campbell and colleagues (2012) found no significant effects of the program on mental health, substance abuse, and self-reported health status. However, the study could be limited by its small sample size to have enough power to detect small effects of the program which could also be significant. In a further follow-up study with a specific focus on health outcomes in mid-thirties, using medical exam data on blood pressure, hypertension, BMI, and cholesterol, Campbell and others (2014) found that the program was associated with a significantly lower prevalence of health risk factors. In the most recent reanalysis of the study data, Garcia and others (2018) found that the ABC/CARE (Carolina Approach to Responsive Education) program had a significant effect on a composite health index of both male and female participants. The index included health outcomes and health behaviors including smoking, body mass index (BMI), psychological distress, asthma, high blood pressure, heart disease, cancer, lung disease, and diabetes, among others, at age 30. While the effect was statistically significant, it was not practically large with an effect size of 0.06.

Dietrichson and co-authors (2020) conducted a meta-analysis of 26 studies that evaluated long-term outcomes of universal early childhood programs across the world and found mixed effects on long-term health outcomes. However, a detailed reading of the study revealed that only three of the 26 studies included in the analysis actually reported measures of health and well-being. Nonetheless, these studies contribute to a small set of literature that evaluates a variety of health outcomes much later into adulthood.

2.2.3 Benefit-Cost Analyses of Early Childhood Programs into Adulthood

Ramon and colleagues (2018) conducted an economic review of eleven studies that evaluated early childhood education programs in the US across the district, state, and federal levels, and found median returns of $4.19 in total benefits for every dollar invested in a program. While the estimated benefits did not include health measures, the study argued from a health equity perspective that the benefits from a more productive labor force could provide cost savings for government health care programs and private health insurers.

Using data from the Head Start Impact Study (HSIS), Kline and Walters (2016) estimated a benefit-cost ratio of the Head Start program to be in the range of 1.10 to 1.84 including only the effects on adult earnings. It is worth noting that the benefits of the program could be much higher if the impacts on crime, health, or other externalities were also incorporated into the analysis.

Two major cost-benefit analyses of the Perry program were conducted at age 27 and age 40, where, the program was estimated to provide a return of $7.16 and $12.90 for every dollar invested in the program in the age-27 and age-40 follow-up respectively (Barnett, 1996; Nores et al., 2005; Schweinhart et al., 1993). While the study accounted for benefits accruing from the reduction in schooling and welfare costs, reduction in the justice system and victim costs from the crime reduction, and increase in taxes paid resulting from higher earnings, health benefits were not included in the analysis. Belfield and colleagues (2021) estimated the benefit-cost ratio going further higher to 12.90 in the age-40 follow-up. However, most benefits were accrued from lower criminal justice system expenditures, higher tax revenues, and lower welfare payments. While the study measured some health outcomes such as smoking, frequency of drug use, and drinking, these were not included in the benefit calculation due to a lack of significant impacts. A re-analysis of the benefits of the program by Heckman and colleagues (2010) produced a similar benefit-cost ratio of 12.20.

Barnett and Masse (2007) conducted a benefit-cost analysis of the ABC program at age 21 and found the program to repay $2.5 for every $1 invested. While they included the benefits from cost savings related to smoking, other health measures were not evaluated in this study. In the most recent follow-up of this sample, Garcia and colleagues (2020) estimated the full life-cycle benefits and costs of the ABC/CARE (Carolina Approach to Responsive Education) programs by forecasting its full array of benefits such as labor income, parental income, health, and reduced crime. They estimate a benefit/cost ratio of 7.3 after adjusting for the welfare cost of taxing the society to fund the programs.

In benefit-cost analyses of the CPC program at ages 21 and 26, Reynolds and colleagues (2002; 2011) found the program to provide returns in the range of $7 to $11 for every dollar invested. However, these studies did not measure the effect of the program on health outcomes, with the majority of the benefits accruing from increased earnings and tax revenues, and averted criminal justice system costs. While the effect on smoking was estimated in the age 26 study, the benefits were not included in the analysis as a statistically significant impact on smoking was not found. A partial CBA comparing the preschool program costs to the benefit solely arising from reduced expenditures on special education has been reported in Temple and Reynolds (2015).

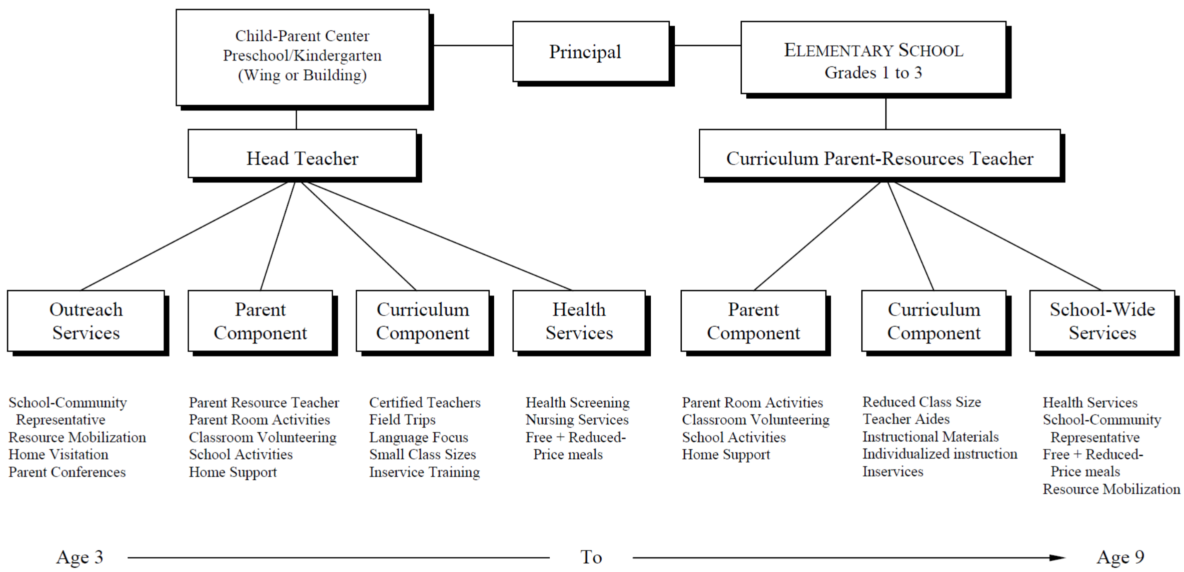
The study reports that the benefits in terms of special education cost savings amount to approximately 60% of the preschool costs.

2.3 Child-Parent Center Program and Pathways to Long-Term Impact

The Child-Parent Center program is a center-based early childhood intervention that provides comprehensive, continuous educational and family-support services to economically-disadvantaged children from preschool through third grade (Figure 2.1). As noted earlier, due to space limitations and clarity in reporting, we focus on the preschool component with adjustment for differential participation in the school-age program. The CPC program focused on five key features: providing an early education intervention no later than age four, a structured learning approach for language and basic skills, increased parent involvement, provision of health and social services, and program continuity between preschool and elementary school (first to third grades) (Reynolds et al., 2003). See also Reynolds et al., 2016 for a historical account and manual for current implementation.

The program operated 3 hours daily for 5 days a week. To ensure individual attention for each child, the centers had a low child-to-staff ratio of 17:2. There was a special focus within the program on increasing the involvement of parents in the school, requiring them to participate at least one-half day per week in activities such as going on field trips or trips to the library, and supervising reading and play sessions at the school. The promotion of health and good nutrition was a component of the CPC program, with physical health and psychological development being one of the important goals of the program during its inception (Reynolds, 2000, p. 27). After enrolling in the CPC program, children were provided a health screening from a registered

Figure 2.1: Child-Parent Center Program Model



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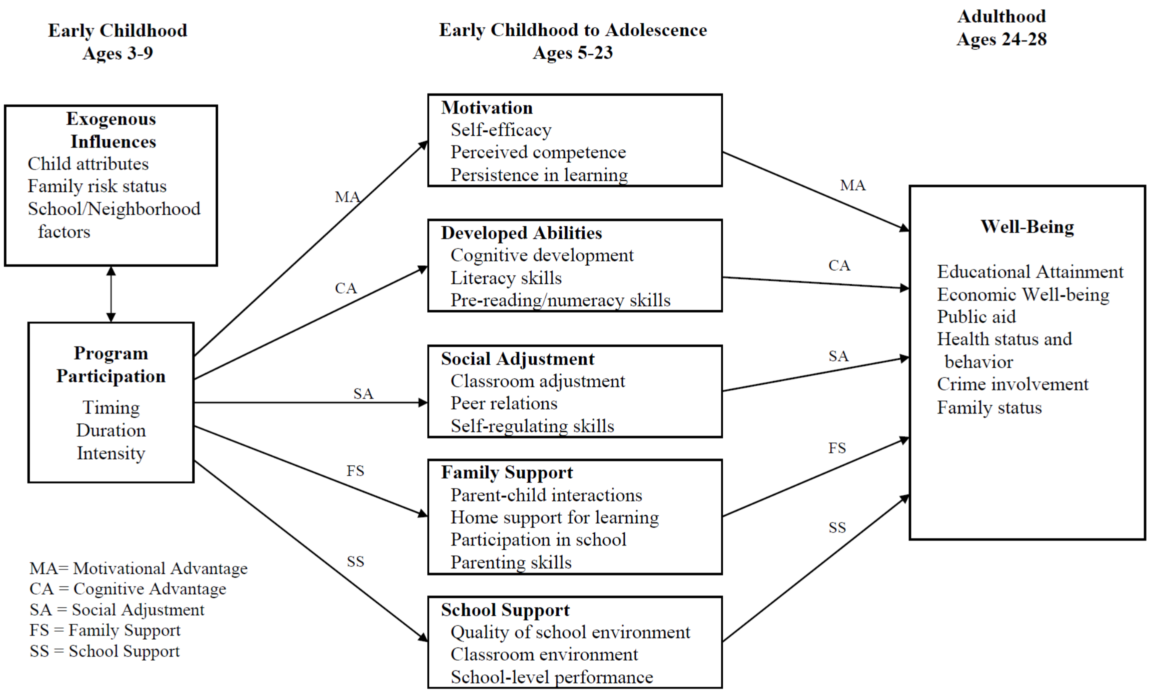
nurse on-site and given tests for vision and hearing. Medical and immunization histories of children were obtained from parents, and they were required to have a physical and dental examination. Children who needed preventative services were then referred to appropriate service agencies (Reynolds, 2000, p. 43). The program also made available special medical and educational services such as speech therapists and school psychologists to the participants (Reynolds, 2000, p. 47).

To promote understanding of how early intervention can affect later outcomes, Reynolds (2000) developed the 5-Hypothesis Model (5HM) (Figure 2.2), where the promotion of cognitive and scholastic advantages, motivational advantages, social adjustment, family support behaviors, and school supports accounted for a majority of the estimated direct effect of preschool on adult well-being (Reynolds & Ou, 2016). These pathways suggest the mechanism through which the

Figure 2.2: Five-Hypothesis Model



Reprinted from "Generative Mechanisms in Early Childhood Interventions: A Confirmatory Research Framework for Prevention" by Reynolds and Ou (2016), *Prevention Science, 17(7),* p. 798. Copyright 2015 by the Society for Prevention Research.

effects of an early childhood program are sustained into adulthood. In another study of the pathways of effects of the CPC program, Reynolds and others (2004) found that higher attendance in high-quality elementary schools, lower mobility, increased literacy skills in kindergarten, avoidance of grade retention, and increased parent involvement in school as a result of CPC participation, mediated the long term effects on educational attainment and reduction in crime. Topitzes and colleagues (2009) conducted an exploratory path analysis of the CPC program to identify the effects of several education-related experiences on health-related outcomes through age 24 and found that the benefits of health-related outcomes in early adulthood can be attributed back to participation in a high-quality, comprehensive preschool program. They found that the program participants were 22% less likely to smoke tobacco daily and were 20% more likely to carry health insurance.

Thus, the focus on physical and mental health during the preschool program and the habits inculcated since early childhood days may have long-term effects on health outcomes in adults in addition to the impact on educational outcomes. In this study, we evaluate whether the CPC program impacts the adult health outcomes in mid-thirties and whether the benefits accrued from these improved health outcomes outweigh the program costs.

2.4 Data

This study makes use of data from the Chicago Longitudinal Study (CLS), which follows a same-age cohort born in 1980 and surveyed most recently at age 35-37. All participants in the CLS attended kindergartens in public schools located in high-poverty neighborhoods in Chicago. The quasi-experimental study design was created by including all students, who were enrolled in the Title-1 funded Child-Parent Center intervention located within the public schools, into the program group. About two-thirds of the total sample (n = 989) were enrolled in these CPC preschool-third grade programs. The comparison group was created from kindergarten programs at randomly selected schools participating in the Chicago Effective Schools Project (CESP), the existing alternative intervention designed to improve student achievement. The remaining one-third of the sample (n = 550), thus, also participated in a government-funded program of all-day kindergarten which was the standard treatment for disadvantaged students at that time. Nearly 15% of the comparison group also attended Head Start preschool. The comparison group in this study received alternate intervention rather than no intervention and matched the poverty characteristics of the CPCs (Reynolds, 2000; Reynolds, Temple, Ou, et al., 2011).

Considering the non-randomized assignment of the children to the program or comparison group, there could be a possibility of selection bias challenging the group comparability. We use a rich array of data on demographic characteristics as statistical control for self-selection on observables and reweight the individual observations to achieve covariate balance in both treatment assignment and attrition as in Reynolds, Temple, Ou, et al. (2011).

A summary of the characteristics of the CPC and comparison groups is shown in Table 2.1. The study participants were predominantly African American (93%) and resided in the most disadvantaged neighborhoods of Chicago that had nearly double the neighborhood poverty rate as compared to the city average. Children in the program group and comparison group were equivalent on child and family characteristics such as gender, single-parent family status, enrollment as 3-year-olds, and receipt of special education services. We account for the difference in some of the child and family risk characteristics between the intervention and the control group by including these as covariates in the main analysis.

The data were collected through numerous sources including but not limited to birth and school records; child maltreatment and justice system records; educational attainment, adult earnings, employment, and public aid; and participant and family surveys. Data collected from these sources has been used in the past research of the CPC program (Reynolds et al., 2018; Reynolds, Temple, Ou, et al., 2011). The data on health outcomes were collected as part of a comprehensive interview during the follow-up at age 35-37 which included 130 questions about physical and mental health, economic wellbeing, life history, and more. The survey was conducted between 2012-2017 and over 80% of the respondents completed the interview via

Table 2.1: Baseline Characteristics of the CLS Study Sample by the Program Status[a]

Characteristic	Total (n=1539)	CPC (n=989)	Comparison (n=550)
Female	50.1	51.8*	47.1
African American	93.0	92.7	93.5
Mother not completed high school by child's age 3[b]	54.3	51.0***	60.2
Ever reported receiving free lunch by child's age 3[b]	83.8	84.2	82.9
Mother under 18 at child's birth[b]	16.1	15.6	17.3
Having 4 or more children at home by child's age 3[b]	16.6	16.0	17.8
Ever reported receiving AFDC by child's age 3[b]	62.8	63.1	62.2
Mother not employed by child's age 3[b]	66.3	67.3	64.6
Single parent by child's age 3[b]	76.5	76.7	76.0
Reside in high poverty school area[b,c]	76.0	77.7**	72.9
Missing on any family risk indicators	16.2	14.8**	18.9
Child low birth weight (<2500g)	11.8	10.9	13.3
Family conflict, child age 0-5	5.7	5.7	5.9
Family financial problems, child age 0-5	7.0	7.1	6.8
Substance abuse parent, child age 0-5	4.1	4.3	3.9
Full-day kindergarten	74.1	59.8***	100.0
CPC school-age intervention (1–3 years)	55.2	69.2***	30.2
CPC extended intervention (4-6 years)	35.9	55.9***	0.0

Significance Level: *** p<0.01, ** p<0.05, * p<0.1
[a]Data are presented as a percentage of individuals. Administrative records (birth certificates, school records) were used for information on the child and family background indicators from birth to 5 years of age. Home environment problems and adverse childhood experiences were obtained from retrospective reports.
[b]Family risk indicators
[c]Children in school areas in which more than 60% of children reside in low-income families

telephone. Ou et al. (2020) provide a detailed description of the approach that was used to locate and interview the participants in this study.

Follow-up data at age 35 was available for a total of 1125 participants (retention rate = 73%), 741 across the program group (75% retention), and 384 across the comparison group (70% retention). As reported in Ou et al. (2020), the retention rate in our study is higher than other large-sample (>200 participants) early childhood intervention studies such as the Infant Health and Development Program (65% up to age 18), the Houston Parent-Child Development Center (63% up to age 18), the Early Head Start Research and Evaluation Project (54% up to age 10), and the Consortium for Longitudinal Study (55% up to age 22).

Table 2.2 compares the child and family characteristics of the in-sample and attrition groups. Non-respondents were more likely to be males, were born into a family that participated in the AFDC program, had mothers who did not complete high school or were teenage at birth, and did not participate in the CPC program. The right-hand side of the table shows the results of using the Inverse Propensity Score Weighting (IPW) procedure, described in the next section. Table 2.3 reports the covariate means for those students who attended the CPC program in preschool and those who did not. A few differences are apparent, specifically for sex, maternal education, and residence in a very high-poverty neighborhood. In both Table 2.2 and Table 2.3, calculating the means after the reweighting of observations via the IPW procedure results in close covariate balance as might be expected if treatment assignment and attrition were random.

The use of self-reported measures of health outcomes is common in early childhood research as conducting medical exams for all participants could be extremely challenging and expensive. Muennig et al. (2009) used self-reported data on health conditions including diabetes, hypertension, obesity, asthma, and arthritis in their age-37 follow-up study of Perry Preschool. Similarly, Campbell et al. (2012) used self-reported health status and measures of drug, alcohol, and tobacco consumption in their age-30 follow-up study of the Abecedarian program. Although in a later study, Campbell and colleagues (2014) were able to use clinical measures of outcomes such as Blood Pressure, Hypertension, BMI, and Cholesterol, the study had a limitation of a lower response rate (~61%). Additionally, in our study, the measure of BMI created using self-reported height and weight data obtained from the survey was highly correlated (r = 0.85) with an in-person BMI measurement conducted with a participant subsample (Eales et al., 2020). We consider the self-reported data used in our study to be a reliable source for health outcomes data and for a subsample of participants these measures can be compared to outcomes obtained through in-person exam data.

Table 2.2: Means of Covariates Without and After Inverse Probability Weighting for Attrition

	Unweighted				Weighted			
25 Predictors used for Attrition[a]	Not in Sample[b]	In Sample	Difference	p-value	Not in Sample	In Sample	Difference	p-value
Mother not completed high school, child age 0-3, %	58.8	52.4	6.4	0.02**	53.1	53.9	-0.8	0.79
Child eligible for subsidized meals, child age 0-3, %	85.7	83.0	2.7	0.18	82.3	83.5	-1.2	0.63
Mother under age 18 at childbirth, %	18.8	15.1	3.7	0.08*	16.1	16.2	-0.1	0.94
Four or more children in the family, child age 0-3, %	16.5	16.7	-0.2	0.94	17.1	16.8	0.3	0.89
Participate in AFDC program, child age 0-3, %	66.7	61.2	5.5	0.04**	61.5	62.4	-0.9	0.78
Mother not employed, child age 0-3, %	68.1	65.6	2.5	0.36	64.6	65.9	-1.3	0.68
Single parent family status, child age 0-3, %	78.7	75.6	3.1	0.19	75.3	76.2	-0.9	0.73
Indicator for missing risk factors, child age 0-3, %	20.6	14.5	6.1	0.00***	15.3	15.6	-0.3	0.88
Reside in high poverty school area, %	77.1	75.5	1.6	0.49	76.2	76.1	0.1	0.97
Low birth weight (<2500g), %	9.7	12.6	-2.9	0.12	11.9	11.9	0.0	0.99
Family conflict, child age 0-5, %	4.6	6.2	-1.6	0.23	6.5	5.8	0.7	0.69
Family financial problems, child age 0-5, %	5.8	7.5	-1.7	0.24	7.4	7.1	0.3	0.83
Substance abuse parent, child age 0-5, %	3.5	4.4	-0.9	0.42	4.3	4.2	0.1	0.91
Female child, %	39.6	54.3	-14.7	0.00***	50.6	50.3	0.3	0.90
African American child, %	91.2	93.7	-2.5	0.08*	93.1	93.0	0.1	0.94
CPC preschool program participation, %	60.0	66.0	-6.0	0.03**	64.0	64.3	-0.3	0.91
CPC School-age program participation, %	50.9	57.0	-6.1	0.03**	55.6	55.5	0.1	0.99
Standardized word test, child age 5	61.6	64.7	-3.1	0.00***	64.2	63.9	0.3	0.67
Proxy of residential mobility	1.0	0.9	0.1	0.01***	0.9	0.9	0.0	0.86
Census tract neighborhood mobility < 1 year, %	19.1	18.8	0.3	0.50	18.8	18.8	0.0	0.85
Census tract neighborhood mobility 1-5 years, %	29.4	29.3	0.1	0.78	29.3	29.3	0.0	0.99
Census tract neighborhood mobility 5-10 years, %	22.8	22.9	-0.1	0.81	23.2	23.0	-0.2	0.68
Census tract neighborhood mobility 10-20 years, %	24.8	25.3	-0.5	0.40	25.0	25.2	-0.2	0.87
Census tract self-employed rate, %	1.9	1.8	0.1	0.20	1.8	1.8	0.0	0.82
Census tract African American female householder, %	40.3	39.5	0.8	0.36	39.8	39.8	0.0	0.99

Significance Level: *** p<0.01, ** p<0.05, * p<0.1

[a]Data are presented as a percentage of individuals except for standardized word test and proxy of residential mobility.

