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Predicting Adult Criminal Behavior from Juvenile Delinquency: Ex-Ante vs. Ex-Post Benefits of Early Intervention

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Abstract

Recent analyses of the long-term societal benefits from early intervention (prenatal care, home visitation, and high quality preschool) for at-risk children commonly include significant savings to society in the form of reduced juvenile delinquency and adult criminal behavior. However, a nontrivial proportion of the reported benefits of several early intervention programs are based on forecasts of criminal behavior throughout adulthood conditional on intervention effects on delinquency in adolescence. Data from the Chicago Longitudinal Study (CLS), an investigation of the life course of 1,539 children from low-income families born in 1979–1980, are used to investigate the bias resulting from predicting the effect of early intervention on adult criminal behavior from the effect on delinquency in adolescence. The investigation concludes that the general method used to predict adult criminal behavior results in a conservative estimate of the reduction in the cost of adult criminal behavior attributed to early intervention.

Introduction

A significant source of the societal benefits from public investment in early education for at-risk children is the reduction in the cost of juvenile delinquency and adult criminal behavior. For example, nearly two thirds of the total estimated benefit attributed to the infamous Perry Preschool Program consists of Criminal Justice System (CJS) savings and averted criminal victimization costs associated with the intervention's effect on delinquency and criminal behavior (Barnett, 1996; Heckman et al., 2010). Similarly, approximately 50% of the benefit attributed to the Chicago Child–Parent Center (CPC) preschool program consists of savings related to the intervention's effect on juvenile delinquency and adult criminal behavior (Reynolds, Temple, Robertson, & Mann, 2002; Reynolds, Temple, White, Ou, & Robertson, forthcoming). To a lesser extent, CJS savings also represent a significant proportion of the

estimated benefits of prenatal intervention and early home visitation (Glazner, Bondy, Luckey, & Olds, 2004; Karoly, Greenwood, Everingham, Hoube, & Kilburn, 1998).

While the benefits of reduced juvenile delinquency and adult criminal activity comprise a sizable proportion of the estimated societal returns of early intervention programs, researchers typically do not have access to complete adult criminal records for program and comparison group participants. In several well-cited evaluations, the effect of the intervention on adult criminal behavior and the associated costs are forecasted primarily from limited information on the effect of the intervention on delinquency in adolescence (e.g., Karoly et al., 1998; Reynolds et al., 2002).

Table 1 shows the predicted reduction in the cost of juvenile delinquency and adult criminal behavior associated with three early intervention programs with long-term follow-up occurring at different ages. While all three programs (the Perry Preschool Program, the Chicago Child-Parent Center preschool program, and the Elmira Prenatal/Early Infancy Project) generate considerable cost savings to society in the form of reduced delinquency and adult criminal behavior, the reliance on anticipated, or predicted, benefits is greater at earlier ages of follow-up. For example, 80% of the reduction in the cost of juvenile delinquency and adult criminal behavior attributed to the Prenatal/Early Infancy Project is forecasted from the intervention's effect on the mean number of juvenile arrests by age 15 (Karoly et al., 1998), and approximately 43% of the reduction in the cost of delinquency and criminal behavior attributed to the CPC program is forecasted from the intervention's effect on the mean number of petitions to juvenile court between age 10 and 18 (Reynolds et al., 2002). In comparison, in the age-27 benefit-cost analysis of the Perry Preschool Program, which employs data on delinquency and adult criminal behavior through age 28, less than a third of the reduction in the costs of delinquency and criminal behavior is forecasted beyond age 28 (Barnett, 1996).

Although juvenile delinquency is believed to be associated with adult criminal behavior, the true relationship is inexplicit. Furthermore, the potential consequences of forecasting effects on adult criminal behavior from intervention effects on juvenile delinquency for analyses of programs and policies aimed at improving life-course outcomes for at-risk children are unclear.

As discussed in a leading text on benefit-cost analysis (Boardman, Greenberg, Vining, & Weimer, 2006), few published studies retrospectively compare ex-ante predictions of program benefits and costs to ex-post results. To illustrate a potential consequence of relying on ex-ante predictions, Boardman et al. (2006) compare three independent benefit-cost analyses conducted at different phases of an infrastructure project. Two of the analyses relied heavily on predicted benefits and costs, while the ex-post evaluation employed observed benefits and costs. All three analyses generated different net present value estimates with inconsistent conclusions about whether the benefits of the project exceeded the initial costs. Although seemingly different, infrastructure development and early intervention for at-risk children represent investment potential, and the discussion by Boardman et al. (2006) suggests that the results of benefit-cost analyses relying on ex-ante predictions, which are often considered in investment decisions, potentially differ

significantly from the results of analyses based on ex-post observations. Considering the importance of predicted crime benefits attributed to early intervention for at-risk children in the current literature, an investigation of the robustness of the method commonly used to forecast and monetize intervention effects on adult criminal behavior from observed effects on juvenile delinquency for benefit-cost analyses of early intervention programs is warranted.