[b]Health outcomes data for 414 participants out of the original sample of 1539 were not available. In-sample group consisted of 1125 participants (program: 741, comparison: 384)

Table 2.3: Means of Covariates Without and After Inverse Probability Weighting for Program Selection

	Unweighted				Weighted			
Predictors for Program Selection[a]	CPC[b]	Comparison	Difference	p-value	CPC	Comparison	Difference	p-value
Females, %	51.8	47.1	4.7	0.080*	49.9	49.5	0.4	0.878
African American, %	92.7	93.5	-0.8	0.589	93.1	93.4	-0.3	0.822
Mother not completed high school by child's age 3, %	51.0	60.2	-9.2	0.001***	54.0	54.0	0.0	0.998
Ever reported receiving free lunch by child's age 3, %	84.2	82.9	1.3	0.502	83.6	83.6	0.0	0.995
Mother under 18 at child's birth, %	15.6	17.3	-1.7	0.385	16.3	16.2	0.1	0.964
Having 4 or more children at home by child's age, %	16.0	17.8	-1.8	0.353	16.9	16.8	0.1	0.946
Ever reported receiving AFDC by child's age 3, %	63.1	62.2	0.9	0.723	62.6	62.8	-0.2	0.948
Mother not employed by child's age 3, %	67.3	64.6	2.7	0.266	66.1	66.1	0.0	0.998
Single parent by child's age 3, %	76.7	76.0	0.7	0.742	76.5	76.6	-0.1	0.964
Missing on any family risk indicators, %	14.8	18.9	-4.1	0.035**	15.6	15.4	0.2	0.916
Reside in high poverty school area, %	77.7	72.9	4.8	0.037**	76.2	76.3	-0.1	0.954
Child low birth weight (<2500g), %	10.9	13.3	-2.4	0.170	11.7	11.7	0.0	0.976
Family conflict, child age 0-5, %	5.7	5.9	-0.2	0.856	5.7	5.7	0.0	0.986
Family financial problems, child age 0-5, %	7.1	6.8	0.3	0.842	6.9	6.8	0.1	0.922
Substance abuse parent, child age 0-5, %	4.3	3.9	0.4	0.718	4.1	4.0	0.1	0.950

Significance Level: *** p<0.01, ** p<0.05, * p<0.1

[a]Data are presented as a percentage of individuals except for standardized word test and proxy of residential mobility.

[b]Out of 1539 study participants, 989 participants were in the CPC group and 550 participants in the comparison group.

2.4.1 Outcome Measures

We analyze the physical and mental health outcomes for participants interviewed as of age 37. First, we created a dichotomous variable for smoking which indicates whether the participants currently smoke any tobacco product more than once a day. Similarly, we created an indicator of drug use based on whether they have ever used drugs harder than marijuana. Next, we used the self-reported information on height and weight to calculate the body mass index (BMI), which is then used to create an indicator of obesity (obesity = 1, if BMI > 30). Finally, we create an indicator for each of diabetes, hypertension, and depression using the self-reported survey responses of whether the respondent was ever diagnosed with these conditions.

Table 2.4 provides information on the outcomes examined and how their means vary across the CPC participants and the comparison group. As shown in Table 2.4, there are significant differences with respect to smoking, drug use, and diabetes between the CPC and comparison groups.

2.5 Methods

Consistent with impact evaluations previously conducted with this sample (Reynolds et al., 2018; Reynolds, Temple, Ou, et al., 2011) we used probit and linear regression to estimate the marginal effects of CPC participation on the health outcomes. The covariates include child and family characteristics such as race/ethnicity, gender, childbirth weight, receipt of child welfare services, parent education, single-parent family status, teen parenthood, employment, four or more children in the family, and school-poverty rate of the kindergarten sites, among others. With the exception of public aid receipt and eligibility for subsidized meals, these control variables were measured from birth to age 3. To estimate the effect of the different components of the preschool

Table 2.4: Unadjusted Mean Comparison of Health Outcomes				
	(1)	(2)	(3)	(4)
Variable Description[a]	Total Sample	CPC Sample[b]	Comparison Sample[c]	Difference in Mean (Standard Error)
Smoking[d]	21.5 n=1100	19.7 n=722	24.9 n=378	-5.2** (0.026)
Drug Use[e]	5.8 n=1097	5.0 n=721	7.5 n=376	-2.5* (0.015)
Body Mass Index[f]	30.49 n=1065	30.29 n=704	30.86 n=361	-0.57 (0.446)
Obesity (BMI > 30)	45.4 n=1065	44.2 n=704	47.6 n=361	-3.4 (0.032)
Diabetes[g]	5.4 n=1097	4.1 n=724	7.8 n=373	-3.7** (0.014)
Hypertension[g]	16.9 n=1096	16.7 n=723	17.1 n=373	-0.4 (0.024)
Depression[g]	12.5 n=1098	13.0 n=723	11.5 n=375	1.5 (0.021)

Significance Level: *** p<0.01, ** p<0.05, * p<0.1
[a] Data are presented as percentage of individuals except for Body Mass Index
[b]CPC = Child-Parent Center program
[c]The comparison group was created from a matched set of similar high-poverty schools
[d]The response was coded as 1 if currently smoke any tobacco product more than once a day
[e]The response was coded as 1 if used drugs harder than Marijuana
[f]BMI measure was created using self-reported measures of height and weight
[g]The response was coded as 1 if the participant was ever diagnosed with the condition

and school-age intervention through third grade, indicators for participation in these components of the PK-3 intervention were included in the regressions.

A key threat to internal validity in any longitudinal study is non-random attrition, where the concern is that participants who leave the sample can have different observed and unobserved characteristics than those who remain, and non-random assignment, where the program participants have different characteristics than the comparison group, which can affect the program estimates. To avoid these concerns of non-random program assignment and attrition, we use Inverse Probability Weighting (IPW), a method of weighting the observations by the inverse probability of each observation being missing conditional on covariates as a regression weight for both attrition and program assignment. Impact evaluations using observational data are increasingly incorporating propensity score methods for estimation of program effects (Austin & Stuart, 2015). An advantage of weighting over matching is that the latter often discards observations and researchers have suggested that IPW methods may have efficiency advantages (Hirano et al., 2003) as long as the trimming of extreme weights is undertaken (Austin & Stuart, 2015).

The IPW results make use of the larger analytic sample to better understand and control for the differences in characteristics of students for whom we have data on health outcomes compared to those who are missing this data (Seaman & White, 2013). To do this, we first run a probit regression using the larger sample of students with and without health outcomes data at age 37 to generate predicted probabilities for each student of having this information using observable characteristics assumed to influence attrition. Being able to predict the missingness of the dependent variable is important. Hence the prediction model includes a comprehensive set of child and family risk variables that also will be included in the main outcomes regressions as well as a set of additional variables that are listed in Appendix 1.1. With the results of the probit estimation, we then assign a weight of $1/p1$ to each child, where p1 is the predicted probability of the child being in the recovery sample ($R = 1$; otherwise 0). The first propensity score is estimated as $P_{1i} = Pr(R = 1|X)$. Similarly, we estimate a propensity score for participation in the program ($T = 1$; otherwise 0) as $P_{2i} = Pr(T = 1|X)$. As a double adjustment, the weights were multiplied together to produce a combined propensity score model as $P_{3i} = P_{2i} * P_{1i}$ following the previous research (Reynolds, Temple, Ou, et al., 2011). Further, we used robust standard errors including the clustering of standard errors at the school level to account for within-site correlation in errors.

Students with characteristics associated with a lower predicted probability of being included in the analysis, but who actually have information for the health outcome, are rarer and consequently are given larger weight. Students with characteristics associated with a higher predicted probability of being in the regression are assigned smaller weights. In a sense, the use of IPW reweights the sample to better resemble a sample in which the outcome is missing at random. Since extreme probability scores (close to 0 or 1) producing large weights can yield unstable estimates, we set a floor and ceiling of weights by trimming them at 0.05 and 0.95 (Austin & Stuart, 2015).

The underlying idea behind the IPW approach is that the reweighting to remove systematic differences between the baseline mean observed characteristics of the program and comparison groups with a rich set of covariates creates a study design that more closely resembles a randomized trial (Austin & Stuart, 2015). While creating group equivalence for participants and controls (and for the retained participants versus those with missing outcomes) on covariates is the intended result, researchers may hope that the groups also are balanced on unobservable baseline traits, even though Austin et al. (2005) point out that this is not necessarily the case. We test for balancing of observed covariates in our subsamples, as presented in the columns to the right side of Table 2.2 and Table 2.3 and find no significant differences between the treatments and controls, and between the retained and dropped samples after weighting.

Once the estimates of CPC effectiveness are obtained in the regression analyses, the economic benefit is estimated by multiplying the marginal effect with the respective monetary estimate of the outcome. The present values of the monetized benefits are then compared to the costs of the intervention to compute the benefit-cost ratio, and the costs are subtracted from the benefits to calculate the net benefit.

2.6 Results

Results from our inverse propensity score weighted estimation approach (Table 2.5 and Appendix 2.2) suggest a relationship between preschool participation and smoking, diabetes, and BMI. The CPC program group was 5.8 percentage points less likely to smoke daily as compared to the comparison group. The prevalence of diabetes was 4.1 percentage points higher among the participants in the comparison group as opposed to the CPC program participants. There was also a statistically significant association between program participation and the body mass index. The differences in prevalence for diabetes were statistically significant at 5% level, while the results on smoking and BMI were significant at 10% level. No significant differences were found in drug use, the prevalence of obesity, hypertension, or depression.

In the economic evaluation that follows, we focus on the estimated effects of participation in the preschool program on reductions in the prevalence of diabetes and the rate of smoking. While the effect of program participation on BMI is marginally significant, we expect that the health consequences of having diabetes overlap in important ways with the consequences of being overweight. To avoid double-counting, we focus solely on reductions in smoking and diabetes diagnoses.

2.6.1 Controlling for Multiple Hypothesis Testing

Since we test multiple non-independent health outcomes in our analysis, there could be a possibility of finding statistically significant results (false positives) for some of the outcomes merely by chance. We apply the Benjamini-Hochberg (BH) procedure (Benjamini & Hochberg, 1995) to control for multiple hypothesis testing as it has been used in other early childhood education studies (Knight et al., 2019) and as Schochet (2008) points out, can have

Table 2.5: Effect of CPC on Health Outcomes			
	(1)	(2)	(3)
Health Outcome[a]	**Sample Mean (Sample Size)**	**Unadjusted group difference (Standard Error)**	**IPW adjusted Regression estimate (Robust SE)**[b]
Smoking[c]	21.5 n=1100	-5.2** (0.026)	-5.8* (0.031)
Drug Use[d]	5.8 n=1097	-2.5* (0.015)	-2.5 (0.018)
Body Mass Index[e]	30.49 n=1065	-0.57 (0.446)	-0.96* (0.528)
Obesity (BMI > 30)	45.4 n=1065	-3.4 (0.032)	-4.7 (0.035)
Diabetes[f]	5.4 n=1097	-3.7** (0.014)	-4.1** (0.018)
Hypertension[f]	16.9 n=1096	-0.4 (0.024)	-0.01 (0.027)
Depression[f]	12.5 n=1098	1.5 (0.021)	1.1 (0.025)

Statistical Significance Levels *** p<0.01, ** p<0.05, * p<0.1
[a]Health outcome data was obtained from self-reported surveys between ages 35 to 37. Data are presented as the percentage of individuals except for Body Mass Index
[b]Regression with covariates adjusted with Inverse Probability Weighting (IPW) for program selection and attrition. Standard errors clustered at the preschool site in parentheses
[c]The response was coded as 1 if currently smoke any tobacco product more than once a day
[d]The response was coded as 1 if used drugs harder than Marijuana
[e]BMI measure was created using self-reported measures of height and weight
[f]The response was coded as 1 if the participant was ever diagnosed with the condition

more statistical power than the Bonferroni method if any positive impacts of program participation truly exist. The BH procedure is easy to perform as it is based entirely on individual p-values. To perform the Benjamini-Hochberg procedure, we first arrange the individual p-values associated with the results in the final column of Table 2.5 in ascending order and rank-order them from i=1 to m (where i is the rank-order of the p-value from smallest to largest, and m is the total number of significance tests performed). Then we compare each individual p-value to the adjusted significance value, which is equal to $(i/m)Q$, where Q is the chosen false-discovery rate. The largest p-value for which $p < (i/m)Q$ is considered to be statistically significant, including all the p-values that are smaller than it.

The choice of the false-discovery rate Q is subjective and depends on the researchers' tolerance for the proportion of false positives, specifically the share of declared positives that are truly negative. Because prior studies based on RCTs of high-quality early childhood programs have reported positive health outcomes in adulthood (Campbell et al., 2014; Muennig et al., 2009, 2011), an expectation of 7 truly null hypotheses for the complete set of health outcomes seems overly conservative. As discussed above, even though 3 of the 7 outcomes were statistically significant in Table 2.5, the economic evaluation is only based on 2 of the 3 significant findings. Ex-ante, we chose a false-discovery rate of Q = 0.20, which in essence means we are willing to allow 20% of the three significant findings in Table 2.5 to be false positives. Table 2.6 shows the Benjamini-Hochberg corrected critical p-value for each of the outcomes using a false-discovery rate *Q=0.2* and m = 7. We find that the program's effect on diabetes, smoking, and BMI is statistically significant even after using this correction for multiple hypothesis testing.

Table 2.6: Benjamini-Hochberg Corrected Critical P-Value

	(1)	(2)	(3)
Health Outcome	**P-value**	**Rank (i)**	**(i/m)Q**
Diabetes	0.020	1	0.029
Smoking	0.063	2	0.057
Body Mass Index	0.069	3	0.086
Drug Use	0.176	4	0.114
Obesity (BMI > 30)	0.183	5	0.143
Depression	0.656	6	0.171
Hypertension	0.996	7	0.2

Note: The table uses the value of Q = 0.2 (False Discovery Rate) and m = 7 (number of outcomes)

2.7 Benefit-Cost Analysis

Following the standard procedure employed in most benefit-cost analysis studies, the main steps in calculating costs and benefits of participation in the CPC program in terms of health outcomes were as follows: (a) the costs and health benefits of the program are calculated in dollar terms, (b) to adjust for inflation, estimates are converted to 2021 dollars using the Bureau of Labor Statistics' Consumer Price Index for All Urban Consumers (CPI-U), (c) a discount rate of 3% was applied to calculate the present value of the costs and benefits at age 3 (start of the program), and (d) the net present value of the program per participant was calculated by subtracting the present value of program costs from the present value of program benefits. Additionally, the program benefits were divided by costs to obtain the benefit-cost ratio (return for every 1 dollar invested). While previous studies (Barnett, 1996; Cannon et al., 2018; Reynolds, Temple, White, et al., 2011) focusing on adult earnings projected the benefits through age 65, we use the CDC (2016) estimates which peg the average life expectancy of African-Americans born in the 1980s to be 68 years, since our sample consists of participants born in 1979 or 1980 who are primarily (93%) Black. Further, we use 62 years as the age of retirement, as people can begin receiving their social security retirement benefits at that age. We used alternative discount rates (1%, 5%, and 7%) as part of the sensitivity analysis.

2.7.1 Program Costs

Two previous cost-benefit analyses have calculated the benefits and costs associated with the Chicago Child-Parent Center program (Reynolds et al., 2002; Reynolds, Temple, White, et al., 2011). The costs were primarily calculated using the operational budget of the program for the year 1985-86 including the costs of instructional staff, staff for family and community support, administration, operations and maintenance, program materials, transportation, food, and community services, school-wide services, and school district support. Additionally, the cost of parent's time was estimated using the minimum wage for 10 hours of participation in the program per month. Imputed costs of capital depreciation and interest was also taken into account as suggested by Levin & McEwan (2000). Based on the cost estimates presented in these studies, the present value cost for one year of the CPC preschool intervention provided in 1986 was estimated to be $7,233 per student in 2021 dollars.

All of the preschool participants received one year of preschool while 55% received an additional year of intervention. Assuming the students that received only one year of preschool intervention entered the program at age 4, while those who received two years of the program started at age 3, the per participant present value of the average cost of the preschool program evaluated at age 3 is *(.55)($7,233) + (1.00)($7,233/1.03) = $11,000*.

2.7.2 Program Benefits

The benefits from reduction in diabetes and smoking can be estimated using two methods: first, through adding the costs of medical expenditure, lost productivity, and the cost of premature mortality attributable to the condition, and second, through accounting for the economic costs of a reduction in quality of life in addition to the healthcare costs.

2.7.2.1 Benefits from Reduced Diabetes

2.7.2.1.1 Medical Expenditure, Lost Productivity, and Premature Mortality Cost of Diabetes

We first estimate the benefits of reduced medical expenditures associated with a diabetes diagnosis using information from the recent study by the American Diabetes Association (ADA, 2018). In 2017, the additional annual per-capita health care expenditures for people diagnosed with diabetes was $9,601 or $10,342 in 2021 dollars. Because medical expenditures rise over time as diabetics age (Trogdon & Hylands, 2008), we adjust the estimates of the health care expenses to allow for this annual increase. Trogdon and Hylands (2008) found that after controlling for several medical conditions that develop over time with diabetes, annual health care costs associated with diabetes rise by $75 per year (or $93 in 2021 US dollars). Therefore, we adjust the cost of health care expenses by applying an age-based escalator of $93 per year to account for higher health care costs among older diabetics to estimate the life-cycle benefits from the reduction in diabetes.

The ADA report also includes estimates of the lost productivity due to a diabetes diagnosis. In 2017 dollars, they report an annual per-capita loss of $2,830 associated with reduced productivity at work including the inability to work, or $3,048 in 2021 dollars.

We make several assumptions in order to estimate the present value at age 3 of a future stream of improved productivity due to reductions in the probability of a diabetes diagnosis. As discussed above, we take the average life expectancy of our sample to be 68 years, and the retirement age as 62 years. Additionally, among our sample, the survey responses suggest that the average age of diabetes diagnosis was 28. We calculate the stream of benefits over the life course of the individual using the above estimates at a 3% discount rate from age 28 through age 68 for health care costs, and up to age 62 for reduced productivity. These present value estimates of a lifetime of higher health care costs and reduced productivity associated with a diabetes diagnosis come out to be $136,207 and $32,218 respectively. For a 4.1 percentage point reduction in diabetes estimated to arise from participation in the CPC program, the present value of these benefits at age 3 is estimated to be $5,584 and $1,321 respectively.