Two evaluations use a similar framework to estimate the effect of the early intervention on adult criminal behavior conditional on the effect of the intervention on juvenile delinquency. The general method of extrapolation employed by Reynolds et al. (2002) in the initial benefit-cost analysis of the CPC preschool program and by Karoly et al. (1998) in the analysis of the Elmira Prenatal/Early Infancy Project is to first assume that the intervention effect on criminal behavior at the beginning of adulthood is equal to 80% of the observed effect on juvenile delinquency, which presumably represents the decaying of the intervention effect between adolescence and the beginning of adulthood. Second, the predicted effect on adult criminal behavior is multiplied by the target population crime rate, which is defined as the percentage of the population targeted by the intervention expected to have an adult criminal career. Demographic information is commonly used to approximate the target population crime rate. Finally, a simple desistance rate of 10% per year is assumed so that the anticipated intervention effect on adult criminal behavior approaches zero by mid adulthood. The predicted effect undoubtedly depends largely on the documented relationship between delinquency in adolescence and criminal behavior in adulthood (see Greenwood et al., 1996; Swain, 1983; Teilmann Van Dusen, & Mednick, 1983).

Using data from the Chicago Longitudinal Study (CLS) on juvenile delinquency through age 18 and adult criminal behavior through age 26 for CPC preschool program and comparison group participants, the current analysis compares the anticipated effect of one or more years of CPC preschool participation on adult criminal behavior, forecasted from the effect on delinquency in adolescence, to the observed intervention effect on adult criminal behavior. In addition, the difference between the present value of the predicted and observed CPC effect on adult criminal behavior is discussed, and the degree to which the disparity affects the results of the initial benefit-cost analysis of the CPC preschool program is examined.¹

The Chicago Longitudinal Study

The CLS is a prospective investigation of the life-course of a cohort of 1,539 children (93% African American, 7% Hispanic) from low-income families born in 1979–1980 (CLS, 2005; Reynolds, 1999; Reynolds, 2000). The original CLS sample includes a complete cohort of 989 children who attended preschool and kindergarten in one of 20 CPCs located in inner-city Chicago and 550 comparable children from randomly-selected schools who did not participate in the CPC program in preschool but instead received full-day kindergarten; the usual early intervention available to low-income children in Chicago at that time. Prior to kindergarten entry, approximately 15% of the comparison group attended Head Start preschool while the majority received in-home care from a parent and/or other relative.

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¹See Levin & McEwan (2001) for a discussion on discounting and net present value.

Program group participants attended CPC preschool for one or two years, with those receiving two years of intervention entering the CPC program at age 3. School-age services (e.g., reduced class sizes and instructional aides) were available to program and comparison group participants in first through third grades in affiliated schools, regardless of preschool and kindergarten participation.

The CLS is described as an alternative-intervention with a quasi-experimental design (Reynolds & Temple, 1995; Reynolds et al., 2002). Program and comparison group participants were matched on age, neighborhood and family poverty status, and eligibility for program participation, defined as (a) residence in a Title I attendance area, (b) demonstration of educational need due to poverty associated factors, and (c) parental consent. As shown in Table 2, the program and comparison groups comprising the original CLS sample as well as the age 27 follow-up sample, which includes over 95% of the original participants, are similar on several child and family characteristics measured prior to CLS participation. Pre-program rates of teen parenthood, maternal employment, subsidized school lunch eligibility, AFDC/TANF participation, and single-parent family status are equivalent. Similarly, the mean family risk index score, a sum of eight dichotomous factors associated with lower levels of adjustment identified in Table 2, is equivalent. Alternatively, the program group has a higher proportion of female participants and a higher proportion of participants with mothers who completed high school by the time their child was three years old. Furthermore, program group participants are more likely than comparison group participants to reside in relatively high-poverty neighborhoods, a result of the CPCs being located in the most disadvantaged areas and CPC personnel efforts to enroll the most at-risk children. Although there are observable differences between the program and comparison group, differences do not appear to systematically favor one group or the other. In addition, results from selection and attrition analyses using latent-variable modeling, econometric methods, propensity scores, and alternative comparison groups consistently indicate that intervention effect estimates are robust (Arteaga, Reynolds, & Temple, 2008; Reynolds, 2000; Reynolds & Temple, 1995; Reynolds et al., 2001, 2007).