The next step is to include the economic costs of early mortality due to diabetes. ADA (2018) used the data from CDC National Vital Statistics Reports for total deaths to estimate the number of deaths primarily attributable to diabetes, and the proportion of deaths due to renal disease, cerebrovascular disease, and cardiovascular disease attributable to diabetes. They then estimated the present value of their foregone future earnings. While the average cost of premature mortality declines with age, ADA (2018) estimated it to average $71,700, or $77,234 in 2021 dollars. Discounting this cost to the present value at age 3, and multiplying it with the program impact of 4.1%, we find the benefits from averted premature deaths to be $554 due solely to CPC participation.

Adding together the present values of reduced medical expenditures, improved productivity, and reduced premature mortality due to diabetes, we estimate the present value of the effect of the preschool program on the probability of being diagnosed with diabetes to be $7,459.

2.7.2.1.2 Reduction in Quality of Life/ Utility Value due to Diabetes

A second way of monetizing the preschool impacts on diabetes is to consider the effect of diabetes on the quality of life in addition to the healthcare costs. Narayan and others (2003) estimated the quality-adjusted life years (QALY) lost due to diabetes across a range of age of diagnosis, gender, and race. Their study highlighted significant racial disparities in health outcomes. For the non-Hispanic Black population diagnosed with diabetes at age 30, they estimated an average loss of 26.15 QALYs (24.2 for men, 28.1 for women) and an average loss of 18.5 total life years lost. While these estimates are almost two decades old, they are still relevant for our sample population, as in a more recent study, Rhodes and colleagues (2012) estimated 22.44 QALYs lost due to Type 2 diabetes in a cohort of 15-24-year-old adolescent Americans. Using the commonly used monetary value of $50,000 per QALY (Grosse, 2008), for a 4.1 percentage point reduction in diabetes attributable to the program, we estimate the benefits from the avoided loss of QALYs at age 30, discounted to the present value at age 3, to be $24,134[4].

An alternate set of literature estimates the QALYs lost due to Diabetes using utility values obtained from using EuroQol five-dimensional (EQ-5D) valuation questionnaire. As opposed to an ideal utility value of 1 for perfectly healthy individuals, researchers have estimated the utility value for individuals diagnosed with diabetes in the range of 0.74 (Clarke et al., 2002; Neumann et al., 2014) to 0.80 (Huang et al., 2007; Zhang et al., 2012). In a meta-review that assessed 61 studies evaluating the utility values corresponding to diabetes complications, Beaudet and colleagues (2014) recommend a proposed utility value of 0.785. Using the utility value of 0.785 and a QALY estimate of $50,000 we estimate the life-cycle benefits from the aversion of reduced utility values between age 28 and 68 to be $5,076 after discounting to the present value at age 3.

Adding the additional healthcare costs attributable to diabetes of $5,584 as obtained above, the QALY approach yields a range of estimates of the economic benefits of a reduced rate of diabetes diagnoses due to preschool between $10,660 to $29,718 (or a mean of $19,935).

The discussion above suggests two approaches to monetizing the benefits of preschool participation in terms of its estimated impact on a diagnosis of diabetes by age 30 specifically tailored to this population of Black study participants born four decades ago. The first approach is to include averted costs from medical expenditure, reduced productivity, and premature mortality. The second approach is to include averted medical costs and improvements in QALYs. As explained by Shiroiwa et al. (2013), it is important not to add the improvement in

[4] (26.15 QALYs*$50,000*4.1%)/(1.03^27)

terms of QALYs to the improved productivity estimates. Combining the two estimates would result in overcounting the benefits to the extent that the estimated utility value of 0.785 for diabetes includes concerns by the survey respondents that this medical condition would reduce work productivity. For our cost-benefit analysis, we use the more conservative value of benefits from the reduction in diabetes to be $7,459.

2.7.2.2 Benefits from Reduced Smoking

The approach to estimating the economic benefits associated with a reduction in smoking is similar to that used above for diabetes. We use the relevant results from a variety of studies that have estimated the economic benefits accruing from a reduction in the rates of smoking in adults in the form of savings in direct medical costs, lost productivity, and reduced mortality costs, and also consider the improvement in QALYs.

2.7.2.2.1 Medical Costs, Lost Productivity, and Premature Mortality Costs of Smoking

Centers for Disease Control and Prevention (CDC) (2008) estimated the average annual healthcare expenditure attributed to smoking to be $96 billion per year between 2000 and 2004. Another CDC report (2005) estimated that approximately 44.5 million U.S. adults were smokers in 2004. Using the above two pieces of information[5], we calculate the per capita annual incremental medical cost of smoking to be $2,157, equivalent to $3,047 in 2021 US dollars after adjusting for inflation.

CDC (2008) also reports annual productivity losses from smoking-attributable diseases to be approximately $97 billion. Similar to the calculations above, we obtain the per-capita annual productivity losses attributable to smoking to be $2,180 or $3,079 in 2021 US dollars.

[5] $96 billion/44.5 million = $2,157

We use similar assumptions for estimating the cost of smoking as used in the section above while estimating the cost of diabetes. The average age around which Americans begin to smoke daily is estimated to be 18 years (U.S. Department of Health and Human Services, 2004). Additionally, studies have found that smokers lose at least ten years of life expectancy as compared to non-smokers (Jha et al., 2013; U.S. Department of Health and Human Services, 2004). Taking the normal life expectancy of our sample as 68 years as explained in the previous section, we assume the average life expectancy of smokers in our sample to be 58 years. Therefore, we estimate the stream of benefits over the life course of the individual due to averted medical costs and reduced productivity estimates attributable to smoking over the ages of 18 through 58, discounted to its present value at age 3. Using the discount rate of 3%, the present value estimates of a lifetime of increased medical expenses and reduced productivity associated with smoking come out to be $47,163 and $47,658 respectively. For a 5.8 percentage point reduction in smoking-attributable to CPC program participation, the present value of these benefits at age 3 is estimated to be $2,735 and $2,764 respectively.

While the above estimates include medical costs and productivity losses, they do not include the cost of premature mortality attributable to smoking. We use two methods to estimate a range of benefits accrued from reduced mortality costs attributable to smoking. First, we estimate the foregone earnings due to premature death as the mortality cost. Based on our survey estimates, the average earnings for the preschool participants group at age 34 is $20,887 as compared to the average earnings of the comparison group which is $18,248 in 2017 US dollars. Among our response sample, 65.6% of participants attended the CPC program, which brings the weighted average earnings of our sample to be $19,979 (equivalent to $21,521 in 2021 US dollars). We then estimate a stream of this earning up to the retirement age of 62 by allowing it to grow at 2% per year. We assume that due to premature mortality, smokers will lose ten years of life, however, they will lose only five years of earnings before retirement (between ages 58 to 62). The present value at age 3 of the last five years of earnings is estimated to be $33,401, which translates to a mortality-cost savings worth $1,937 corresponding to a 5.8 percentage point reduction.

The alternate method to estimate the mortality costs is using the Value of Statistical Life (VSL). VSL estimates vary depending on the characteristic of a disease, and due to a shortage of condition-specific VSL studies in the literature it is relatively uncommon to be able to use them in studies of cost of a particular illness (Peterson et al., 2018). However, there exists a smoking-specific VSL study by Viscusi & Hersch (2008) who used the variation in smoking rates and fatality rates over the life-cycle to estimate the mortality costs (in 2000 US dollars) of smoking to be $1,538,631 for males and $563,299 for females, respectively. Taking the average of these values, we find the mortality cost of smoking to be $1,050,965 using the VSL estimates, which is equivalent to $1,628,635 in 2021 US dollars. We then discount the average present value mortality cost from age 58 to age 3: $\$1,628,635/(1.03^{55}) = \$320,462$. So, the estimated mortality cost savings from a 5.8 percentage point reduction in smoking is expected to be $18,587.

Adding together the present values of reduced costs of medical expenditure, lost productivity, and premature mortality attributable to smoking, we estimate the present value of the effect of participation in the CPC program on the prevalence of smoking to be in the range of $7,436 to $24,086.

2.7.2.2.2 Reduction in Quality of Life due to Smoking

We also estimate the economic impact of smoking using the quality-adjusted life years (QALY) method. In a recently published study, Xu and others (2021) estimated that cigarette smokers aged 35-39 years lost an average of 7.4 QALYs as compared to non-smokers. Using the monetary value of $50,000 per QALY as in the section above, we estimate the savings at age 37 discounted to the present value at age 3 to be $7,855[6]. Adding the additional healthcare costs attributable to smoking of $2,735 as obtained above, the QALY approach yields a benefit of $10,591 from a reduced rate of smoking due to preschool participation.

As above for diabetes, we use the more conservative estimates of $7,437 as the benefit from reduced smoking in our cost-benefit analysis. In Table 2.7, we report the benefits by category, and in Table 2.8, we report the total health benefits obtained using a variety of methods of estimation as described above.

Table 2.7: Distribution of Benefits by Category

Benefits	**Diabetes**	**Smoking**
Increased healthcare costs	5,584	2,735
Reduced productivity	1,321	2,764
Pre-mature mortality		
using foregone earnings method	554	1,937
using value of statistical life method	-	18,587
Reduction in QALYs	24,134	7,855
Reduction in utility value	5,076	-

Note: All benefit estimates are in 2021 US dollars

[6] (7.4 QALYs*$50,000*5.8%)/(1.03^34)

Benefits Included	Estimate 1[a]	Estimate 2[b]	Estimate 3[c]	Estimate 4[d]
Healthcare Costs	✓	✓	✓	✓
Lost Productivity	✓	✓		
Pre-Mature Mortality (using foregone earnings method)	✓			
Pre-Mature Mortality (using VSL method for smoking)		✓		
QALYs lost			✓	
Lost Utility value (for diabetes estimate)				✓
Total Health Benefits	**$ 14,896**	**$ 31,546**	**$ 40,308**	**$ 21,250**
Total Costs	**$ 11,000**	**$ 11,000**	**$ 11,000**	**$ 11,000**
Benefit-Cost Ratio	**1.35**	**2.87**	**3.66**	**1.93**
Net-Benefit	**$ 3,896**	**$ 20,546**	**$ 29,308**	**$ 10,250**

Table 2.8: Total Health Benefits and Benefit-Cost Ratio by Estimation Method

[a] In this estimate, we add the healthcare costs, lost productivity costs, and premature mortality costs calculated through the foregone earning method for both diabetes and smoking.
[b] In this estimate, we add the premature mortality costs calculated through the foregone earning method for diabetes and VSL method for smoking to the healthcare costs and lost productivity costs.
[c] In this estimate, we add the healthcare costs to the economic cost of QALYs lost due to diabetes and smoking.
[d] In this estimate, we add the healthcare costs to the economic cost of QALYs lost due to smoking and lost utility value due to living with diabetes.

2.8 Sensitivity Analysis

There are various sources of uncertainty in our analysis, such as those associated with the coefficients of estimated health benefits from participating in the CPC program, discount rates used in our calculation, and the dollar estimate of benefits from the reduction in adverse health outcomes. We tested the robustness of economic benefits by using alternate discount rates and conducted a Monte Carlo simulation to estimate the likelihood of getting positive returns on investment considering the uncertainty in impact estimates and economic values.

2.8.1 Alternate Discount Rates

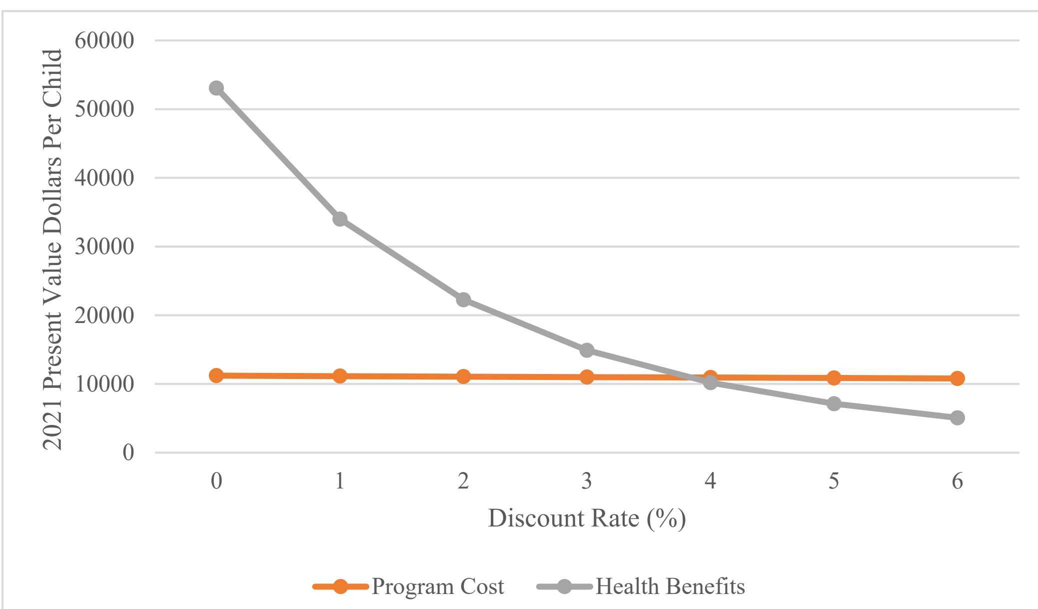
The discount rate reflects the worth of the dollar in the distant future as compared to the present. Since the choice of an appropriate discount rate can have an impact on the economic estimates, we used alternative discount rates of 1%, 5%, and 7% as part of sensitivity analysis. Table 2.9 and Figure 2.3 compare the estimates of various cost and benefit components and the associated benefit-cost ratios and the net benefits for each of the discount rate values. Because the benefits are accrued much later in life, the net benefits of the program decrease with the increase in discount rates.

Table 2.9: Economic Estimates Based on the Discount Rate

Component	1%	3%	5%	7%
Program Cost ($)	11,140	11,000	10,867	10,738
Benefits*				
Diabetes ($)	17,714	7,459	3,364	1,613
Smoking ($)	16,279	7,437	3,751	2,067
Total Health Benefits ($)	33,993	14,896	7,115	3,680
Benefit-Cost Ratio	3.05	1.35	0.65	0.34
Net Benefit ($)	22,853	3,896	-3,752	-7,058

*We use the most conservative estimates of diabetes and smoking benefits in this table.

Figure 2.3: Sensitivity Analysis for Estimated Costs and Health Benefits of the CPC program



2.8.2 Monte Carlo Analysis

We conducted a Monte Carlo analysis to account for uncertainty in the estimated effect of the program on outcomes. We ran 10,000 simulations based on the assumption of a normal distribution of the effect size and accounting for a 10% margin in the dollar estimate of the health benefits. We found the Benefit-Cost Ratio to be in the range of 0.30 to 2.72 with a mean of 1.36. We also find that in ~77% percent of the simulations, the benefit-cost ratio was greater than one, indicating a positive economic return.

2.9 Discussion

In this study, we follow a cohort of students born in 1980 who attended kindergarten in high-poverty neighborhoods of Chicago, nearly two-thirds of who also attended a center-based preschool program. Making use of extensive information collected over more than three decades from the study participants, we evaluate the impact of the preschool program on the long-term health outcomes in adulthood.

We employ the inverse probability weighting approach to ensure comparability of the program and comparison groups and address missing data concerns and conduct a benefit-cost analysis. While there may be threats to internal validity due to non-observables predicting both participation and the outcome, we showed that the weights work well to ensure covariate balance. Our results indicate that participation in the CPC program is associated with a significantly lower prevalence of diabetes (effect size[7]: -0.17) and smoking (effect size: -0.31) in adulthood as well as lower body mass index. The effect size may be interpreted as small to medium, but they are nonetheless practically important considering that the effects are sustained

[7] Probit effect size estimates were calculated for the dichotomous outcome variables

over three decades (Kraft, 2020). In our study, we did not find any significant impacts of the program on depression, which could be attributed to the self-reported measure of diagnosis, as opposed to a multiple-item measure of symptoms. Indeed, a recent study by Mondi and colleagues (2020) found that the CPC program was associated with a 7.1 percentage point reduction in one or more depressive symptoms.

Based on the calculations in the previous section, we obtain the total health benefits to be in the range of $14,896 to $40,308 depending on the preferred method of estimation of program benefits. Dividing by the cost of the program, which is estimated to be $11,000, we obtain a range of benefit-cost ratios from 1.35 to 3.66. A benefit-cost ratio of greater than one indicates that the health benefits of the program by themselves outweigh its costs. On subtracting the cost of the program from the total health benefits, we obtain the net benefit of the program to be in the range of $3,896 to $29,308. While the health benefits of $1.35 per dollar invested are smaller than benefits from savings in crime reduction which were $4.99 per dollar invested, and benefits from increased earnings and tax revenues which were $3.39, they are higher than benefits from the reduction in spending on child welfare which was $0.86, and on special education, which was estimated to be $0.62 per dollar invested (Reynolds, Temple, White, et al., 2011).

We also conducted a Monte Carlo analysis to account for uncertainty in the estimated effect of the program on outcomes. This is important for two reasons; one, our estimates of the impact of the program on the health benefits could be imprecise, and second, the dollar value of benefits we use from the literature could vary based on the assumptions. From a simulation of 10,000 iterations, we found the Benefit-Cost Ratio to be in the range of 0.3 to 2.72 with the average ratio coming to 1.36 and a ratio of greater than one, in 77 percent of the simulations.

This study is strengthened by its use of correction for multiple hypothesis testing which reduces the false-discovery rates of multiple outcomes back to the level of an individual significance test. This procedure is rarely adopted in the literature while testing multiple outcomes at once but is important to ensure that the statistical significance of each outcome is not achieved merely by chance. In addition to the range of methodologies employed for robustness check, another major strength of this study which adds to the validity of the results is its low attrition, with nearly three-fourth of the original participants still being followed-up after over thirty years, which is uncharacteristic of studies with a large sample greater than 1500.

On the lines of previous findings by Garcia and colleagues (2020), Muennig and colleagues (2009), and Belfield and others (2021) in their cost-benefit analyses of the Perry Preschool, as well as a previous cost-benefit analysis of the Child-Parent Center intervention (Reynolds, Temple, Ou, et al., 2011; Reynolds, Temple, White, et al., 2011; Temple & Reynolds, 2015), the results suggest that the health impacts of early educational intervention are significant and may by themselves offset the costs of the intervention, even if no other benefits were observed.

Evidence that participation in school-based education intervention from preschool to third grade can have an impact on health outcomes in adulthood is of great importance to the current debate of how much resources to devote to publicly funded preschool and early elementary school programs. While most of the longer-term research evidence on the impacts of early education focus on outcomes such as earnings and involvement in criminal activity (e.g., Heckman et al., 2010), this study adds to a much smaller set of recent studies on the potential for early investments in education to have long-lasting health effects. Certainly, some of the health benefits found in the Child-Parent Center intervention are driven by the intervention's effect on educational attainment. While crime and violence reduction has been an important contributor to the large social benefits calculated for high-quality preschool investments in studies based on the Perry Preschool program and the Child-Parent Center program, the new results reported in this paper are likely to further amplify the rationale for government investments in early education by focusing more attention on the significant and economically important health savings that may accrue from these public investments.

2.10 Conclusion and Future Directions

In this partial benefit-cost analysis, we focused solely on the health outcomes at age 37 for the preschool component of the CPC program. The results suggest that the health impacts of early educational intervention are significant and may by themselves offset the costs of the intervention, even if no other benefits were observed. However, a future study may look at incorporating benefits across a domain of outcomes such as gain in income and reduction in crime, in addition to health. This will help in calculating a comprehensive benefit-cost ratio of the program. A limitation of our study is that we rely on the self-reported data of health outcomes by the participants. However, the in-person health examination of CLS particpants reported moderate to high correlations between self reports and exams for BMI, hypertension, and diabetes (Reynolds, Eales, et al., 2021; Reynolds, Ou, et al., 2021). The Framingham Risk Score, which includes obesity and hypertension, in a broader index, provides complementary outcome data for further analysis. A future study could look at the health data collected through physical health exams which could enhance the range of outcomes studied and improve the validity of the outcomes. Some recent studies have also gone on to evaluate the impact of early childhood education programs such as the Perry preschool program on mortality (Heckman & Karapakula, 2021). Further research would be needed to evaluate the impact of the CPC program on the premature mortality of participants. In a prior benefit-cost analysis of this sample, a small induced cost (or negative benefit) was reported in terms of the higher required costs to taxpayers if preschool participation induces greater enrollment in public universities (Reynolds, Temple, White, et al., 2011). However, this current health study does not report additional costs or negative benefits arising from better health and longevity. Higher expenditures on social security retirement benefits might be an example of such an induced cost.

While the estimation of the effects of program participation on the various health outcomes suggested significant effects on diabetes, smoking, and BMI, our corrections for multiple inferences led to these results holding at a seemingly high false discovery rate of 0.2. McDonald (2009) and Lee and Lee (2018) have recommended using an FDR value of 0.2 when the cost of false positives (missing potentially important findings) is high. However, if we were to use a more conservative FDR value of 0.1 or lower, then these estimates of program impact would no longer be statistically significant at conventional levels. Finally, we only examined depressive symptoms as a measure of mental health outcomes. Mondi (2020) examined a broader measure of midlife psychological well-being in which CPC participants fared better. Other indicators such as life satisfaction warrant further investigation and potential inclusion in economic returns. Future studies in this field also can increase the focus on mental health by studying other determinants of mental health. This will help us get a better understanding of the impact on overall health including physical and mental health.

Chapter 3: Investing to Scale-Up High-Quality Early Childhood Education: Estimating the Costs of Midwest Child-Parent Center Program

3.1 Introduction

Early childhood education (ECE) programs have been found to be effective in enhancing long-term well-being (Council of Economic Advisers, 2015; McCoy et al., 2017). While the magnitude of the effect may vary due to differences in program quality, duration, levels of family and school involvement, and teaching practices, the cumulative research over the last three decades has shown enduring effects on the educational, financial, and health outcomes of the participants, as well as on the reduction of poverty and crime in the society (Campbell et al., 2014; García, Heckman, et al., 2021; Gray-Lobe et al., 2023). However, despite the accumulated evidence, early childhood education programs have not been scaled to the population level. An analysis of the American Community Survey (ACS) data reveals that less than 50% of 3 and 4-year-olds were enrolled in preschool pre-pandemic (McElrath, 2021). As per the latest estimate from the National Institute for Early Education Research (NIEER), only eight U.S. states (Florida, Georgia, Iowa, New York, Oklahoma, Vermont, West Virginia, and Wisconsin), and D.C. were serving more than 60% of the 4-year-olds through Head Start, state preschool, and special education (Friedman-Krauss et al., 2022).

Many preschool programs with documented evidence of impact provide comprehensive and intensive services with a higher quality of programming that requires additional resources, usually at a cost premium (Council of Economic Advisers, 2023). These programs tend to have smaller class sizes, well-trained and better-compensated staff, and components such as home visits and nutritional programs. The total cost of these evidence-based early childhood programs ranges from $11,700-$57,000[8] (in 2022 U.S. dollars) per child depending on the duration of the

[8] $7,384 to $35,864 in 2002 US dollars

program, which can be a barrier to the successful scaling-up of early childhood education programs (Reynolds et al., 2010). Parents of young children find it challenging to pay for ECE programs as they are often relatively early in their careers, making public investment necessary to make these programs affordable (Davis & Sojourner, 2021).

Ongoing federal and state policy discussions may lead to tremendous increases in access and expenditures in early childhood education. Notably, in 2022, the U.S. Congress considered the Biden Administration's Build Back Better plan, which would have significantly expanded access to early learning opportunities, including universal preschool (Romm, 2021). Thus, learning about the cost of scaling up effective early education programs can be particularly significant for their expansion. Some issues involved with PreK scale up recently have been discussed in List et al. (2021). A theme in the List work is the difficulty in predicting program effectiveness based on studies of smaller-scale programs. In this dissertation, I focus on issues involving the estimation of costs. Only some ECE programs in the literature have reported their cost estimates; however, among those that have, the cost information is often provided as a summary estimate. The lack of detail may make it difficult for others to estimate their own costs when attempting to replicate the program (Jones et al., 2019). In particular, it would be useful to have cost estimates that allow for variation in class size, education requirements for early educators, and other alterable program features associated with quality.

Past studies of ECE programs have estimated the program's costs through one of two methods: one is to assess the economic costs, which is the true resource cost of offering a program, including donated time and facilities. This is required for estimating the societal return on investment for the program. The second is accounting or budgeted costs, which tell policymakers how much funding is needed to provide the program. While economic costs are essential for resource allocation decisions, budgeted costs are useful for policymakers. Through this study, we estimate both – the economic and budgeted costs of implementing a high-quality early childhood education program.

Estimating the costs of ECE interventions can be challenging due to several factors. A key challenge is calculating the "shadow prices" for inputs not included in annual organizational budgets, such as facilities costs and voluntary contributions involving time and money. Instructional costs constitute a large part of the ECE program costs, which may vary vastly by site and the scale of the program. With an increase in the requirement of skills and the number of educators, cost analyses will need to account for the fact that the wages will need to be raised to staff new instructional sites. Finally, while recent public attention has focused on the variation in benefits across studies of different publicly funded PreK programs, there also is a need to better understand the variation in the costs of recent ECE programs.

In this study, we conduct a cost-analysis of the Midwest Child-Parent Center Program (MCPC), a scale-up of the Child-Parent Center Program (CPC). MCPC is a preschool-to-third-grade (P-3) school reform effort implemented across five school districts spanning two states in the Midwestern U.S. The MCPC program has six major components of effectiveness or program quality: collaborative leadership, parent involvement, effective learning, aligned curriculum across grades, continuity and stability, and teacher professional development (Reynolds et al., 2021). While prior cost analysis of the CPC program also assessed school-age services from first to third grade and the extended (preschool to third grade) program for 4–6 years, this study focuses on the preschool component of the expansion program for efficiency purposes. Through this study, we aim to answer the following research questions:

1. What are the economic and budgeted costs to implement the MCPC expansion program in Chicago, and how do they compare to the costs of the original CPC program and other preschool programs?
2. What are the marginal costs of each of the six quality elements associated with the CPC program?
3. What are the implications of this cost analysis for scaling-up early childhood education programs more generally?

3.2 Cost Analyses of Early Childhood Education Programs

Economic evaluations of ECE programs are increasingly being used to inform policy decisions on educational investment, which can be categorized into cost analysis, cost-feasibility analysis, cost-utility analysis, cost-effectiveness analysis, and benefit-cost analysis (Levin et al., 2018). Conducting a rigorous cost analysis that captures the value of all resources utilized in successfully implementing a program is foundational to conducting other forms of economic evaluations identified here (Shand & Bowden, 2022).

Nearly four decades ago, Levin (1975) introduced the "ingredients method" approach to conducting cost analysis. Since then, numerous studies have systematically conducted cost analyses of various early childhood education programs. So far, the most substantial evidence of the impact of early childhood education programs comes from the cost-benefit analysis of three programs – the Perry Preschool Program, the Abecedarian Program, and the Chicago Child-Parent Center program. These programs have shown significant returns to society, with a benefit-cost ratio of 3.8 to 10.8 (Dalziel et al., 2015).

Barnett (1985) estimated the average annual per-child cost of the half-day Perry Preschool Program to be $4,960 in 1981 U.S. dollars ($15,980 in 2022 U.S. dollars). This amount included the cost of instruction, administration and support staff salaries, overhead costs, costs of food and supplies, screening costs for the study, and the costs of interest and depreciation on the fixed capital. Masse and Barnett (2007; 2002) estimated the average annual per-child cost of the full-day Abecedarian program to be $13,900 in 2002 U.S. dollars ($22,610 in 2022 U.S. dollars). They included the cost of staff and volunteers, equipment, supplies, and facilities.

Reynolds and colleagues (2002) found the Chicago Child-Parent Center's half-day preschool program costs to be $4,400 per child per year in 1998 U.S. dollars ($7,900 in 2022 U.S. dollars). The costs included instructional staff, family and community support staff, administration, operations and maintenance, program materials, transportation, food, community services, school-wide services, and school district support. Additionally, they also included the imputed costs of capital depreciation and interest and the cost of parents' time at the minimum wage rate. However, the programs discussed above were targeted, small-scale interventions with high-quality programming implemented more than four decades ago. In the current scenario, understanding the costs of more recent and scalable interventions may be more relevant for policy implications in the field (Decker-Woodrow et al., 2020).

There have been some recent economic evaluations of Pre-K programs in U.S. cities such as Tulsa in Oklahoma, San Antonio in Texas, and Boston in Massachusetts. Bartik and others (2017) conducted a benefit cost-analysis of the Tulsa universal Pre-K program. They estimated the cost of a half-day preschool program in 2005-2006 to be $5,540 in 2013 U.S. dollars ($6,960 in 2022 U.S. dollars) and that of the full-day program to be double the half-day cost. They used the information on the State aid received, Title-I funds used, and the local funds matched by Tulsa Public Schools to estimate the cost. In a more recent cost-benefit analysis, Bartik and colleagues (2022) find a benefit-cost ratio of 2.65 for the Tulsa Pre-K program. In these studies, both the cost and benefit estimates may be fairly conservative as the costs are not calculated using the ingredients method, while the benefits only include the impact of higher earnings.

In another recent cost analysis, Decker-Woodrow and colleagues (2020) found the per child total cost to provide full-day, one-year preschool education at Pre-K 4 San Antonio centers to be $15,270 in 2018 U.S. dollars ($17,800 in 2022 U.S. dollars). This estimate includes the cost of personnel, materials and equipment, facility, and services. It also includes the cost of family engagement, teacher's professional development, and grants provided as part of the program to increase access and quality. Karoly and Walsh (2020) estimated the costs of Early Childhood Care and Education (ECCE) in Oklahoma by collecting data from 25 non–Head Start centers- and home-based ECCE providers throughout the state. They found the annual per-child cost for three-year-olds to be $6,550 in 2018 U.S. dollars ($7,630 in 2022 U.S. dollars). They included the costs of classroom personnel, administrative personnel, staff professional development, classroom materials, food, transportation, space, and administration overheads. Kabay and colleagues (2020) found the costs of Boston's public Pre-K program to be $15,240 to $18,210 per year in 2018 U.S. dollars ($17,760 to $21,220 in 2022 U.S. dollars). Their estimates included the public sector expenditures at the school and district level specific to early childhood education, excluding out-of-pocket expenses from teachers and voluntary contribution of parents' time and resources.

Table 3.1: Summary of Cost Analyses of Early Childhood Education Programs						
Program Name	**Perry Preschool**	**Abecedarian**	**Chicago Child-Parent Center**	**Tulsa Universal PreK**	**Boston Public PreK**	**PreK 4 San Antonio**
Year Implemented	1962	1972	1985	2006	2007	2013
Program Duration	2 Years (3 to 4-year-olds)	5 Years (until kindergarten)	2 Years (3 to 4-year-olds); Extended (4 to 6 years)	1 Year	1 Year	1 Year
Length	Half-Day	Full-Day	Half-Day	Half-Day	N/A	Full-Day
Location	Ypsilanti, MI	Chapel Hill, NC	Chicago, IL	Tulsa, OK	Boston, MA	San Antonio, TX
Per-Child Annual Costs[a]	$15,980	$22,610	$7,900	$6,960	$19,490	$17,800
Per-Child Total Costs[a]	$31,260	$109,360	$17,950	-	-	-
Inclusions	Cost of instruction, administration, support staff salaries, overhead costs, food and supplies, interest and depreciation on the fixed capital	Cost of staff and volunteers, equipment, supplies, and facilities	Cost of instructional, family and community support staff, administration, operations and maintenance, program materials, transportation, food, community services, school-wide services, school district support, capital depreciation and interest, and the cost of parents' time	Costs to all levels of government (State aid received, Title-I funds used, and local funds by Tulsa Public Schools)	Public sector expenditures at the school and district level specific to early childhood education	Cost of personnel, materials and equipment, facility, and services, family engagement, teacher's professional development, and grants provided as part of the program to increase access and quality
Reference	Barnett (1985)	Barnett & Masse (2007)	Reynolds et al. (2002)	Bartik et al. (2016)	Kabay et al. (2020)	Decker-Woodrow et al. (2020)

[a] Costs converted to 2022$ using BLS CPI-U calculator

As identified here and summarized in Table 3.1, most economic evaluations of ECE programs, with the exception of the Boston Pre-K study, have been in the form of benefit-cost analysis, which usually measure the costs with less rigor than the benefits (Karoly, 2012). As noted by Karoly, cost studies should account for all economic costs, including cash and in-kind resources and opportunity costs, such as participant time. However, evaluations of early childhood programs, including the Boston Pre-K study, often overlook these costs, relying solely on budget or expenditure data, and fail to capture all the economic costs of the program.

Through this study, we add to the existing literature on cost studies in early education by evaluating the economic and budgeted costs of the Midwest Child-Parent Center, a high-quality early childhood education program, with the goal of providing helpful estimates for others that aim to replicate the program. More generally, however, we highlight the differences in reported costs in terms of the distinction between economic costs versus budgeted costs. We also estimate the nationally representative costs, which can be helpful for scale-up. We follow the guidelines Karoly (2012) and Shand and Bowden (2022) recommend for conducting economic evaluations of educational interventions and report additional estimates using the recommended assumptions to strengthen the validity of our results and increase comparability across similar programs.

3.3 Midwest Child-Parent Center Program

The Midwest Child-Parent Center Expansion Program (MCPC) is a preschool-to-third grade (P-3) school reform effort implemented across five school districts spanning two states in the Midwestern U.S. This program is a scale-up of the original Child-Parent Center Program (CPC) implemented in 1967 in the Chicago Public Schools. The original program provided comprehensive (education, family, health, and social services) and continuous education and family support services from preschool to third grade in high-poverty neighborhoods of Chicago. However, the program was limited to a half-day preschool of 3 hours.

Prior studies of the CPC program have shown that the program is effective in reducing the achievement gap in school readiness, child maltreatment rates, remedial education, and juvenile arrests, and increasing the rates of high school completion, economic well-being, and physical health in mid-adulthood (Ou & Reynolds, 2006; Reynolds et al., 2018; Reynolds, Temple, Ou, et al., 2011; Varshney et al., 2022). The MCPC scale-up builds up on the original model by incorporating modified and strengthened program elements and also expands the program to full-day preschool at some sites (Reynolds et al., 2017). Appendix 3.1 compares the expanded CPC program with the original program.

With a 5-year Investing in Innovation (i3) grant from the United States Department of Education (USDE), the MCPC program was implemented with a targeted approach in high-risk school communities for at-risk children in economically disadvantaged neighborhoods beginning in the fall of 2012. During the first year, the program served approximately 2,500 3 and 4-year-olds across 26 preschool sites in five communities - Chicago, Evanston, and McLean County in Illinois, and Saint Paul and Virginia[9] school districts in Minnesota. The program aims to promote school readiness and improve early school achievement, which will impact graduation rates, career success, and economic well-being in the longer term. The program has five key objectives within this overarching goal, as outlined in Table 3.2 (Hayakawa et al., 2015).

There is, however, some flexibility in program implementation depending on the families' and communities' needs at each center. This is achieved by following a menu-based

[9] Virginia school district discontinued the program halfway into the preschool year

TABLE 3.2: Child-Parent Center Objectives	
Objective 1	Promote readiness for kindergarten in language and literacy, math, science, and socioemotional learning.
Objective 2	Increase proficiency and excellence in early school achievement, including reading, math, science.
Objective 3	Enhance social adjustment and psychological development in the early grades, including socioemotional learning, school commitment, and self-control.
Objective 4	Increase parent involvement and engagement in children's education throughout early childhood.
Objective 5	Enhance educational attainment, career opportunities, and personal development for parents and family members.
Source: (Hayakawa et al., 2015)	

approach of guidelines based on six core elements that are required to be implemented by each site. These elements are:

a) Collaborative Leadership Team – The Head Teacher (HT) manages each site in collaboration with the principal, Parent Resource Teacher, and School-Community Representative.

b) Effective Learning Experiences – The class sizes were limited to 17 for preschool (as opposed to the usual size of 20) and 25 for K-3 classes. A state-certified teacher and a full-time classroom assistant provide an equal balance of teacher-directed and child-initiated instructional activities. The emphasis is on acquiring basic skills in core learning domains such as language and literacy, math, science, and socio-emotional development.

c) Parent involvement and engagement – This is an intensive menu-based approach designed to maximize the participation of parents in their child's education with the help of a Parent Resource Teacher (PRT) and School-Community Representative (SCR). Each site had a dedicated parent resource room for activities and workshops informed by a needs assessment of the parents. Parents are expected to participate for at least 2.5 hours per week in events and activities such as volunteering in the classroom, attending field trips, and workshops on topics ranging from financial literacy to nutrition, among others.

d) Aligned Curriculum – The principal develops an evidence-based annual curriculum plan and maintains a balanced, activity-based approach toward student learning.
e) Continuity and Stability – Providing continuity between preschool to school-age services through co-located or close-by centers which incorporate comprehensive services delivery and year-to-year consistency for children and families. As part of this element, instructional and family support services are integrated across grades.
f) Professional development system – It includes online teaching modules for the professional development of teachers on topics such as oral language, thinking skills, movement, inquiry, socio-emotional learning, and on-site follow-up support.

The impact of the MCPC program on various outcomes of interest is being evaluated through a quasi-experimental longitudinal study, Midwest Longitudinal Study (MLS). Prior MLS studies have found the program to be associated with significantly higher language and literacy proficiency levels in both preschool and kindergarten (Reynolds, Richardson, et al., 2021) and effective in increasing sustained parent involvement through the second grade (Varshney et al., 2020). Reynolds and colleagues (2014) found the full-day program to be associated with higher school readiness skills, attendance, and reduced chronic absence compared to the half-day program. With this cost analysis of the MCPC program, we aim to open a pathway to conduct future studies on the cost-effectiveness and cost-benefit analysis of the MCPC program.

3.4 Cost Analysis of the MCPC Program

3.4.1 Methods

We employ the 'ingredient-method' approach as defined by Levin and colleagues (Levin et al., 2018) to identify the costs of the Midwest CPC program in Chicago. This approach involves identifying the program inputs necessary for effective implementation, including explicit budget items such as personnel, materials, equipment, and space costs, as well as less explicit items such as the value of time contributed by parents and other volunteers. We reviewed all program budget documents and assessed the personnel and overhead costs of the Chicago Public School district. To ensure comparability, we divide the program's total costs by the number of children served, estimating the per-child cost. Finally, we conduct a sensitivity analysis incorporating uncertainties in costs, which may vary across settings, and compare these costs to the original CPC program's cost to discuss scaling implications.

We also estimate the marginal costs of each of the six major components of MCPC: effective learning, parent involvement, collaborative leadership, aligned curriculum across grades, continuity and stability, and teacher professional development (Reynolds et al., 2021). This will help in identifying the differences between the costs of other preschool programs in the U.S. and the components they offer.

All program costs were calculated in U.S. dollars and converted to 2022 dollars using the Bureau of Labor Statistics' Consumer Price Index for All Urban Consumers (CPI-U) to adjust for inflation. We use a discount rate of 3% to calculate the present value of costs at the start of the program. All cost figures were rounded to the nearest 10 to avoid false imprecision.

3.4.2 Data Analyses

In Chicago, Illinois, of the 16 sites, nine offered both full-day and half-day preschool programs, while five offered only a half-day program and two sites only a full-day program. A total of 85 classrooms offered a half-day program to 1,315 students, while an additional 23 classrooms provided a full-day program to 409 students, equivalent to 1,067 full-time enrollments. In Evanston, Illinois, one site offered a half-day preschool program in ten classrooms, and another offered a full-day program in two classrooms. In McLean County, Illinois, one site provided a half-day program to 85 students across five classrooms.

In St. Paul, Minnesota, a total of five half-day sites offered the program to 260 students in 16 classrooms, and one site offered a full-day program to 24 students across two classrooms. In St. Paul, the Head Teachers and Parent Resource Teachers served two sites instead of one, though the effects of this modification still need to be studied (Reynolds et al., 2021). The Virginia school district in Minnesota discontinued the program halfway through the preschool year due to unforeseen issues.