Juvenile Delinquency and Adult Criminal Behavior in the CLS

Approximately two-thirds of the CLS participants are believed to currently reside in Illinois; therefore, adult arrest and incarceration data for program and comparison group participants were largely obtained from archived Cook County, IL circuit court records, the Illinois Department of Corrections, and the Federal Bureau of Prisons. Additional county-level data were obtained from all counties representing Wisconsin and Iowa, as well as Hennepin County, which encompasses Minneapolis and St. Paul, Minnesota. State and Federal incarceration data were also compiled for participants detained outside of Illinois.² Self-reported arrest and incarceration data from CLS participant interviews were instrumental in documenting incidences of adult criminal behavior, especially incidences occurring outside of Illinois.

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²CLS participants were incarcerated in a total of 21 different states.

Measures of juvenile delinquency and adult criminal behavior are presented in Table 3. Between age 10 and 18, nearly 20% of CLS participants had been petitioned to juvenile court. The rates for male and female participants are 32.3% and 7.5%, respectively. The average number of petitions to juvenile court is 0.57. The average number of petitions for males and females in the CLS is 1.04 and 0.11, respectively. By age 27, approximately 43% of CLS participants had been arrested for a criminal offense (misdemeanor or felony) and 21.5% had been arrested for a felony offense. As expected, rates of adult criminal behavior are higher for males than for females. Approximately 39% of males had been arrested for a felony offense by age 27, while less than 5% of females had been arrested for an equivalent offense by the same age. Similarly, the mean number of adult felony arrests for males is 0.94, while the mean for females is less than 0.10.

The relationship between CPC preschool participation and juvenile delinquency has been documented by Reynolds et al. (2001; 2002). One or more years of preschool participation is estimated to reduce the probability of receiving a juvenile court petition by approximately 8 percentage points (17% vs. 25%, $p < .01$). Furthermore, CPC participation is associated with a 0.33 reduction in the mean number of petitions to juvenile court (0.45 vs. 0.78, $p < .05$). Although the estimated effect of the intervention on measures of adult criminal behavior is less significant (practically and statistically) than the estimated effect on juvenile delinquency, CPC preschool participation does appear to be associated with a reduction in adult criminal behavior. Controlling for gender, race/ethnicity, participation in the CPC school-age program, child welfare involvement, and eight indicators of early risk status (i.e., neighborhood poverty, eligibility for free or reduced school lunch program, TANF/AFDC participation, three or more siblings, and mother's age, education, marital status, and employment status), one or more years of CPC preschool participation is associated with a 0.12 reduction in the mean number of felony arrests by age 27 (0.32 vs. 0.44, $p < .05$). Furthermore, CPC participation is estimated to reduce the probability of incarceration or jail by 4 percentage points (8% vs. 12%, $p < .05$). Estimates of the effect of CPC preschool participation on alternative measures of adult criminal behavior are presented in Table 4.

The pattern of observed intervention effects from adolescence to adulthood suggests a relationship between juvenile delinquency and adult criminal behavior in the CLS, which is supported in the current analysis. As shown in Table 5, the estimated probability of a juvenile offender in the CLS being arrested for a misdemeanor or felony offense in adulthood is approximately 71%. In comparison, the likelihood of a CLS program or comparison group participant being arrested given the participant has not been petitioned to juvenile court is 36%. Therefore, participants petitioned to juvenile court between age 10 and 18 are 35 percentage points more likely to have been arrested by age 27. Participants petitioned to juvenile court are also 29 percentage points more likely to have been arrested for a felony offense in adulthood. Similarly, a petition to juvenile court is associated with a 22 percentage point increase in the probability of incarceration by age 27.

Although both male and female juvenile offenders in the CLS are more likely to participate in criminal activity in adulthood, the relationship between juvenile delinquency and adult criminal behavior appears to differ practically by gender, potentially due to the low rate of delinquency and criminal behavior for females relative to males in the CLS. For males, a

petition to juvenile court is associated with a 40 percentage point increase in the probability of being arrested for a felony offense by age 27. In comparison, for females, a petition to juvenile court is associated with a 7 percentage point increase in the probability of being arrested for an equivalent offense by the same age. However, the interaction between gender and juvenile delinquency in predicting adult criminal behavior is not statistically significant at even the 10% level.

Although the results suggest a significant relationship between juvenile delinquency and adult criminal behavior and arguably validate (at least in the absence of actual adult criminal records) the method employed by Reynolds et al. (2002) to extrapolate the CPC effect on adult criminal behavior from the intervention effect on juvenile delinquency, the correlation between delinquency and adult criminal behavior in the CLS is less than perfect. In fact, the correlation is less than .50. Therefore, the actual benefit, in terms of reduced CJS expenditures and criminal victimization costs, associated with the CPC program potentially differs significantly from the benefit predicted by Reynolds et al. (2002). The prominence of the initial benefit-cost analysis of the CPC preschool program in the field of early intervention and prevention sciences, and the potential policy implications of the analysis, further warrant an investigation of the bias resulting from predicting the CPC effect on adult criminal behavior from the intervention effect on delinquency in adolescence.

Ex-Ante Prediction

Reynolds et al. (2002) forecast the CPC effect on adult criminal behavior from the intervention effect on juvenile delinquency, defined as the estimated effect of one or more years of CPC preschool participation on the mean number of petitions to juvenile court from age 10 through 18. As explained, previous analyses indicate that CPC preschool participation is associated with a 0.33 reduction in the mean number of petitions to juvenile court (see Table 4). Assuming 30% of the program group is expected to have an adult criminal career in the absence of the intervention and the effect on criminal behavior at the beginning of adulthood is equal to 80% of the effect on juvenile delinquency, the predicted CPC effect on the mean number of incidences of criminal behavior at the beginning of adulthood is approximately 0.08.³

The anticipated effect is multiplied by the present value cost of an adult criminal career, estimated by Greenwood et al. (1996). Assuming a real annual discount rate of 4%, and a 10% annual reduction in criminal behavior from the beginning of adulthood, Greenwood et al. (1996, Table B.15, pg. 57) estimate the present value cost of an adult criminal career discounted to age 19 to be \$40,751.⁴ The estimate is largely based on CJS expenditures and excludes the social costs of crime, commonly captured through analysis of jury awards to the victims of crime and their families and methods designed to measure society's willingness-to-pay for crime avoidance (e.g., contingent valuation surveys). Therefore, the cost reported by Greenwood et al. (1996) is believed to be conservative.

³The predicted CPC intervention effect on the mean number of incidences of adult criminal behavior is $(0.30)(0.80)(0.33) = 0.079$

⁴The estimated cost of an adult criminal career reported by Greenwood et al. (1996; \$27,303) is converted to 2008 dollars using the Bureau of Labor Statistics' Consumer Price Index for All Urban Consumers. The CPI-U values for 1993 and 2008 are 144.5 and 215.303, respectively.

Employing the estimate reported by Greenwood et al. (1996), which assumes a real annual discount rate of 4%, the estimated present value cost of an adult criminal career discounted to age 19 assuming a real annual rate of 3% (the rate employed in the initial benefit-cost analysis of the CPC program) is approximately \$43,553 (Reynolds et al., 2002, Appendix B, pg. 297).⁵ Assuming one or more years of CPC preschool is associated with a 0.08 reduction in the mean number of incidences of adult criminal behavior, the predicted reduction in the CJS cost of an adult criminal career is approximately \$3,449 per program participant, evaluated at age 19 (Reynolds et al., 2002, Appendix B, pg 297).

In an attempt to account for a proportion of the social benefits associated with reduced adult criminal behavior, Reynolds et al. (2002) estimate the value of averted tangible and intangible criminal victimization costs from the anticipated intervention effect on adult criminal behavior. Consistent with prior analyses (Barnett, 1996; Karoly et al., 1998; Miller, Cohen, & Wiersema, 1996), criminal victimization costs are assumed to be 4.5 times larger than CJS expenditures. Assuming CPC preschool participation is associated with a 0.08 reduction in the mean number of incidences of criminal behavior, the predicted benefit, in terms of averted criminal victimization costs, attributed to the CPC program is \$15,521 per participant. Averted tangible costs (e.g., medical costs, stolen or damaged property, and lost productivity) account for 23.3% of the benefit, and averted intangible costs (e.g., averted reductions in the quality of life of potential victims and their families) account for the remaining 76.7%. Including the reduction in CJS expenditures and victimization costs, the predicted benefit discount to age 19 is approximately \$18,970 per program participant.⁶