Since the costs of each ingredient vary significantly by location, conducting a thorough analysis for each of the districts would have vastly increased the length and complexity of this study. Hence, in this study, we limit our analysis to estimating the costs of the MCPC program in Chicago, Illinois.

3.4.3 Cost Ingredients

Following the recommendations of Levin and colleagues (2018), we identify all the resources or ingredients required to replicate the implementation and impact of the MCPC program. We categorize the resources into four major categories: personnel, non-personnel (facilities, materials, etc.), parents' time, and additional professional development.

3.4.3.1 Personnel Costs

The costs of early childhood education programs are primarily driven by personnel costs, which include salaries and fringe benefits provided to teachers, their assistants, and other staff members, such as school community representatives and parent resource teachers. The official budget documents from the Chicago Public School for the school year 2012-13 showed the average fringe rate to be 36%. Hence, we utilized a fringe rate of 36% in addition to the salary when estimating the personnel costs. Table 3.3 provides a summary of the number of teachers and other staff personnel who were involved in delivering the CPC program across 16 sites in Chicago.

3.4.3.1.1 Head Teachers

The CPC program requires one head teacher for approximately every 100 students. In Chicago, one head teacher was appointed for each site, while in St. Paul, one head teacher was responsible for overseeing two sites. The program budget documents revealed a median salary of $85,260 per year (Range: $80,200 - $90,320) for Head Teachers in 2012. Accounting for inflation, we estimate the annual salary of Head Teachers in Chicago to be $108,680 in 2022 U.S. dollars. CPC Head Teachers were among the most experienced teachers in the district and therefore attracted a higher salary.

Table 3.3: Personnel Required to Provide Pre-K in Chicago

	Half-Day	**Full-Day**	**Full-Day Equivalent**
No. of students	1315	409	1067
No. of Pre-K sites	14	11*	-
No. of classrooms	85	23	65
Head Teachers	-	16	16
School Community Representatives	-	16	16
Parent Resource Teachers	-	16	16
Teachers	-	65	65
Teachers' Assistants	-	65	65

*9 sites in Chicago offered both – half-day and full-day programs

3.4.3.1.2 Teachers and Teachers' Assistants

The program required one teacher and one assistant teacher for each class of approximately 17 students. Program documents indicate that the average student-to-teacher ratio was about 16 in Chicago, with the median annual salary of CPC teachers being $73,450 (Range: $58,110 - $82,160). Adjusting for inflation, we estimate the average yearly salary to be $93,620 in 2022 U.S. dollars. The program budget documents show the median annual salary for teacher's aides to be $30,740 (Range: $27,010 - $33,900) in 2012 ($39,180 in 2022 U.S. dollars).

3.4.3.1.3 Parent Resource Teachers

The program appointed a 50% FTE Parent Resource Teacher (PRT) in the St. Paul and Normal School districts, while in Chicago, they worked full-time. The program budget documents show that the average annual salary for this position was $60,000 in 2012 or $76,480 in 2022 U.S. dollars. For a half-time equivalent PRT, we assume a salary of $38,240.

3.4.3.1.4 School Community Representatives

One School Community Representative is required for each school, whose primary responsibility is to reach out and connect with families in the community. According to Hayakawa et al. (2015), the SCR's duties include contacting families whose children have chronic absences, providing home visits to all families, collaborating with community organizations to host workshops for MCPC families, and recruiting families with eligible children from the community. The program's budget documents indicate that the annual salary for this position was $30,000 in 2012 or approximately $38,240 in 2022 U.S. dollars. The SCR were appointed for a 50% FTE appointment for half of the year and a 100% FTE appointment for the remaining half-year, resulting in an average FTE appointment of 75% for the year, with an estimated salary of $28,680.

3.4.3.1.5 Per-Child Personnel Cost

Table 3.4 summarizes the personnel costs required to provide the preschool program in Chicago. Based on the calculations above, we estimate the total personnel costs in Chicago to be around $16.4 million. Of the 1,724 students, 409 received the full-day program, while the remaining 1,315 received the half-day program, equivalent to 1,067 full-time enrollments. By dividing the total personnel costs by the number of full-time equivalent enrollments, we estimate the per-child personnel cost to be $15,360.

Table 3.4: Personnel Costs to Provide MCPC Pre-K in Chicago

	Number	Average Salary	Average Benefits	Per-Personnel Total	Chicago Total
Head Teachers	16	108,680	39,120	147,800	2,364,800
Parent Resource Teachers	16	76,480	27,530	104,010	1,664,160
School Community Representatives	16	28,680	10,320	39,000	624,000
Teachers	65	93,620	33,700	127,320	8,275,800
Teachers' Assistants	65	39,180	14,100	53,280	3,463,200
Total Cost					**16,391,960**

3.4.3.2 Non-Personnel Costs

The Illinois Governor's Office of Early Childhood Development (GOECD) estimated the average non-personnel costs of providing Pre-K in the Chicago metro area during 2017 (Hawley & Ritter, 2021). Table 3.5 outlines these costs in 2022 U.S. dollars after adjusting for inflation, including food, education supplies and equipment, assessment tools, staff training and education, I.T. support and consultation services. The costs for rent, utilities, insurance, administrative staff, and maintenance services, were included under Central Office and Maintenance & Operations lines. The total non-personnel costs per child are estimated to be $4,580 in 2022 U.S. dollars.

Table 3.5. Non-Personnel Costs Required to Provide Pre-K in Chicago (2022 U.S. $)	
Expense	**Cost Per-Child**
Food (including food and kitchen supplies)	$281
Education supplies & equipment	$278
Child Assessment Tool	$30
Staff training & education	$149
Consultation (mental health, nutrition, health, etc.)	$388
IT support	$340
Central Office (includes employee benefits)	$1,437
Maintenance & Operations (includes employee benefits)	$1,676
Total Non-Personnel Costs	**$4,580**

Note: Costs converted to 2022$ using BLS CPI-U calculator.
Food & Consultation costs were divided by 17 to convert per classroom rate to per child rate.
Source: Illinois Cost Model for Early Childhood Education and Care Services (Hawley & Ritter, 2021)

3.4.3.3 Parent's Time Cost

As part of the MCPC program, parents are expected to participate in activities of their choosing for at least 2.5 hours per week. Karoly (2012) recommends valuing the parents' time when their participation in the program is mandatory. Prior studies have valued parents' time using their hourly wages or the prevailing minimum wage. For this program targeted toward children and parents living in high poverty neighborhoods, we use the minimum wage of Chicago, which was $8.25 in 2012 ($10.5 in 2022$), as the opportunity cost of one hour of parent time. The cost of parents' time in the program can be calculated as follows: 2.5 hours per week for 36 weeks per year equals a total of 90 hours, multiplied by the minimum wage of $10.5 per hour, which results in an estimated cost of $950.

This estimated cost of parental involvement should be considered when evaluating the economic feasibility of early childhood education programs, as parental participation is a critical component of these programs. Additionally, this cost may have implications for families with limited financial resources who may need help to meet the program's expectations, affecting their willingness and ability to participate in such programs.

3.4.3.4 Additional Professional Development Cost

In addition to regular staff training provided by the school district, the CPC program utilized the Erikson Institute services to offer teachers additional professional development opportunities. According to the program budget, the total cost of this training in the 2012-13 academic year was $416,970 ($531,500 in 2022$). To calculate the total economic costs of this training, we also accounted for the time cost of teachers, which consisted of 24 hours of instruction per year. Assuming the teacher's salary is paid for 36 weeks per year, five days per week, and eight hours per day of work, the hourly cost of the teacher's time was approximately $88.4. Thus, the total cost of teachers' time spent on the training was $137,930 (24 hours per year*$88.4 per hour*65 teachers), bringing the total cost of additional professional development to $669,430. Shand and Bowden (2022) recommend annualizing training costs for a program over five years based on the prevailing teacher turnover rates. Assuming the training provided to teachers is effective for five years, we estimate the annualized per-child cost of professional development to be $140.

3.4.4 Marginal Costs of the Six CPC Quality Elements

The total cost estimate reflects the value of all the resources required to implement the MCPC program effectively. As discussed earlier in the study, the effectiveness of the CPC program relies on the six core elements required to be implemented by each site: collaborative leadership, parent involvement, effective learning, aligned curriculum across grades, continuity and stability, and teacher professional development. Various early childhood studies have identified elements that are crucial to the program's success. The U.S. President's Council of

Economic Advisers (CEA) (2015) identified these elements as: curriculum, program duration, teacher quality and professional development, and parental involvement and quality of out-of-school time. Table 3.6 compares the CPC elements with those identified by the CEA and the ten benchmarks for high-quality preschool identified by the National Institute for Early Education Research (Friedman-Krauss et al., 2022).

Table 3.6 : Elements of Effectiveness of Preschool Programs

NIEER (2021)	CEA (2015)	Midwest CPC
Comprehensive, aligned, and culturally sensitive early learning & development standards	Program Duration: Full-Day preschool	Collaborative Leadership Team
Teachers have bachelor's degree		State-Certified Teacher
Teachers have specialized training in Pre-K		
Assistant Teachers have CDA or equivalent		
Professional Development & Coaching for Staff	Coaching & Professional Development for teachers and aides	Teacher professional development
Class size of 20 students or lower		Class size of 17 or lower
Staff-Child Ratio of 1:10		Staff-Child Ratio of 2:17
Vision, hearing, and health screenings and referrals		Vision, hearing, and health screenings and referrals
Curriculum Supports	Effective Curriculum focusing on social and emotional development (non-cognitive skills) and math and reading (cognitive skills)	Aligned curriculum across grades
Continuous quality improvement system		Continuity and stability between preschool to school-age services
	Parental Involvement and Quality of Out-of-School Time	Parent Involvement: Atleast 2.5 hours per week

For new early childhood education programs to produce similar long-term effects as CPC, it is imperative to include the program's six quality elements in their implementation. This section estimates the additional cost of having these six quality elements over and above the usual preschool program. We interviewed program stakeholders to estimate the time each category of staff personnel devotes to the six CPC program elements as demonstrated in Appendix 3.2. We then multiplied this by the annual personnel cost to calculate the additional cost of devoting personnel time to these elements.

a) Collaborative Leadership Team – This element requires each site to have a head teacher, a parent resource teacher, and a school-community representative, in addition to the principal, who would oversee the program operations. The Head Teacher spends 60% of their time building a collaborative leadership team. In comparison, the parent resource teacher (PRT) devotes 30%, and the school-community representative (SCR) devotes 5% of their time towards this element. Thus, the costs of this element represent the personnel costs involved with these additional resources, estimated to be $1,830, as depicted in Table 3.7.

Table 3.7: Personnel Costs for Collaborative Leadership Team in Chicago

	Number of Personnel	Per-Personnel Total Cost	Percentage Time Allocation	Total Cost
Head Teacher	16	147,800	60%	1,418,880
Parent Resource Teacher	16	104,100	30%	499,250
School Community Representative	16	39,000	5%	31,200
Total Cost				*1,949,330*
Per Child Cost				**$1,830**

b) Effective Learning Experiences – As a component of the MCPC program, the preschool class size is limited to 17 children, as opposed to the typical class size of 20 children. The smaller student-to-staff ratio necessitated by the smaller class size increases the per-child cost, as more teachers and teaching assistants are required to provide instruction and care to the same number of students. To estimate the additional personnel costs of teachers and assistant teachers associated with reducing class size, we calculated the difference between the personnel costs per child in a 20-child classroom and the personnel costs per child in a 17-child classroom. This calculation yielded a difference of $1,650[10], indicating the additional cost associated with reducing the class size from 20 to 17 children.

c) Parent involvement and engagement – This quality element requires parents to devote a minimum of 2.5 hours per week or approximately 90 hours in a school year towards their children's school activities. Furthermore, each school requires a Parent Resource Teacher (PRT) and School-Community Representative (SCR) who allocate 50% and 85% of their time, respectively, towards this component. Consequently, this quality element comprises the cost incurred in terms of parent's time ($950, as calculated above) and the personnel costs of PRT and SCR at each site, which are $1,280, as shown in Table 3.8. Thus, the total economic costs of this quality element amount to $2,230.

Table 3.8: Personnel Costs for Parent Engagement in Chicago

	Number of Personnel	Per-Personnel Total Cost	Percentage Time Allocation	Total Cost
PRT	16	104,010	50%	832,080
SCR	16	39,000	85%	530,400
Total Cost				*1,362,480*
Per Child Cost				**$1,280**

d) Aligned Curriculum – The head teacher and teacher spend 10% of their time ensuring an aligned curriculum. The cost of their time is estimated to be $1000, as calculated in Table 3.9.

[10] $(11,739,520/1067)*(1- 17/20)

Table 3.9: Personnel Costs for Aligned Curriculum in Chicago				
	Number of Personnel	Per-Personnel Total Cost	Percentage Time Allocation	Total Cost
Head Teacher	16	147,800	10%	236,480
Teacher	65	127,320	10%	827,580
Total Cost				*1,064,060*
Per Child Cost				**$1000**

e) Professional development system – As calculated in the section above, the annual cost of additional professional development for teachers is estimated at $140.

f) Continuity and Stability – The head teacher spends 10% of their time on ensuring continuity and stability. The cost of their time is estimated to be $220, as calculated in Table 3.10.

Table 3.10: Personnel Costs for Continuity and Stability in Chicago				
	Number of Personnel	Per-Personnel Total Cost	Percentage Time Allocation	Total Cost
Head Teacher	16	147,800	10%	236,480
Per Child Cost				**$220**

3.5 Sensitivity Analysis

In this section, we examine the sensitivity of the cost analysis results to variations in key assumptions and input parameters. Given that personnel costs account for more than two-thirds of the program cost, we explore alternate scenarios by adjusting the wages of personnel involved in implementing the CPC program. Teacher salaries are subject to significant variation based on location and experience. The head teachers and teachers involved in the CPC program implementation were relatively experienced and therefore attracted higher salaries. However, new teachers with bachelor's degrees but little to no teaching experience could be hired if the program were to be scaled up. We use the estimates of starting salaries for teachers, head teachers, and teaching assistants from the district budget documents to estimate the program cost in Model 2 of Table 3.11.

Additionally, the wages in Chicago Public School district are among one of the highest in the nation (Geiger, 2019). In Model 3, we use salary estimates of teachers, head teachers, and teaching assistants from the McLean County school district in Illinois, where the CPC program was also implemented. The estimates were obtained from the district's budget document, which did not report the salaries of teaching assistants. Therefore, we assumed that teaching assistants' salaries were 30% lower than those of Chicago based on the difference in teachers' and head teachers' salaries between Chicago and McLean County. Finally, in Model 4, we use the starting salaries for teaching personnel in McLean County to obtain a conservative estimate of the cost of scaling up the MCPC program. The estimates in models 2-4 suggest that the program costs could be reduced by 10-30% depending on the hiring of experienced teachers and location of the program.

Table 3.11: Impact of Varying Teaching Personnel Cost on Program Economic Costs

	Model 1: Average Salary Chicago	Model 2: Starting Salary Chicago	Model 3: Average Salary McLean County	Model 4: Starting Salary McLean County
Head Teachers	108,680	102,230	97,500	78,000
Teachers	93,620	74,000	65,275	40,180
Teaching Assistants	39,180	34,430	27,430	24,100
PRTs*	76,480	51,600	45,520	28,010
SCRs*	38,240	30,230	26,660	16,410
MCPC Economic Costs	**21,030**	**18,240**	**16,670**	**13,390**

*The salaries of PRTs and SCRs were assumed to be in the same proportion with Teachers as Chicago

The Midwest CPC program enlisted the help of paraprofessionals as School Community Representatives. If the program were to be scaled up, districts could recruit volunteers from the parent or community worker pool to fulfill this role. In such situations, we would value the volunteer's time at the prevailing minimum wage when assessing the economic costs; but could reduce the budgeted costs of SCR to zero. Although this would have a negligible effect on the economic costs of the program ($20,780 compared to $21,030), it could lower the budgeted costs of the program to $19,470 compared to $20,050. The combined approach of hiring less experienced teachers and recruiting volunteers as School Community Representatives could help reduce the costs of replicating the CPC program in other locations with limited access to funds.

3.6 Summary and Interpretation

In this study, we calculate the economic as well as the budgeted costs of the Midwest CPC program, which allows us to compare the costs of this program with a wider range of past economic evaluations of preschool programs that estimated their costs using either of the two methodologies. We estimate the economic costs associated with the full-day Midwest Child-Parent Center program in Chicago, which includes personnel and non-personnel expenses, parents' time cost, and the cost of additional professional development. The total annual per-child economic costs of the MCPC program are estimated to be $15,360 for personnel costs, $4,580 for non-personnel costs, $950 for parent's time costs, and $140 for the cost of additional professional development. Therefore, the total cost per child per year is $21,030. Personnel costs represent almost 70% of the program costs, consistent with previous cost studies in early childhood education. To calculate budgeted costs, we exclude the cost of parents' time ($950) and the cost of teachers' time from their additional professional development ($30). We estimate the budgeted costs of the MCPC program to be $20,050.

Prior cost-benefit studies of the original CPC program in Chicago have estimated the annual program cost to be $7,900 (in 2022 U.S. dollars) for the preschool component (Reynolds, Temple, White, et al., 2011). However, the original program was only offered as a half-day program. Hence, the full-day program costs of the Midwest expansion program at $21,030 are comparable to the original program cost. This may not be entirely surprising, as personnel costs, which comprise a significant share of the program cost, have not increased as fast as inflation. An Economic Policy Institute report found that the inflation-adjusted wages of public school teachers increased by only 2.2% in 25 years between 1996 and 2021, as opposed to a 28.5% increase in the wages of other college graduates (Allegretto, 2022).

This study also estimates the marginal costs of each of the six components that make the CPC program a 'high-quality' preschool program. This estimate will help us know the cost of scaling up the quality components of the preschool program. We find the per-child economic cost of these elements as listed in Table 3.12.

Table 3.12: Summary of the Marginal Costs of Six CPC Quality Elements

Element	Per-Child Cost
Collaborative Leadership Team	$1,830
Effective Learning Experience	$1,650
Parent Involvement	$2,230
Aligned Curriculum	$1,000
Continuity & Stability	$220
Professional Development	$140

In our sample of 1,724 students who attended the MCPC program in Chicago, 409 students received the full-day program, while the remaining 1,315 students received the half-day program. The average annual cost of attendance for each child is calculated to be $12,780 using the formula: ((1,315*20,650)/2 + (409*20,650)) / 1,724 = $12,780.

The costs estimated in this study are comparable to the costs estimated in recent economic evaluations of other preschool programs in the U.S., such as the ones in Boston, Massachusetts, and San Antonio, Texas. Decker-Woodrow and colleagues (2020) estimated the annual economic costs of the full-day Pre-K program in San Antonio to be $17,800. While slightly lower, these costs are comparable due to the relatively lower wages for teachers and a lower minimum wage prevalent in San Antonio, Texas as compared to Chicago, Illinois. The Decker-Woodrow study also estimated the cost of the program's four components – two of which are similar to the six CPC quality elements. They estimated the cost of professional development to be $140 per child ($160 in 2022 U.S. dollars), similar to the MCPC program cost. However, their estimate for the family engagement component is $830 ($970 in 2022 U.S. dollars), significantly lower than the MCPC program's parent involvement component. One plausible reason for this difference could be the lower rate of minimum wage in San Antonio, Texas. Additionally, it is possible that the program required less time commitment from parents as compared to the MCPC program, or the authors may not have valued either the economic costs of parents' time or teacher's time in their study.

The budgeted costs of the MCPC program are also in the similar range as the costs of the universal Pre-k program in Boston estimated by Kabay and colleagues (2020), who estimate the program to cost between $17,760 to $21,220 in 2022 U.S. dollars. This could partially be attributed to slightly higher teacher wages in Boston than in Chicago, as reported by the U.S. Bureau of Labor Statistics (2022).

Finally, the costs of the MCPC program in Chicago are also comparable to the budgeted cost estimates produced by the Illinois Governor's Office of Early Childhood Development

(GOECD) who estimate the per-child annual cost of a full school day preschool program in the Chicago metro area to be $18,560 (Hawley & Ritter, 2021).