Although Reynolds et al. (2002) attempt to incorporate the social benefits of crime reduction by including averted victimization costs in the analysis, the predicted adult crime benefit attributed to the CPC preschool program is believed to be conservative for several reasons. First, reduced expenditures for private security (e.g., alarms, security guards, locks, and property insurance) and reduced feelings of fear and insecurity are unaccounted for. Second, the benefit does not account for the cost of unreported adult criminal behavior. The Bureau of Justice Statistics estimates that 54% of all violent victimizations and 63% of all property crimes went unreported in 2007 (Rand, 2008). Accounting for the cost of unreported victimization in the CLS is expected to increase the estimated reduction in the cost of adult criminal behavior by more than 100%. Third, the actual target population crime rate is expected to be greater than 30%. Greenwood et al. (1996) assume a target population crime rate of 66% in the analysis of the educational incentive program, which targeted a low-income welfare population. Karoly et al. (1998) also assume a target population crime rate of 66% to extrapolate the effect of the Elmira Prenatal/Early Infancy Project on adult criminal behavior for a population of at-risk children. Although, the CPC program targeted a comparable population of at-risk children from low-income families, the assumed target population crime rate is more consistent with the expected rate for the general population (22%; see Greenwood et al., 1996). The observed rate of adult arrest for the CLS

⁵The cost of an adult criminal career reported by Reynolds et al. (2002; \$32,973) is converted to 2008 dollars using the Bureau of Labor Statistics' Consumer price index for All Urban Consumers. The CPI-U values for 1998 and 2008 are 163.0 and 215.303, respectively.

⁶Because of rounding, the predicted benefit is slightly less than the original estimate Reported by Reynolds et al. (2002; \$18,976, converted to 2008 dollars).

comparison group, the rate expected for the CLS program group in the absence of the intervention, is approximately 46%, which is closer to the assumed rate for at-risk populations in prior analyses. The observed rate of arrest for CLS comparison group males is equivalent to the rate assumed by Greenwood et al. (1996) and Karoly et al. (1998).

Ex-Ante Predication vs. Ex-Post Benefit

For the current analysis, the predicted CPC effect on criminal behavior at the beginning of adulthood is compared to the observed intervention effect on the mean number of felony arrests by age 27. Felony offenses (e.g., robbery, assault, murder, and rape) are generally associated with considerable CJS and criminal victimization costs. As explained, one or more years of CPC preschool participation is associated with a 0.118 reduction in the mean number of felony arrests by age 27 (see Table 4). The predicated effect on the mean number of incidences of adult criminal behavior at the beginning of adulthood is 0.079, which is nearly 50% less than the observed effect. Because the predicted intervention effect at the beginning of adulthood is assumed to decline by 10% per annum from age 19 to 44, the disparity between the predicted effect on the mean number of incidences of adult criminal behavior extrapolated to age 27 and the observed intervention effect on the mean number of felony arrests by age 27 is expected to be greater than 0.039. In fact, assuming a 10% annual desistance rate, the anticipated CPC effect extrapolated to age 27 is less than 0.035, which is significantly less than the observed intervention effect of 0.118 felony arrests by age 27. However, the rate of desistance from the beginning of adulthood is accounted for in the cost of an adult criminal career reported by Greenwood et al. (1996) and employed in the benefit-cost analysis of the CPC program. Therefore, to avoid overestimating the present value of the difference between the predicted and observed CPC effect on adult criminal behavior, the observed effect on the mean number of felony arrests by age 27 is defined as the intervention effect at the beginning of adulthood. Although not available, because of the timing of CLS data collection, the actual CPC effect on the mean number of felony arrests at the beginning of adulthood, age 19, is expected to be greater than 0.118.

Assuming the present value of the cost of an adult criminal career evaluated at age 19 is \$43,553, as assumed in the initial benefit-cost analysis of the CPC program, the estimated reduction in CJS costs associated with the 0.118 reduction is the mean number of felony arrests is approximately \$5,139 per participant. The present value of averted tangible and intangible criminal victimization costs are \$5,388 and \$17,737 per program participant, respectively. Therefore, the total estimated benefit discounted to age 19 associated with the observed intervention effect on adult criminal behavior is \$28,264 per participant. As demonstrated in Table 6, the ex-post benefit per program participant is \$9,294, or 49%, greater than the ex-ante benefit extrapolated from the intervention effect on juvenile delinquency. The disparity affects the estimated return per dollar invested in the CPC preschool program.

Consequences for Benefit-Cost Analysis

CLS program participants received one or two years of CPC preschool between ages 3 and 4. The estimated present value cost for one and a half years of the CPC preschool,

discounted to the average age at enrollment, is approximately \$8,839 per participant (Reynolds et al., 2002). Benefit-cost analysis requires all costs and benefits be evaluated at the same time point. However, as in the initial analysis of the CPC preschool program (Reynolds et al., 2002), the ex-ante and ex-post reduction in CJS expenditures and victimization costs reported above are discounted to age 19, rather than to age 3. Although calculating the present value of the average cost of the CPC program at the beginning of adulthood is less involved than discounting the estimated cost of an adult criminal career to age 3, additional benefits attributed to the CPC program (e.g., reduced expenditures for child welfare services, special education, grade retention, and juvenile delinquency, and increased earnings potential) are also discounted to age 3. Therefore, in order to discuss the bias resulting from relying on ex-ante predictions of reductions in adult criminal behavior for the benefit-cost analysis of the CPC preschool program, the following method was used to estimate the present value of the reduction in CJS expenditures and victimization costs evaluated at age 3.⁷ The present value of the predicted effect and the effect on the mean number of felony arrests by age 27 are discounted to age 3.

To be consistent with the initial benefit-cost analysis of the CPC program and facilitate the comparison, the current analysis employs the cost of an adult criminal career estimated by Greenwood et al. (1996, Table B.15, pg. 57). In addition, the inconsistency between the discount rate assumed by Greenwood et al. (1996) to estimate the present value cost of an adult criminal career from age 19 to 44, and the discount rate assumed by Reynolds et al. (2002) to estimate the present value of the benefits and costs of the CPC preschool program is accounted for.

Discounting the estimated CJS cost of an adult criminal career to age 3 and adjusting for the difference in discount rates requires several steps. First the estimated cost of an adult criminal career, evaluated at age 19 (\$40,751; Greenwood et al., 1996), is treated as the present value of an annuity (PV_A), where the annual discount rate (i) is equal to 4% and the number of periods (n) is equal to 25 (from age 19 to 44). Second, the formula for the present value of an annuity is used to determine the annual annuity (A), which is approximately \$2,609.⁸ The annual annuity is defined as the undiscounted annualized CJS cost of an adult criminal career. Finally, the annualized costs of a criminal career over 25 years are discounted to age 3 assuming a real annual rate of 3%. The resulting estimated present value CJS cost of an adult criminal career evaluated at age 3 is approximately \$29,155.

Assuming the discounted present value CJS cost of an adult criminal career is \$29,155, the benefit, in terms of reduced CJS and criminal victimization costs, forecasted from the CPC

⁷Reynolds et al. (2002) evaluated the predicted CPC effect on adult criminal behavior at age 19. However, the cost of the CPC preschool program and all other reported benefits are discounted to age 3. As a result, the predicted adult crime benefit, net present value, and return per dollar invested in the CPC preschool program reported by Reynolds et al. (2002) are overstated. Updated results are reported in Reynolds et al. (forthcoming).

⁸The formula for the present value of an annuity is:

$$PV_A = A \left[\frac{1 - \frac{1}{(1+i)^n}}{i} \right]$$

effect on juvenile delinquency is \$12,700 per program participant.⁹ In comparison, the present value of the benefit, discounted to age 3, estimated from the observed intervention effect on the mean number of felony arrests is approximately \$18,922 per program participant.¹⁰ Again, the benefit based on the observed CPC effect on adult criminal behavior is 49% greater than the predicted benefit conditioned on the intervention effect on juvenile delinquency. Furthermore, the disparity between the ex-ante prediction and the ex-post benefit is equal to 70% of the average cost of the CPC preschool program. However, although the method used to forecast the CPC effect on adult criminal behavior appears to have resulted in a conservative estimate of the reduction in CJS expenditures and victimization costs attributed to the CPC preschool program, both the ex-ante and ex-post benefits presented in Table 7 exceed the initial cost of the intervention.

The present value of additional benefits attributed to the CPC preschool program total \$70,745 per program participant (Reynolds et al., 2002). Additional benefits include reductions in the cost of grade retention, special education, child welfare services, and juvenile delinquency, as well as increased earnings potential and associated government tax revenues. Including the reduction in CJS expenditures and victimization costs, extrapolated from the intervention effect on juvenile delinquency, the estimated return per dollar invested in the CPC preschool program is \$9.44. In comparison, including the present value of the benefit estimated from the observed CPC effect on criminal behavior by age 27, the ex-post return per dollar invested is \$10.14. The associated net present value estimates are \$74,606 and \$80,828 per program participant, respectively.¹¹

Conclusion & Discussion

Several influential analyses attribute significant benefits in terms of Criminal Justice System (CJS) savings and averted criminal victimization costs to early intervention. However, effects on criminal behavior in adulthood, and, therefore, monetary benefits, are commonly forecasted using a simple formula based on the assumed relationship between juvenile delinquency and adult criminal behavior. The results also largely depend on the expected target population crime rate, which is selected by the researcher. However, as longitudinal studies progress and participants enter early adulthood, researchers gain access to information on criminal behavior in adulthood, which can be used to verify ex-ante predictions of program benefits. Although the benefits of the well-known Perry Preschool Program are continuously revised to account for observed criminal activity (e.g., Barnett, 1985; 1996; Schweinhart et al., 2005; Heckman et al., 2010), which increases the reliability

⁹The ex-ante predicted benefit is $[(\$29,155)(0.80)(0.30)(0.33)] + [(\$29,155)(0.80)(0.30)(0.33)(4.5)] = \$12,700$.