3.7 Discussion and implications for national scale-up

The method used in this study to estimate the cost of the MCPC program can be used to estimate the costs of scaling up this program nationally. Following the recommendations of Shand and Bowden (2022), in addition to the local wages, we also use the national average salaries for teaching personnel to estimate the average costs of implementing the program nationally.

We obtain the median salaries of preschool teachers, head teachers, and teaching assistants at elementary and secondary schools from the U.S. Bureau of Labor Statistics' Occupational Employment and Wages data from May 2012 and adjust them to 2022 U.S. dollars (U.S. Bureau of Labor Statistics, 2012). The median salary in 2022 U.S. dollars was found to be $62,370, $87,200, and $36,210, respectively, for the teachers, head teachers, and teaching assistants. We assume the salaries of PRTs and SCRs to vary in the same proportion as compared to the teacher's salaries in Chicago. Similarly, we assume the non-personnel costs of the program to vary in the same proportion as the personnel costs. Additionally, we use the federal minimum wage rate of $7.25 to value volunteers' time. Finally, our value of fringe rates at 36% was based on the actual school district budget in Chicago, which can vary for other school districts. Shand and Bowden (2022) recommend a higher rate of fringe benefits in the range of 46% to 58%. We use the average value of 52% as the fringe rate for estimating the nationally representative program costs.

Using these estimates, we find the nationally representative program costs to be $17,060, nearly 20% lower than the program's estimated costs in Chicago. However, these estimates assume that additional personnel can be recruited at the same costs while scaling the program nationally. Past research shows that an increase in demand for teachers may lead to a rise in their wages. Brewer and colleagues (1999) estimated that a 3% increase in the demand for teachers can lead to a 1% increase in the salary of all teachers.

Cost- benefit analysis of labor costs often considers complications in addition to the upward sloping supply curve of teachers. As discussed by Boardman et al. (2017), these additional considerations include the estimation of the welfare gains for teachers as their market wages increase and the need to consider the proper reservation wage associated with scale up if the market from which new teachers are hired is characterized by involuntary unemployment. Moreover, future work on the cost analyses of PreK programs might also consider the role of unionization in estimating the reservation wage, which is important for public school based PreK programs where a significant majority of teachers are unionized.

When considering scaling up the MCPC program, it may also be possible to utilize parent or volunteer resources to take on the Parent Resource Teachers and School Community Representatives role. We discuss the impact of doing this on the program's costs in the sensitivity analysis section. While this approach may not significantly impact the program's economic costs, it could help reduce the budgeted costs by 5 to 10% and make program expansion more feasible.

3.8 Conclusion and Future Directions

This study is significant because it evaluates the costs of expanding a tested and proven ECE program on a larger scale. These estimates provide a more realistic indication of the resources needed to scale up early childhood education in the current circumstances. In this study, we follow the best practices recommended in the literature to estimate both the budgeted as well as the economic costs, valuing all ingredients, including overhead costs and parents' time that are often overlooked. Considering that various ECE interventions measure the program costs using either of these methods, we highlight the differences in costs for each of these measures.

We find the economic costs of the MCPC, a full-day high-quality preschool program, to be $21,030 and the budgeted costs to be $20,050 in Chicago. Some of the areas where the costs will vary across the two estimates are parental time, teacher's time for training and professional development, and voluntary contributions in form of time and money from teachers and other stakeholders. If the program operates from a donated or previously constructed space, then the facilities costs will also be excluded when estimating the budgeted costs. While, in this study, we find relatively smaller differences in the two cost measures (around 5%) due to fewer in-kind contributions to the program, we provide the reader with a framework to consider the implications of these differences in other contexts.

Further, this is one of the first cost analyses of a preschool program that measures the marginal costs of each of the six components that make it a high-quality ECE program. When scaling or replicating this program to other locations, it will be essential to implement these quality elements in order to observe impacts similar to that of the MCPC program. Hence, estimating the marginal costs of these quality elements helps in understanding the costs required to scale up this program.

In this study, along with the local estimates of the cost of implementation of the MCPC program in Chicago, we also evaluate the nationally representative costs, which help us enhance the comparability of our estimates. Given that the wages in Chicago are relatively higher owing to its major metropolitan status, the program is estimated to cost 10% to 20% lower on average if replicated nationwide with similar implementation fidelity.

As the evaluations of the long-term impacts of the MCPC program are currently underway, this cost analysis will open a pathway to conduct future studies on cost-effectiveness analysis and cost-benefit analysis of the program. Finally, this study can guide policymakers on effective resource allocation decisions in ECE, which is a growing need in the current times.

While this study has many merits, it suffers from some limitations. First, this study was done as a retrospective analysis almost a decade after the program's implementation. Thus, some of the actual program costs, such as the actual salaries given to PRTs and SCRs, were unavailable, necessitating us to go with the average budgeted costs for these personnel. Additionally, the Chicago Public School district budget from the program's implementation year did not allow us to ascertain the non-personnel and overhead costs of the program accurately. Hence, in this analysis, we relied on the closest estimate of these costs provided by the Illinois Governor's Office of Early Childhood Development (GOECD). Finally, this study only estimates the costs of implementing the program in Chicago. A future study can expand this analysis to estimate the costs of the program's implementation across the three other school districts.

Chapter 4: Exploring Innovative Financial Mechanisms for Expanding Nurse Home Visiting Programs: A Cost-Benefit Analysis Perspective

4.1 Introduction

Early childhood development (ECD) is a critical period of growth and development that lays the foundation for future success. However, some groups of children, particularly Black and Hispanic children and those from low-income families in the U.S., face greater challenges, as they are more likely to experience a lack of access to quality healthcare and education, be born with developmental disabilities, and are more likely to be exposed to environmental toxins (Burris & Hacker, 2017; Martinson & Reichman, 2016). These disparities can have significant negative impacts on children's cognitive and socioemotional development, including language and literacy skills, social competence, and self-regulation (Figlio et al., 2014).

One potential solution to addressing these disparities in ECD is nurse home visiting, where trained nurses and paraprofessionals provide comprehensive education and support to expectant mothers from disadvantaged backgrounds (Olds, 2010). Still, despite considerable research demonstrating the positive impacts of these programs, they are currently only able to serve less than 10% of high-risk mothers across the U.S. (NHVRC, 2022).

Public funding plays a critical role in addressing disparities in ECD, supporting access to quality healthcare, nutritious food, and programs that provide support for families, such as home visiting programs and parent education programs. Investing in ECD programs not only leads to improved long-term outcomes for individuals but also benefits society by promoting greater productivity, economic growth, reduced reliance on government transfers, and fewer costly outcomes such as poor health, high school dropout rates, and crime (Council of Economic Advisers, 2023).

In practice, public funds are limited, so allocating public resources across a wide range of programs that are effective in serving young children can be challenging. For example, a wide range of high-quality preschool programs have been shown to improve children's cognitive and socioemotional skills, leading to benefits across a range of outcomes that last for decades through adulthood, particularly for children from disadvantaged backgrounds (Bailey et al., 2021; Campbell et al., 2014; García, Bennhoff, et al., 2021; Gray-Lobe et al., 2023; Varshney et al., 2022). In addition, studies have found substantial impacts of child care and early home visiting programs on children's long-term outcomes as well as maternal employment (Duffee et al., 2017; Herbst, 2017). When deciding between different programs, economic evaluation methods such as Cost-Benefit Analysis (CBA) are often used by policymakers and funders to make informed decisions about allocating resources across various programs (Boardman et al., 2017).

Cost-benefit analysis is a method of comparing the costs of an intervention to the benefits it generates. When the total expected benefits of a program exceed the total expected costs, it may be beneficial to invest in the program; however, when deciding between comparable programs, the one with a higher benefit-to-cost ratio or the one with the highest net benefit may receive preference. Thus, conducting CBAs of ECD programs can help promote efficiency in public decisions regarding which programs to fund and how much to invest in them.

The typical approach to conducting benefit-cost analysis considers the societal benefits, i.e., the benefits for all members of the society. However, this approach leads to questions around the issue of equity because benefits to people across different income groups may be valued differently. Therefore, when conducting a cost-benefit analysis, it is important to consider the distributional impacts of a policy or program. For example, we may disaggregate the benefits of a program to (a) the intended beneficiaries, (b) the government or taxpayer savings, and (c) to people in the society at large. In the case of ECD programs for children from low-income families, studies have reported that the benefits for the second and third categories are far larger than the first category. While investing in a program, funders may value these benefits differently. For instance, the government may be more interested in savings for taxpayers and society. At the same time, philanthropies may be more interested in the benefits to low-income program participants.

In this study, I draw on existing economic evaluations of Home Visiting programs to examine the distribution of benefits across these categories. Home Visiting programs have been well-studied with multiple evaluations based on randomized controlled trials showing short- and long-term effects (Dodge et al., 2014; E. Lee et al., 2009; Olds et al., 2002). Based on these impact evaluations, cost-benefit analyses typically show social benefits higher than costs (Olds et al., 2019; Wu et al., 2017). Further, several benefit-cost analyses of Home Visiting programs have reported disaggregated benefits by outcome and beneficiaries (Miller, 2013; Miller et al., 2011).

I first highlight different approaches to conducting cost-benefit analysis and then discuss two newer approaches to social impact financial investment that rely on economic evaluation methods – Pay for Success (PFS) and Data-Driven Philanthropy. PFS is a type of financing mechanism where private investors provide funding for a social program, and the government pays back the investors based on the program's success in achieving pre-determined outcomes solely in terms of government cost savings (e.g., reduced welfare expenditure). Data-driven philanthropy involves using data and evidence to guide philanthropic investments and maximize impact in terms of the benefits received by low-income community members (e.g., increased employment or earnings).

I show that even after restricting the benefits of Home Visiting programs solely to government cost savings or the target population, the benefits of home visiting programs outweigh the program's costs, making it a worthwhile investment for Pay for Success projects as well as data-driven philanthropy endeavors. I discuss how these innovative financial mechanisms can expand access to home visiting programs by leveraging private sector resources and ensuring that public funding is used effectively. Finally, I suggest that these social impact approaches can help integrate concerns about equity into benefit-cost analysis and help target resources to communities most in need.

4.2 Home Visiting Programs and their Funding

Home Visiting programs are an important initiative for early childhood development that provide comprehensive assistance and support to new and expectant parents to promote positive parenting, maternal and child health, household safety, and food security. These programs aim to connect poor and high-risk families with a designated support person, such as a trained nurse, social worker, or early childhood expert, to provide supportive services that foster positive parenting and improve household safety, food stability, and maternal and child health (Howard & Brooks-Gunn, 2009). These services are offered to participating families at no cost. Typical services offered by home visiting programs include screening, case management, counseling, and caregiver skills training.

Home visiting programs have numerous advantages that are often overlooked. For instance, families can benefit from not having to search for services or arrange for transportation to reach the services. By visiting homes, professionals can observe the living environment of families, enabling them to recognize the unique needs of each family and provide more personalized attention than traditional clinic-based consultations. Additionally, home visiting allows professionals to build relationships with families that may not be possible with other interventions (Goldfeld et al., 2018).

The Maternal, Infant, and Early Childhood Home Visiting (MIECHV) Program was created in 2010 as a federal initiative to assist pregnant women and families with children aged zero to five. The primary objectives of the MIECHV program include improving maternal and child health outcomes, promoting school readiness, and preventing child abuse and neglect (U.S. Department of Health and Human Services, 2022). Over the last decade, this program has been the most significant source of funding for home visiting in the U.S., providing funding to states and territories to execute evidence-based programs. In 2014, a budget of $1.5 billion was approved over a ten-year period (2015-2024) to maintain and expand these evidence-based home visiting programs. The program was reauthorized in 2018 by the Bipartisan Budget Act, which allocated $400 million annually until the fiscal year 2022 (Sandstrom, 2019). In December 2022, the U.S. Congress further reauthorized the program for another five years, doubling appropriations to $800 million through 2027 (*Jackie Walorski Maternal and Child Home Visiting Reauthorization Act of 2022*, 2022).

In addition to the MIECHV funds, other public funding streams such as Medicaid and Temporary Assistance for Needy Families (TANF) have also supported home visiting programs. Some states have also used funds from their education programs, tobacco settlements and taxes, lotteries, or general fund to expand these programs (Sandstrom, 2019). However, the current funding sources for home visiting are insufficient to meet the needs of eligible families. According to the National Home Visiting Resource Center's (NHVRC) 2022 Yearbook, more than 21,000 home visitors delivered evidence-based home visiting programs across all fifty states, the District of Columbia, five U.S. territories, and twenty-five tribal communities, covering 54% of U.S. counties in 2021. Despite this broad geographic coverage, home visiting programs could only cater to the needs of around 280,000 families out of more than 17.5 million eligible families across the country (~1.6%). Even among the families identified as very high-priority based on having two or more risk factors, such as having an infant, single mother, parent with no high-school diploma, mother under 21 years, or family with income under the federal poverty threshold, these home visiting programs could only cater to around 8.7% of high-risk families (NHVRC, 2022). Therefore, there is a need to not only expand public funding but also to find innovative funding strategies that can involve interested private players in meeting the unmet needs.

4.3 Nurse-Family Partnership Home Visiting Program

A variety of home visiting programs are currently being implemented in the U.S. and globally. These models vary in their objectives, the approach used, the range and level of service intensity provided, the workforce involved (nurses vs. paraprofessionals), and the types of families and children they serve. There is mixed evidence regarding the effectiveness of various home visiting programs. However, there are currently 17 home-visiting models operational in the U.S. that meet the U.S. Department of Health and Human Services criteria to be recognized as evidence-based programs, including some of the popular programs such as the Nurse-Family Partnership (NFP), Healthy Families America (HFA), Parents as Teachers (PAT), and Early Head Start (EHS) (NHVRC, 2022).

The principles of the effectiveness of home visiting are a big feature as the programs differ in their goals and characteristics. NFP requires their nurses to have baccalaureate degrees, whereas other programs like PAT and HFA employ paraprofessionals with at least a high school credential. There are also big differences in the program's intensity and training. EHS implemented weekly home visits for approximately 90 minutes, while HFA and NFP also conducted weekly visits with a shorter duration of around 60 minutes. On the other hand, PAT offered varying visit frequencies of monthly, biweekly, or weekly, with each visit lasting approximately 60 minutes, depending on the specific needs of the families involved (Corso et al., 2022). A systemic review of various home visiting programs found the NFP program to demonstrate positive effects across the widest range of outcomes, including physical and psychosocial health outcomes for both - the child and the mother, parenting skills, and the mother's self-sufficiency outcomes (Beatson et al., 2021). Hence, we focus on the NFP home visiting program model for the rest of this study.

Nurse-Family Partnership (NFP) is one of the largest and most popular home-visiting models aimed at low-income expectant mothers with their first child. As of 2021, the program is operational in 40 states and the U.S. Virgin Islands, providing over 500,000 visits to more than 50,000 families (National Home Visiting Resource Center, 2022). The curriculum of the NFP program focuses on promoting healthy habits during pregnancy, educating parents with skills suitable for their child's developmental stage, helping reduce subsequent pregnancies, and extending the time between them. The program provides services from the twenty-eighth week of pregnancy until the child turns two. The home visiting frequency for the NFP program is as follows: a) during the first program month – weekly; b) until delivery – biweekly; c) first six weeks after birth – weekly; d) until the child is 20 months – biweekly; e) till the child is 24 months – monthly (Howard & Brooks-Gunn, 2009).

4.3.1 Evidence of Effectiveness of the NFP Program

There have been a series of randomized trial studies of the NFP program examining the impacts of the program on a variety of short and long-term outcomes. The first Randomized Controlled Trial (RCT) of the NFP program started in 1977 in a semi-rural setting in Elmira, NY which enrolled around 400 low-income first-time mothers. The study, led by David Olds and his team, surveyed participants at regular intervals and last followed them up to age 19 measuring the impact of the NFP program on a wide range of outcomes for both – the mother and the child. The positive effects observed in the Elmira study spurred a lot of home visiting programs and studies in the field, and also led to a rare replication and extension of the study in Memphis, TN and Denver, CO (Olds, 2010). Table 4.1 provides a summary of the latest follow-up studies of all the three cohorts.

In a post hoc analysis of over 20 impact evaluations spanning three randomized controlled trials (RCT) of the NFP programs in Elmira, NY, Memphis, TN, and Denver, CO, over a period of three decades, Donelan-McCall, and colleagues (2021) found that the NFP program was associated with lower rates of all-cause maternal mortality and preventable-cause mortality among the children.

Table 4.1: Summary of Results from the Follow-up of 3 Key NFP Studies			
Location	Elmira, NY	Memphis, TN	Denver, CO
Year of Enrollment	1978-1980	1990-1991	1994-1995
Sample Size	400 (216: Nurse; 184: Control)	1138 (458: Nurse; 680: Control)	735 (Nurse: 235; Paraprofessional: 245; Control: 255)
Demographics	88.5% White; Semi-Rural community	92.4% Black	47% Hispanic, 35% White, 15% Black
Last follow-up at age	19 Years	18 Years	9 Years
Impacts	Reduction in likelihood of arrests (Relative Risk [RR]: 0.33) and convictions (RR: 0.20). Fewer lifetime arrests (RR: 0.18) and convictions (RR: 0.11). Nurse visited girls had fewer children (RR: 0.35) and less Medicaid use (RR:0.40).	Better receptive language (Effect Size [ES] = 0.24), Math achievement (ES = 0.38), Fewer convictions for female children (Incidence ratio = 0.47). Reduction in all-cause mortality among mothers (p=0.007), and preventable-cause mortality in children (p=0.04).	Lower emotional/ behavioral problems (RR = 0.45), internalizing problems (RR = 0.44) and dysfunctional attention (RR = 0.34). Better receptive language (ES = 0.30) and sustained attention (ES = 0.36).
Reference	(Eckenrode et al., 2010)	(Kitzman et al., 2019; Olds, Kitzman, et al., 2014)	(Olds, Holmberg, et al., 2014)

4.3.2 Economic Evaluations of the NFP Program

Past cost-benefit analyses of the NFP program have found that its benefits outweigh the costs. Different studies have included estimates of the benefits for different outcomes and at varying ages of participants for programs implemented in different locations across the U.S.

In a study of the NFP program in Denver, Miller and others (2011) evaluated the program's benefits through age nine across a range of maternal and child outcomes. They valued the benefits of NFP participation on increased maternal earnings, reductions in pregnancy complications, maternal depression, and domestic violence for mothers, reductions in remedial services, the prevalence of ADHD, and being held back in school for the child. They found the program's benefits on these outcomes to outweigh the program's costs by a ratio of 3.05:1.

In a follow-up cost-benefit analysis, Miller (2013) analyzed the long-term benefits of the NFP program on a comprehensive set of maternal and child outcomes, including preterm births, immunization, childhood maltreatment and injuries, youth substance abuse and criminal involvement, and use of public assistance such as Medicaid, TANF and food stamps. He used data from more than 30 national evaluations of the NFP program across six states and found the program's benefit-cost ratio to be 6.2:1. In this study, he also segregated the benefits accrued to participants, governments at the federal or state/local level, or other stakeholders.

Olds and colleagues (2019) accounted for reductions in costs for specific public benefits such as Medicaid, SNAP, AFDC, and TANF through the child's age of 18 in their latest economic evaluation of the NFP program in Memphis, Tennessee. They found the program benefits on these measures amounting to $17,310 by themselves, outweighed the program costs, which were estimated to be $12,578. If benefits on other outcomes were to be also valued, the program's benefit-cost ratio would improve substantially. The Washington State Institute for Public Policy (WSIPP, 2019) conducted a meta-analysis of several randomized controlled studies of the NFP program. They estimated the program benefits to be $16,993 against a cost of $12,437 for every child served by an NFP program in 2018 dollars.

Table 4.2 compares the total costs and benefits of the NFP program per family across a range of outcomes as evaluated in these studies. The estimates vary across studies as each of these studies evaluated the program's impacts on a different sample of participants and measured a different set of outcomes. For example, Olds et al. (2019) only measured the benefits in form of public savings from reduced welfare expenditure. Table 4.3 shows the disaggregated benefits across these outcomes to families, taxpayers, and others as reported in the Miller et al. (2011) and WSIPP (2019) studies. Disaggregated benefits for taxpayers from Miller (2013) are discussed in later sections.

Table 4.2: Comparison of NFP Program Costs and Benefits Across Studies (2022 U.S. Dollars)				
	Miller et al., 2011[a]	Miller, 2013	Olds et al., 2019[b]	WSIPP, 2019[c]
Program Total Costs	15,739	11,515	17,158	14,495
Total Program Benefits	55,783	71,253	23,621	19,805
Benefit-Cost Ratio	3.5	6.2	1.4	1.4
Benefits by Category				
Reduced Smoking While Pregnant	19	15		
Increased Maternal Earnings	26,667			1,755
Reduced Domestic Violence	7,453			
Reduced Maternal Depression	13,990			(90)
Fewer Remedial School Services	199			
Reductions in ADHD	7,840			
Reduced Grade Repetition	(387)			(114)
Reduced Preeclampsia		863		
Fewer Preterm First Births		2,609		
Fewer Subsequent Births		600		
Fewer Subsequent Preterm Births		2,185		
Fewer Infant Deaths		33,210		10,077
Fewer Child Maltreatments		14,849		13,965
Fewer Nonfatal Child Injuries		1,186		
Fewer Remedial School Services		98		(1,117)
Fewer Crimes		13,716		1,869
Reduced Youth Substance Abuse		46		2
Increased Immunizations		145		
Reductions in SNAP Costs			8,835	94
Reductions in AFDC and TANF Costs			4,499	550
Reductions in Medicaid Costs			9,516	
Reductions in Low Birthweights				58

Note: All estimates are per family. The costs are for the full program. Benefits are reported through age 9 in the Miller et al. (2011), age 18 in Miller (2013) and Olds et al. (2019), and lifetime in WSIPP (2019).
[a] Miller et al. (2011) did not include benefits from the reduction in ADHD in their Benefit-Cost Ratio calculation
[b] Benefits across categories do not add up to the total reported benefits in Olds et al. (2019)
[c] The WSIPP estimates reduce benefits by $7,248 to adjust for program deadweight costs

Table 4.3: Benefits Disaggregated by Beneficiaries (2022 U.S. Dollars)						
	Miller et al. (2011)			**WSIPP (2019)**		
	Family	**Taxpayer**	**Other**	**Family**	**Taxpayer**	**Other**
Reduced Smoking While Pregnant	19					
Increased Maternal Earnings	24,000	2,667		1,231	524	
Reduced Domestic Violence	7,370	84				
Reduced Maternal Depression	13,494	72	424	(9)	(30)	(51)
Fewer Remedial School Services			199			
Reductions in ADHD	7,759	81				
Reduced Grade Repetition			(387)		(76)	(38)
Fewer Infant Deaths				1,030	438	8,607
Fewer Child Maltreatments				10,387	3,593	(15)
Fewer Remedial School Services					(745)	(372)
Fewer Crimes					545	1,324
Reduced Youth Substance Abuse				1		2
Reductions in SNAP Costs				(136)	154	77
Reductions in AFDC and TANF Costs				(177)	484	242
Reductions in Low Birthweight					38	20

4.4 Different Approaches to Conducting Benefit-Cost Analysis of the NFP Programs

When performing a benefit-cost analysis, the conventional method, also called societal cost-benefit analysis, considers calculating and adding all benefits. Nevertheless, the question arises as to whether all benefits should be considered equally. For instance, childcare provision may lead to increased earnings for mothers as they are able to join the workforce. While this may lead to increased tax collection for the government, the private benefits to the mothers are expected to be much higher than the public benefits to the government.

Let the following equation represent the total benefits (B_t) of the NFP program:

$$B_t = w_1 B_g + w_2 B_p + w_3 B_o,$$

Where B_g represents the benefits to the government (savings accruing to all levels of government: local, state, and federal), B_p represents the benefits to the program participants and their families, who usually come from disadvantaged backgrounds, and B_o represents the benefits to other stakeholders such as the employers and other community members. The weights to differentially value the benefits across these categories are denoted by w_i.

The most common approach to conducting benefit-cost analysis involves calculating the societal benefits. In this approach, the benefits to everyone are given equal consideration, i.e., one dollar of benefit to the public sector is considered equally beneficial as a one-dollar benefit to the program participants. Hence, under this approach, all the weights are given an equal value of 1, and one can simply add up the benefits across each category to compute the total program benefits, $B_t = B_g + B_p + B_o$. Under this approach, there is no need to disaggregate these governmental benefits accruing to different levels of government: local, state, and federal because they are all valued equally.

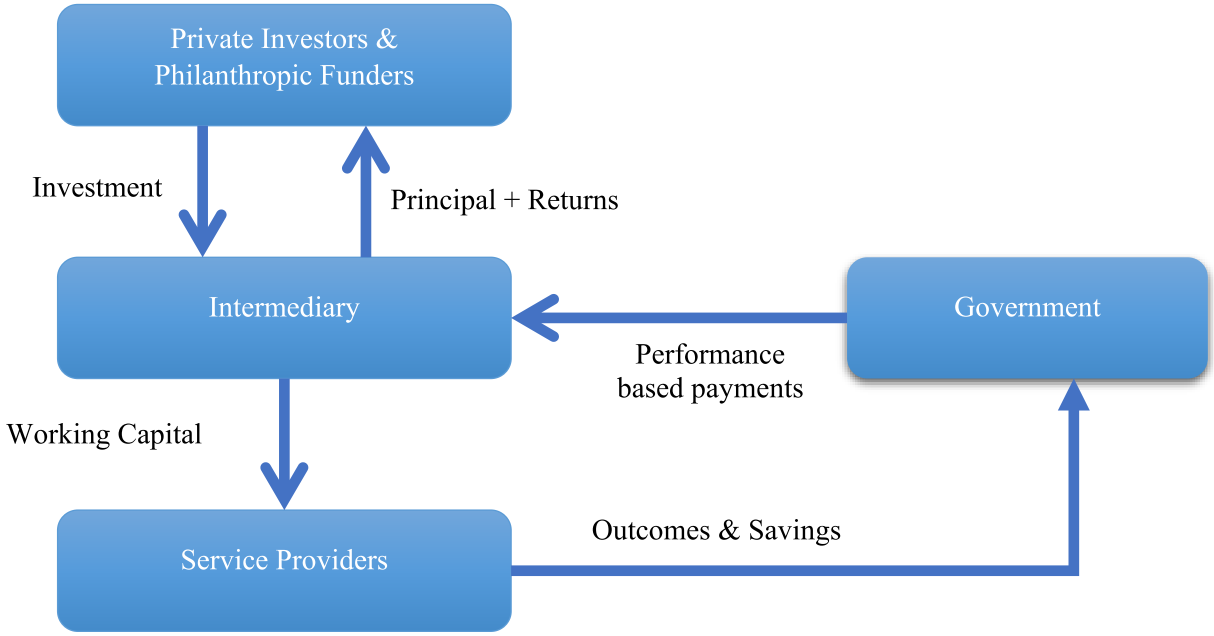
However, the benefits across these categories may be valued differently under some cost-benefit analysis approaches. Further in this section, I discuss two innovative financing mechanisms that can be used to expand funding for the Nurse-Family Partnership programs through the use of differential cost-benefit analysis approaches.

4.4.1 Pay for Success (PFS)

Introduced to the U.S. just over a decade ago, Pay for Success (PFS) (also referred to as Social Impact Bond (SIB)) is a novel model of financial arrangement that uses public-private partnerships to increase investment in evidence-based prevention programs that can potentially improve participants' social outcomes. Public savings resulting from these outcomes are then used to repay the private investors if and only if the pre-determined targets of program success are met. Details about the first 25 PFS deals launched in the U.S. are found in Nonprofit Finance Fund (2019).

Figure 4.1 shows the PFS model. For example, an investment bank like Goldman Sachs or a philanthropy might decide to provide $15 million in funding to support the expansion of a proven or promising preventive intervention. An intermediary organization such as the United Way oversees the deal and ensures the projects are implemented according to the agreed-upon terms using the funds provided. They also manage an independent evaluator who determines if the target outcomes were achieved using rigorous impact evaluation. Non-profit service providers are engaged to deliver the program services to the target population. A typical PFS program includes one or more levels of government, who would then repay the investors from the savings accrued to them.

Figure 4.1: Pay for Success Model



Note: Arrows denote the flow of funds
Source: Kadam et al. (2018)

4.4.1.1 Identification of Public Savings in PFS

Under the PFS approach, we are only interested in estimating the benefits to the government in the form of taxpayer savings. Therefore, the weights for the benefits to program participants and other stakeholders can be assumed to be zero, yielding the total benefits (B_t) equal to the benefits to the government (B_g). However, the program's benefits may be realized by different levels of government – federal, state, or local. Since all levels of government may not be involved in the PFS project, we should be careful in estimating the share of benefits accruing to the level of government responsible for repaying the investors.

Dubno and colleagues (2014) identify two criteria used to measure "success" in PFS agreements: cost avoidance and outcome improvement. "Cost avoidance" denotes tangible reductions in government operational expenses as an impact of the program, such as lower medical costs due to fewer preterm and low birth weight infants. “Outcome improvement” signifies the quantifiable change in pre-determined outcomes, which may not be immediately monetizable but can lead to long-term benefits such as a decrease in the incidence of child abuse.

The evidence presented in the sections above shows that the benefits of the NFP program on savings in the form of “cost avoidance” on programs like Medicaid, SNAP, AFDC, TANF, and others may by itself offset the program costs. Miller (2013) found that if the NFP program were to be fully funded by Medicaid, then state and federal governments would be able to fully recoup the program’s costs from savings through the Medicaid program itself. If savings through TANF, food stamps, and other government costs were to be added, then the public sector could save over $2.2 in the long term (through a child’s 18 birthday, discounted to present value) for every dollar invested in the program, as depicted in Table 4.4. Hence, this approach can be instrumental in increasing access to funding for expanding the NFP program.

Table 4.4: Government Cost Savings per Family Served by NFP (2022 $)

Medicaid	$14,065
Food Stamps	$3,836
TANF	$2,302
Child Protective Services	$2,045
Police Adjudication & Sanctioning	$1,790
Special Education	$1,023
Miscellaneous	$511
Total Government Savings	**$25,573**
Program Costs	**$11,515**

Source: Miller (2013). Values adjusted to 2022$ using the BLS CPI-U calculator

4.4.1.2 Challenges in Calculating Public Savings by the Level of Government

The benefits in government savings identified in Table 4.4 are realized at different levels of government, making it challenging to identify a plan for using these savings to repay the private investors. For instance, the financial responsibility for Medicaid is split roughly 50-50 among the state and federal levels, while the child protective services often are the responsibility of the county. Special education costs are divided between local, state, and federal governments. Therefore, for a PFS project to be viable, the benefits incurred to the entity serving as the success payment payor should be large enough to cover the program's costs. A feasibility study often is undertaken to determine which level of government (local or state, for example) should serve as the payor. The choice of the payor is based on what level of government receives the majority of the cost savings from expansion of a successful preventive intervention.

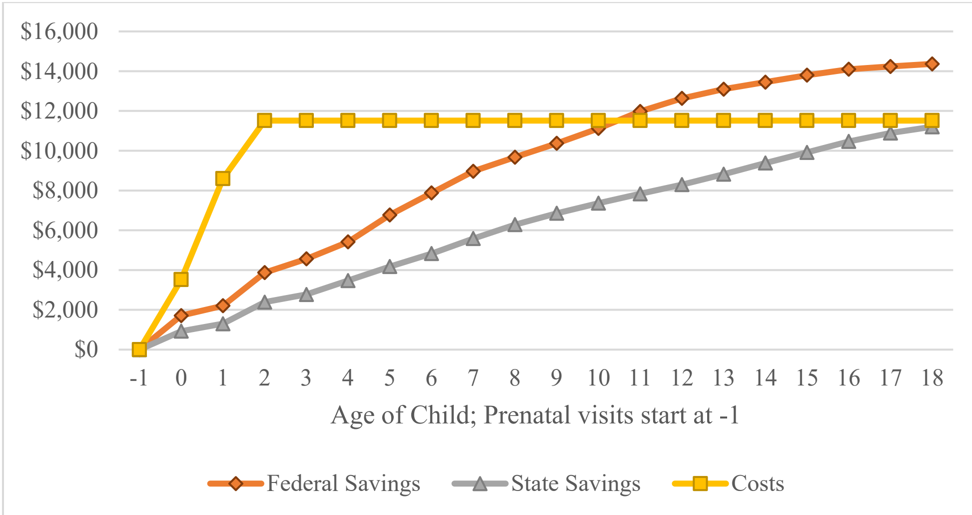
Miller (2013) found that when the public savings are disaggregated according to the level of government experiencing the cost savings, the federal savings alone exceed the program's costs. State savings by themselves are slightly lower than the costs, as shown in Figure 4.2. This indicates that if the federal dollars are used to expand NFP, the federal government will save enough in the long term to recoup the project's cost, making it a viable project for PFS. Furthermore, in these calculations, Miller only estimated the benefits until age 18. The benefits are expected to be larger for a longer-term follow-up, which might make it viable for the state to cover the program's cost.

4.4.1.3 NFP Pay for Success Project in South Carolina and Delaware

The MIECHV program reauthorization permitted the states to allocate up to 25% of their grant funds through pay-for-success financing to private entities offering initial financing for the program (Sandstrom, 2019). Many U.S. states, including South Carolina, Delaware, and Connecticut, have tapped into the Pay-for-Success models to expand NFP programs.

In 2016, South Carolina launched a four-year PFS project with $17 million in funding from philanthropies and $13 million from Medicaid funding to expand the program to serve an

Figure 4.2: Costs of the NFP Program Compared with Federal and State Savings



Note: Values adjusted to 2022$ using the BLS CPI-U calculator and discounted to present value using a 3% discount rate.
Source: Miller (2013)

additional 3,200 mothers, a nearly three times growth, as compared to the 1,200 mothers that were being served at that time (Goldberg, 2017). Table 4.5 provides the details of the stakeholders involved in the project implementation. While Miller (2013) found that state savings were just not enough to cover the program's costs, in South Carolina, the state's Department of Health and Human Services is acting as the payor. This could be feasible as the state has used the 1915(b) Medicaid waiver to use the funds awarded to the state by the federal Centers for Medicare and Medicaid Services (South Carolina Department of Health and Human Services, 2016).

Success payments in this program were tied to four outcomes - reduction in preterm births; reduction in child injury (hospitalization and emergency department usage); increase in healthy spacing between births; and increase in the program participants from pre-identified neighborhoods with high concentrations of poverty. This PFS project differs from traditional PFS projects in one significant way – the maximum payment outcome of $7.5 million is not only less than the total project investment but also, the success payments would be completely reinvested into the program rather than being returned to the private investors.

Table 4.5: Stakeholders involved in the South Carolina NFP Pay for Success project

Role	Stakeholder
Investors	BlueCross BlueShield - $3.5 million The Duke Endowment - $8 million The Boeing Company - $800,000 Greenville First Steps - $700,000 Laura and John Arnold Foundation - $491,000 Other private funders -$4 million Medicaid - $13 million
Project Intermediary	Social Finance
Fiscal Intermediary	Children's Trust of South Carolina
Service Provider	Nurse-Family Partnership
Evaluator	J-PAL North America
Outcome Payer	South Carolina Department of Health and Human Services (SCDHHS)
Technical Assistance	Government Performance Lab at the Harvard Kennedy School
Legal Assistance	WilmerHale Nelson Mullins Riley & Scarborough LLP

Source: Urban Institute. Information retrieved from: https://pfs.urban.org/pfs-project-fact-sheets/content/south-carolina-nurse-family-partnership-project, dated April 30, 2023

An interim evaluation of the NFP PFS program, through a randomized controlled trial, shows that the program impacts failed to meet the targets set to trigger outcome payments for three of the four outcome areas: reduction in preterm births, an increase in healthy birth spacing and reductions in childhood injury (McConnell et al., 2022). However, a more comprehensive evaluation of the program's full impact is currently underway, the results from which will only be available after 2024. The evaluator, JPAL, will continue to evaluate the program's impacts on a range of long-term outcomes related to the child and families' health and well-being through a longitudinal study over the next three decades. While these evaluations will not be associated with the PFS outcome payments, they could provide evidence of the long-term effectiveness (or the lack thereof) of the NFP program.

Using a similar approach, New Castle County in the state of Delaware also announced in late 2022 that they would use the Pay-for-Success model to provide NFP services to an additional 120 mothers over four years. In this model, Children & Families First (CFF), a local non-profit, will provide the program services, while Social Finance will provide technical expertise. Wilmington-based philanthropy, Longwood Foundation, will provide the initial funding of $1.8 million, with an additional $1.2 million if CFF delivers on a pre-determined set of maternal and child outcome metrics. New Castle County will reimburse the Longwood Foundation up to $3 million in success payments depending on the outcomes achieved after four years of the program. Longwood has committed to reinvesting a portion of the success payments back into the program supporting its further expansion beyond the initial commitment of four years (Owens, 2022).

4.4.1.4 NFP Pay for Success Rate Card Project in Connecticut

While the social impact bond initiatives described above depended heavily on the role of impact evaluation to identify if the funded intervention actually led to improved outcomes that were associated with taxpayer savings, a newer pay for success mechanism called the Rate Card approach does not involve direct estimation of program impacts. In 2018, the Office of Early Childhood (OEC) in Connecticut launched a pilot program to expand evidence-based home visiting models, including Parents as Teachers (PAT), Early Head Start (EHS), Nurse-Family Partnership (NFP), and Child First through Outcomes Rate Card (ORC) approach. As opposed to the typical PFS approach, where the government is interested in improved longer-term outcomes, in the rate card approach, the government selects specific shorter-term outputs - a measure of the delivered service – such as the number of people served - and sets a pre-determined dollar amount for each outcome in advance. Unlike the PFS strategy, this approach avoids the additional expense of conducting an impact evaluation since the relevant outcomes and their payments are finalized before the project's initiation (Kadam et al., 2018).

In the Rate Card approach, after determining the outputs and relevant metrics, the government releases a Request for Proposal (RFP) to invite private investors and service providers to participate in the program. For home visiting programs, OEC selected four different outcomes - full-term birth, safe children, family stability, and caregiver employment for which the providers could earn a bonus payment of up to 3% of their contract value. They also offered a higher bonus amount for high-risk families, identified based on historical MIECHV data, across each outcome in order to incentivize enrolling harder-to-serve families. Table 4.6 defines the selected outcomes and the bonus payment value for each family that attained the required outcome.

Table 4.6: Outcomes selected for the Rate Card approach in the Connecticut OEC program

Outcome	Definition	Bonus Rate for Low-Risk Family	Bonus Rate for High-Risk Family
Safe Children	No substantiated cases of maltreatment and no injury- or ingested-related E.R. visits	$90	$115
Caregiver Employment/ Education	Caregiver is employed or enrolled in education or training	$180	$225
Full-Term Birth[a]	Baby is born after 37 weeks of gestation	$135	$170
Family Stability[b]	Identified family need was met in at least one of three areas: childcare, health care, housing	$150	$220

[a] Only for the PAT, NFP, and EHS models
[b] Only for the Child First model
Source: (Elevate, 2019)

The rate card approach in Connecticut has been viewed as successful in meeting its objectives. As per Social Finance, during the first year of rate cards, "metric achievement rates align with expectations, and numbers of metric achievements are higher than expected for three out of the four metrics" (Dear et al., 2022). Following the success of the initial rate cards pilot, Social Finance has worked with Connecticut OEC to develop at least six rate cards across its home visiting system over the last five years "to strengthen service delivery, improve performance, and reward providers for achieving priority outcomes" (Social Finance & The Connecticut Office of Early Childhood, 2021). In the future, OEC hopes to expand rate card metrics for other early childhood services, such as increasing staff diversity, partnering with doulas, and referring families to English as a Second Language (ESL) classes.

4.4.2 Data-Driven Philanthropy

Unlike the PFS approach, where the focus is on the savings generated for the government, the data-driven philanthropy approach focuses on the benefits accruing to the program participants who are traditionally from low-income or disadvantaged communities. Here, the weights for the benefits to governments and other stakeholders can be assumed to be zero, yielding the total benefits (B_t) to be equal to the benefits to the program participants (B_p).