¹⁰The ex-post benefits is $[(\$29,155)(0.118)] + [(\$29,155)(0.118)(4.5)] = \$18,922$.

¹¹Reynolds et al. (2002) reported that the CPC preschool program returned \$10.15 for every \$1.00 in costs. However, although program costs and all other benefits are discounted to age 3, the predicted adult crime benefit included in the calculation of the estimated return per dollar invested is discounted to age 19. The value of difference resulting from the discounting error is approximately equal to the disparity between the predicted adult crime benefit and the benefit estimated from the observed intervention effect on the mean number of felony arrests reported in the current analysis. Therefore, although the general method used to predict and monetize the effect on adult criminal behavior in the initial benefit-costs analysis of the CPC program resulted in a conservative estimate, the estimated adult crime benefit discounted to age 3 (\$18,922), the net present value (\$80,828), and the return per dollar invested in the CPC preschool program reported in the current analysis (\$10.14) are similar to the ex-ante estimates reported by Reynolds et al. (2002). If Reynolds et al. (2002) had discounted the predicted adult crime benefit to age 3, the return per dollar invested would have been approximately equal to \$9.44.

of results extrapolated over the duration of an adult criminal career, to date a systematic comparison of the predicted and observed intervention effect on criminal behavior has not been released. Evaluations of alternative interventions including the Abecedarian Project (Barnett & Masse, 2007; Masse & Barnett, 2002) and Project STAR (Krueger, 2003), where a significant proportion of the reported benefits are also predicted from outcomes measured before participants enter adulthood, are also candidates for ex-ante vs. ex-post analyses.

The current analysis of the Chicago Child- Parent Center (CPC) preschool program indicates the method used to forecast the intervention effect on adult criminal behavior from the effect on juvenile delinquency generates a conservative estimate of the reduction in CJS expenditures and victimization costs associated with one or more years of CPC preschool participation. The present value of the predicted benefit evaluated at age 3 is approximately \$6,222 less than the benefit estimated from the observed effect on the mean number of felony arrests. However, although the difference between the ex-ante prediction and ex-post benefit approaches the average cost of the CPC preschool program, the disparity has a modest effect on the benefit-cost ratio and net present value of the intervention. Furthermore, a less conservative target population crime rate is expected to reduce the difference. In fact, increasing the assumed target population crime rate from 30% to 46%, which is equivalent to the actual rate of arrest for the comparison group and closer to the rate assumed for predicting adult criminal behavior for comparable populations (e.g., Greenwood et al., 1996; Karoly et al., 1998), eliminates the disparity. Therefore, assuming an appropriate target population crime rate, the general method used to forecast intervention effects on adult criminal behavior from observed effects on juvenile delinquency appears to generate fairly precise estimates. Considering the availability of information on crime rates by age, race, gender, and geography, this is encouraging for researchers attempting to extrapolate effects on adult criminal behavior from limited information on delinquency in adolescence.

The current analysis used juvenile and adult arrest data from the Chicago Longitudinal Study (CLS) to investigate the robustness of the general method used to forecast the effect of one or more years of CPC preschool participation on adult criminal behavior. However, an investigation of the appropriateness of the estimated cost of an adult criminal career employed in the initial benefit-cost analysis of the CPC program (Reynolds et al., 2002) and the economic analysis of the Elmira Prenatal/Early Infancy Project (Karoly et al., 1998) is believed to be equally important. Although the ex-ante and ex-post adult crime benefits attributed to the CPC program in the current analysis are expected to be conservative, as a result of the exclusion of various social costs and the costs of unreported adult criminal behavior, investigating alternative methods of estimation based on individual adult criminal records in the CLS and social costs for specific criminal offenses (see Aos, Miller, & Drake, 2006; Cohen, 1988; 1998; Cohen, Rust, Steen, & Tidd, 2004; Miller et al., 1996) will increase confidence in the estimated benefits attributed to the CPC preschool program. Mapping each CLS participants' criminal history to the estimated social costs associated with specific criminal offenses (e.g., burglary, robbery, assault, murder), which differ significantly across offenses, would allow for a discussion of the potential intervention effect (positive or negative) on the severity of offenses committed by program and comparison group participants. The current analysis monetized the estimated CPC effect on the mean

number of felony arrests, but does not account for the possibility that either the CLS program or comparison group committed more severe, and, thus, costly offenses. Furthermore, the observed intervention effect on the mean number of felony arrests is potentially influenced by the possibility that CLS participants in either the program or comparison group, on average, commit offenses associated with stricter sentences, and, thus, have less opportunity to commit additional felonies due to duration of incarceration.