Under this approach, which Weinstein and Bradburd (2013) define as *Relentless Monetization* (R.M.), the philanthropy reviews the available research evidence to estimate the impact of every dollar invested in a non-profit on the program's participants. In this framework, they first identify every outcome associated with the intervention and assign it a dollar value. If an intervention causes more than one outcome, then the benefits of each of those outcomes are added. Finally, a benefit-cost ratio of the program is calculated and compared to other interventions to choose the program with the largest impact on poverty fighting. To the extent possible, the philanthropies strive to use research closest to the program's evaluation context and use local data to estimate the likely benefits (Temple & Varshney, 2023). This approach is also similar to the rate card approach in the way that it does not require a formal impact evaluation to assess the program's impact. Rather, past research is used to develop relevant monetary estimates associated with each outcome.

Several philanthropies in the U.S. currently operate on this model, such as the Robinhood Organization in New York, Tipping Point Community in San Francisco, and the Constellation Fund in the Minneapolis-St. Paul Twin Cities area. In this section, I illustrate how Constellation uses a metrics framework to estimate the benefits of Nurse-Family Partnership home visiting programs in high-poverty communities of Minneapolis, as shown in Table 4.7.

First, through an extensive review of existing literature, Constellation created a metric for each outcome that is associated with the NFP program, such as increased academic achievement for children and mothers, increased Quality Adjusted Life Years (QALYs) for mothers and children, reduction in child abuse and neglect, and increased contraceptive use among mothers.

Through the first metric, they estimate the impact of the NFP program on children's improved academic achievement in the form of high school graduation and monetize it through differences in lifetime earnings as a result of this improved graduation rate. Through a literature review, they find that the average effect size of the combined impact of NFP programs on reducing externalizing behavior and the subsequent impact on the high school graduation rate is 0.0142. Further, using the American Communities Survey (ACS) data for the Minneapolis Twin Cities area, they estimate the difference in lifetime earnings of high school graduates as compared to dropouts to be $140,800. Assuming the program serves 100 children, the intervention's estimated benefit for this metric can be computed as *100*0.0142*$140,800 = $199,936*.

Table 4.7: Metrics used by The Constellation Fund for NFP Home Visiting Program

Metric	Outcome	Metric Formula	Value
NFP1	Child: improved academic achievement	(# children) * (Q-linked: Impact of treatment on externalizing behavior and high school graduation) * ($ difference in lifetime earnings for high school graduates vs. no high school completion)	*100 * 0.0142 * 140,800 = $199,936*
NFP2	Mother: improved academic achievement	(# mothers) * (Q: % increased chances of graduating from high school due to the intervention) * ($ additional lifetime earnings between high school vs. no high school)	*100 * 0.124 * 140,800 = $1,745,920*
NFP3	Child & Mother: increased QALYs	(# parent-child pairs) * (# QALY increase) * ($ QALY)	*100 * 0.211 * 50,000 = $1,055,000*
NFP4	Child: reduced abuse and neglect	(# children) * (Q: % reduction in child abuse and neglect due to the intervention) * ($ benefit from reduced out of home placement)	*100 * 0.013 * 35,00,000 = $4,550,00*
NFP5	Mother: increased contraceptive use	(# mothers) * (Q: Increased contraceptive use due to the intervention) * (# QALY increase) * ($ QALY)	*100 * 0.17 * 0.0664 * 50,000 = $56,440*

Similarly, they estimate the benefits of each outcome and add all of them to calculate the total benefits of the intervention. By dividing these benefits by the total costs of offering the program, they obtain a benefit-cost ratio (BCR), and the philanthropy can prioritize funding interventions with the highest BCR. For example, assuming an average program cost of $10,000 results in a benefit-cost ratio of 7.6:1. Since the ratio is much greater than 1, the NFP program can be a suitable candidate for funding, depending on how it compares with the BCR of other interventions.

4.5 Promoting Equity in Cost-Benefit Analyses

In 2021, the Biden administration urged federal agencies to prioritize fairness and promote equitable service delivery (Exec. Order No. 13985, 2021). One of the key aspects of this order is encouraging state and local governments to explicitly embrace advancing racial equity and supporting underserved communities as goals. The financing mechanisms suggested in this study incorporate equity considerations in conducting cost-benefit analysis through their focus on serving the communities that are most in need of these programs by differentially valuing the outcomes for the underserved communities.

The U.S. Office of Management and Budget (OMB) provides guidelines on weighing the benefits to people across different income distributions. In their most recent draft guidelines, they suggest the recommended weight for a subgroup of the population to be $w_i = \left(\frac{\bar{y_i}}{y_{med}}\right)^{-1.4}$, where $\bar{y_i}$ is the average income of the specific subgroup, and y_{med} is the median U.S. income (US Office of Management and Budget, 2023). For example, if we are interested in analyzing the distributional impact of a program on families living under the federal poverty guideline of $30,000 for a family of four, and the median household income in the U.S. is $70,000, then we would weigh the benefits to people belonging to this subgroup by a factor of $w_{FPL} = \left(\frac{30{,}000}{70{,}000}\right)^{-1.4} = 3.27$. In other words, one dollar benefit to a family living on the federal poverty guideline level is valued at $3.27. In contrast, the same benefit to a median U.S. household is valued at $1. On the other end of the income spectrum, a family of four with an income of $200,000 would be assigned a weight of 0.23 instead of 1. This approach can be utilized when conducting a societal cost-benefit analysis to differentially weigh the benefits to different beneficiaries. Applying a higher weight to the benefits accruing to low-income population can increase the attractiveness of funding to projects that are targeted to serve the most vulnerable populations.

In Pay for Success projects, the main focus so far has tended to be on expanding interventions that generate large savings to the taxpayers and not necessarily the needs of the community. However, the preventive interventions chosen as part of PFS projects are often intended to benefit low-income individuals. Thus, PFS projects may serve as a promising financial mechanism for expanding social or health services to disadvantaged people even though only the benefits occurring to the taxpayers are relevant, by funding programs such as the NFP, which generates sufficient benefits for both – the taxpayers and the program participants.

Unlike the PFS approach, the data-driven philanthropy framework incorporates equity considerations in conducting cost-benefit analysis by limiting their focus solely on the benefits to the low-income community members. This approach operates at a more local level, with a strong emphasis on prioritizing equity and effectiveness when distributing resources to meet the specific needs of communities. While this approach has received less academic attention, it can be an efficient way to redirect private funds to target social disparities (Temple & Varshney, 2023).

4.6 Discussion

A significant amount of research and policy attention has been focused on preschool programs catering to children over three years of age. However, more recent research on the benefits of social programs targeting children from prenatal to two to three years of age shows that the benefits of home-visiting programs far outweigh their costs (Duncan et al., 2022; Michalopoulos et al., 2017). Hence, there is a need to expand public funding to evidence-based home visiting programs such as Nurse-Family Partnership.

In this study, I show different approaches to conducting benefit-cost analysis and how they can be used to expand funding to the NFP home visiting programs. After first discussing the standard approach of societal benefit-cost analysis, I discuss new developments for expanding funding for promising programs that highlight both equity and equity considerations. The two innovative financial mechanisms - pay-for-success and data-driven philanthropy, can supplement scarce public funds and help increase the reach and impact of home visiting programs while providing a financial return for private sector investors willing to invest in programs with a strong track record of success. There is currently a huge unmet need across the nation for evidence-based home-visiting programs that necessitate innovative financial strategies to meet the demands of families. For instance, PFS was instrumental in expanding the program in South Carolina to serve three times more families than earlier. Still, even after this expansion, the program could cater to less than 10% of Medicaid-covered first-time births in the state[11] (CDC, 2023). Similarly, in New Castle County, it is estimated that 780 first-time mothers give birth on Medicaid each year, while the PFS program will serve only 120 mothers over four years. Hence, expanding these services further is still necessary to reach all expectant mothers who need them.

Pay-for-success projects may effectively improve outcomes as they typically use evidence-based programs for providing services. The South Carolina PFS project is based on the NFP model, and another preschool PFS project in Chicago is based on the Child-Parent Center model, for both of which there is strong empirical research suggesting evidence of effectiveness (Temple & Reynolds, 2015). Although, the impact evaluation of the NFP South Carolina PFS

[11] Based on the CDC tool's estimation of 9,821 first live births in South Carolina in 2016 that were funded with Medicaid.

did not find significant impacts of the program. One possible reason for this could be attributed to the poorer implementation quality of the expansion program as compared to the trials. Also, it is possible that while the short-term impacts were not significant, the long-term follow-up may reveal larger impacts as time goes on. However, one potential problem with PFS projects is the need to identify interventions that can generate sufficient taxpayer savings and repayments to investors within a time window of perhaps 4 to 6 years or longer. Social programs that may generate benefits far in the future may not be ideal for a social impact bond.

In this study, I also offer a comparison of the traditional PFS approach used by South Carolina and New Castle County in Delaware with the rate card approach used by Connecticut. The rate card approach offers several advantages. First, it reduces the costs and efforts required to conduct an impact evaluation as the cost-benefit analysis is performed beforehand to arrive at the success payment rates for each desired outcome. Second, it also has the potential to solve the problem of government savings being accrued at different levels of government or departments, as the outcome payment can be divided across them depending on their share in the total benefits. Third, the rate card approach is also easier to scale as it does not require a new service contract every time and provides the ability to contract with multiple service providers throughout a state. However, there is a risk of overspending public funds without achieving the desired impact as it focuses on short-term outputs compared to long-term outcomes, and there is no mandate for an impact evaluation.

4.7 Conclusion and Future Directions

In this article, I analyze the economic evaluations of home-visiting programs to identify several innovative financing mechanisms to expand funding for effective programs like the

Nurse-Family Partnership. There are two major contributions of this research. First, home visiting programs are one of many proven interventions where social benefits are estimated to be significantly higher than the costs. Higher investments in these programs, perhaps by raising taxes, can lead to higher societal benefits. However, political constraints appear to be a major impediment in scaling up these programs. Here, I look at two newer funding approaches – Pay for Success, and Data-Driven Philanthropy, that can be used to promote public-private partnerships to expand home visiting programs by providing incentives for private sector investors.

A second contribution is this approach's usefulness in incorporating equity in benefit-cost analyses. While public investments in home visiting programs may generate large net benefits to society at large, a more detailed look at the distribution of the benefits may provide guidance for whether there are substantial benefits for the program's participants or the government. I show that the economic benefits of the NFP program are so large that even after restricting the benefits to one set of stakeholders – the government or the program participants – the benefits outweigh the program costs, making it a viable candidate for funding through these approaches. This is also corroborated by a most recent study of another home visiting program targeted towards low-birthweight preterm infants discharged from a neonatal intensive care unit found the program's benefit-cost ratio to be as high as 28:1 through reductions in healthcare costs and infant deaths suggesting that the expansion of these programs targeted towards most in need can yield very large benefits (Lewis et al., 2023).

The approaches suggested in this study are gaining increased attention in the U.S. As recently as last year, the Connecticut Office of Early Childhood partnered with several state agencies to launch a new two-year pilot rate card program to provide preventative public health services, with a total budget of $4.5 million. Nearly $2.5 million were allocated for implementing a shorter, universal home visiting program through the Family Connects model, which provides one to three postpartum visits from a registered nurse and referrals to voluntary community resources for all participating families (Connecticut Office of Early Childhood, 2022). Other states could follow suit to utilize PFS or rate card approach to expand access to NFP home visiting programs.

While funding is an important consideration, several other factors may influence the scaling up of these programs. First and foremost, these programs require the services of trained professional nurses; thus, their expansion relies on a consistent supply of skilled nurses. Further, an increase in demand, coupled with a shortage in supply, can lead to a demand for higher wages, in the absence of which, these programs can suffer from high rates of staff turnover affecting the program's quality (Sandstrom, 2019).

The approaches outlined in this paper can also add value to these programs in addition to providing funds to expand services, such as helping to streamline service delivery through establishing stronger relationships between various stakeholders and encouraging innovative approaches. For example, the South Carolina PFS project helped foster a stronger working relationship between the state's Department of Health & Human Services and the Nurse-Family Partnership. They also established a new process to share Medicaid referrals directly with NFP, which can help scale the program rapidly (Social Finance, 2021).

Overall, this paper provides a valuable economic framework to expand funding for evidence-based home visiting programs such as NFP, which can be instrumental in reducing the disparities in early childhood development. This study also provides a framework to help policymakers determine the feasibility of these approaches which are based on monetary calculations of actual or potential benefits to different sets of stakeholders.

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Appendices

Appendix 1.1: Variables included as covariates in the Regression and Inverse Probability Weighting (IPW) models for Program Selection and Attrition

Variable	IPW Selection Model	IPW Attrition Model	Regression Model
Mother did not complete HS, child age 0-3	Yes	Yes	Yes
Child eligible for subsidized meals, child age 0-3	Yes	Yes	Yes
Mother under age 18 at childbirth	Yes	Yes	Yes
Four or more children in the family, child age 0-3	Yes	Yes	Yes
Participate in AFDC program, child age 0-3	Yes	Yes	Yes
Mother not employed, child age 0-3	Yes	Yes	Yes
Single parent family status, child age 0-3	Yes	Yes	Yes
Reside in high poverty neighborhood	Yes	Yes	Yes
Indicator for missing risk factors, child age 0-3	Yes	Yes	Yes
Family conflict, child age 0-5	Yes	Yes	Yes
Family financial problems, child age 0-5	Yes	Yes	Yes
Substance abuse parent, child age 0-5	Yes	Yes	Yes
Female child	Yes	Yes	Yes
African American child	Yes	Yes	Yes
CPC preschool program participation	No	Yes	Yes
CPC School-age program participation	No	Yes	Yes
Standardized word test, child age 5	No	Yes	No
Proxy of residential mobility	No	Yes	No
Have social security number	No	Yes	No
Census tract neighborhood mobility < 1 year	No	Yes	No
Census tract neighborhood mobility 1-5 years	No	Yes	No
Census tract neighborhood mobility 5-10 years	No	Yes	No
Census tract neighborhood mobility 10-20 years	No	Yes	No
Census tract self-employed rate	No	Yes	No
Census tract African American female householder	No	Yes	No

Note: Data on these variables were collected from school administrative records and parent surveys.

Appendix 1.2: IPW adjusted regression outcomes							
VARIABLES	(1) Outcome 1: Smoking	(2) Outcome 2: Drug Use	(3) Outcome 3: BMI	(4) Outcome 4: Obesity	(5) Outcome 5: Diabetes	(6) Outcome 6: Hypertension	(7) Outcome 7: Depression
CPC	-0.058*	-0.025	-0.960*	-0.047	-0.041**	-0.000	0.011
	(0.031)	(0.018)	(0.528)	(0.035)	(0.018)	(0.027)	(0.025)
CPC School-age program	0.018	0.005	0.110	0.002	0.011	-0.009	0.028
	(0.031)	(0.018)	(0.529)	(0.035)	(0.017)	(0.027)	(0.025)
Female child	-0.086***	-0.086***	2.97***	0.150***	0.026	0.025	-0.055**
	(0.028)	(0.016)	(0.482)	(0.033)	(0.017)	(0.026)	(0.022)
African-American child	0.058	-0.022	0.177	-0.006	0.051**	0.012	0.049
	(0.065)	(0.045)	(0.811)	(0.074)	(0.022)	(0.062)	(0.049)
Mother did not complete high school	0.009	0.023	-0.724	-0.025	0.033*	0.045*	0.046*
	(0.031)	(0.018)	(0.514)	(0.036)	(0.017)	(0.027)	(0.025)
Child eligible for subsidized meals	0.022	0.003	0.275	0.044	0.019	-0.045	0.009
	(0.038)	(0.022)	(0.675)	(0.047)	(0.019)	(0.036)	(0.027)
Mother under age 18 at childbirth	0.048	-0.035	0.630	0.006	-0.005	0.007	-0.049
	(0.046)	(0.024)	(0.674)	(0.050)	(0.025)	(0.042)	(0.034)
Four or more children in the family	0.047	0.002	1.038	0.026	-0.013	-0.001	0.045
	(0.040)	(0.023)	(0.675)	(0.045)	(0.022)	(0.033)	(0.031)
Participate in AFDC program	0.029	0.003	-0.611	-0.041	-0.026	0.035	0.047
	(0.038)	(0.018)	(0.660)	(0.048)	(0.027)	(0.035)	(0.029)
Mother not employed	0.037	-0.005	0.719	0.048	0.020	-0.022	0.014
	(0.036)	(0.018)	(0.653)	(0.047)	(0.026)	(0.033)	(0.029)
Single parent family status	-0.031	-0.009	-0.187	-0.019	-0.023	0.052*	0.019
	(0.036)	(0.022)	(0.582)	(0.040)	(0.024)	(0.030)	(0.026)
Indicator for missing risk factors	0.080*	0.037	-0.791	-0.091**	-0.012	0.005	0.007
	(0.042)	(0.027)	(0.636)	(0.045)	(0.021)	(0.035)	(0.032)
Reside in high poverty neighborhood	0.033	-0.064***	0.294	-0.035	-0.006	0.028	-0.033
	(0.031)	(0.022)	(0.498)	(0.037)	(0.019)	(0.028)	(0.026)
Family conflict	0.033	0.004	-2.152**	-0.141*	0.020	0.037	0.114*
	(0.072)	(0.045)	(0.889)	(0.074)	(0.033)	(0.059)	(0.063)
Family financial problems	-0.050	0.082*	1.616*	0.047	-0.010	-0.021	0.087
	(0.056)	(0.049)	(0.891)	(0.068)	(0.022)	(0.049)	(0.055)
Substance abuse parent	0.044	0.002	0.252	-0.049	-0.010	-0.008	-0.120**
	(0.074)	(0.049)	(1.173)	(0.082)	(0.034)	(0.070)	(0.047)
Constant	0.142**	0.173***	29.2***	0.441***	0.011	0.095	0.018
	(0.069)	(0.058)	(1.090)	(0.092)	(0.030)	(0.073)	(0.054)
Observations	1,100	1,097	1,065	1,065	1,097	1,096	1,098
R-squared	0.031	0.067	0.063	0.039	0.020	0.013	0.045

Statistical Significance Levels *** p<0.01, ** p<0.05, * p<0.1

Appendix 3.1: Comparison of CPC Program Before and After Midwest Expansion

	Pre-Midwest Expansion	Midwest Expansion
Populations Served	• The program primarily served African American youth living in urban Chicago. • 93% Black and 7% Hispanic • 9 in 10 families were low-income (up to 185% of the federal poverty line)	• The program serves children from diverse racial and ethnic backgrounds (e.g., African American, Hispanic, Hmong) living in several Midwest states. • 60% Black, 25% Hispanic, 8% Asian, 2% American Indian • 7 in 10 families were low-income (185% of the poverty line)
Collaborative Leadership Team	School principals were minimally involved in program implementation.	School principals have a central role in program implementation and planning.
Effective Learning Experiences	Preschool sessions were part-day. Curriculums emphasized teacher-directed activities.	Full- and part-day preschool options are offered in many districts. Curriculums emphasize a balance of teacher-directed and child-initiated activities.
Aligned Curriculum and Practices	There were no documented curriculum alignment plans.	Schools develop plans to align curriculums across grades.
Parent Involvement and Engagement	Parent involvement in school was the main focus.	Schools provide a menu of options for parent involvement at home and school.
Professional Development	School leadership teams facilitated professional development.	On-site facilitation, coaching, and online professional development modules are offered.
Continuity and Stability	There were limited efforts to reduce mobility and increase continuity between school years.	Parent involvement staff, teachers, and site mentors engage in extensive outreach to promote continuity and stability.

Source: CPC P-3 Program Manual (2016)

Appendix 3.2: Distribution of Personnel Time on Each of the Six CPC Quality Elements							
	Collaborative Leadership Team	Effective Learning Experience	Parent Involvement	Aligned Curriculum	Continuity & Stability	Professional Development	Other
Head Teacher	60	-	-	10	10	-	20
Teacher	-	15	-	10	-	5	70
Parent Resource Teacher	30	-	50	-	-	-	20
School Community Representative	5	-	85	-	-	-	10
Assistant Teacher	-	15	-	-	-	-	85