Finally, further effort is required to identify and investigate the robustness of predictors of additional measures of adult well-being (e.g., earnings, physical and mental health, substance abuse, occupational prestige, and welfare participation), identifiable in childhood and adolescence through observed effects on reading achievement, socio-emotional maturity, child welfare involvement, and high school completion. This process will (a) expand our knowledge of the relationship between early intervention and life-course development, (b) enhance the ability of researchers to appropriately attribute anticipated benefits in adulthood to early intervention, (c) reduce costs associated with undesirable adult outcomes by establishing reliable indicators in adolescence, alterable through early intervention, and (d) assist policy makers in determining the relative cost-effectiveness of programs and policies in the absence of rigorous longitudinal investigations.

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Table 1

Benefits Attributed to Three Early Interventions (Present Value 2008 Dollars)

	Perry Preschool Program	Child-Parent Center Program	Prenatal/Early Infancy Project
Average age at follow up	27	21	15
Measured crime benefit	\$75,262	\$25,172	\$2,684
Forecasted crime benefit	\$32,744	\$18,976	\$10,890
Total crime benefit	\$108,006	\$44,148	\$13,574
Total benefit	\$165,739	\$89,721	\$42,218
Total crime benefit/Total benefit	0.65	0.49	0.32
Forecasted crime benefit/Total crime benefit	0.30	0.43	0.80

Source: Estimates for the Perry Preschool Program, the Chicago Child-Parent Center preschool program, and the Elmira Prenatal/Early Infancy Project are from Barnett (1996), Reynolds et al. (2002), and Karoly et al. (1998), respectively. Estimates are converted to 2008 dollars using the Bureau of Labor Statistics' Consumer Price Index for All Urban Consumers (CPI-U).

Table 2

Equivalence of CPC Preschool Program and Comparison Groups on Pre-Program Attributes

Child/Family Characteristics ^b	Age-27 Follow-up Sample ^a			Original Sample p-value
	Program Group (n=950)	Comparison Group (n=523)	Crime Sample p-value	
Sample recovery, %	96.1	95.1	na	na
African American, %	93.1	93.1	.96	.59
Female participant, %	52.1	47.0	.06	.11
60% of families in poverty in school attendance area, % ^c	77.8	73.4	.06	.04
Child welfare case histories by age 4, %	3.2	5.2	.07	.08
Mother under age 18 at child birth, % ^c	15.9	17.8	.35	.29
Mother did not complete high school, % ^c	50.7	59.7	.001	.001
Single parent family status, % ^c	77.1	75.7	.56	.59
Mother not employed, % ^c	67.3	63.5	.14	.11
Eligible for subsidized school lunch, % ^{c, d}	84.2	82.6	.42	.39
Participate in AFDC/TANF program, % ^c	63.1	61.2	.48	.59
Four or more children in family, % ^c	16.1	18.4	.29	.27
Undesirable early home environment, % ^e	55.7	52.8	.28	.27
Missing on 1 or more early risk indicators, %	12.6	16.3	.05	.03
Risk index (0 to 8), mean (SD)	4.33 (1.71)	4.28 (1.76)	.56	.39

^aThe age-27 follow-up sample had verified arrest records through age 26. P-values show the significance of mean (or percentage) group differences for the adult crime and the original samples.

^bData on child and family characteristics from birth to age 3 were collected from multiple administrative records and parent surveys. Data on AFDC/TANF and subsidized meals were collected up to age 8.

^cVariable included in the risk index.

^dEligibility defined at <130% of the federal poverty level.

^eDefined as frequent family conflict, child welfare history, or parental substance abuse from age 0 to 5.

Table 3

Measures of Juvenile Delinquency and Adult Criminal Behavior in the CLS

Measures	Overall	Males	Females
Juvenile Delinquency through age 18			
Any petition to juvenile court, %	19.8	32.3	7.5
Any petition to juvenile court for violent offense, %	12.5	20.4	4.7
Number of petitions to juvenile court, mean (SD)	0.57 (1.64)	1.04 (2.18)	0.11 (0.48)
Adult Criminal Behavior through age 26			
Any arrest, %	42.6	63.9	21.6
Any felony arrest, %	21.5	39.1	4.2
Any incarceration, %	16.9	32.2	1.8
Any violent offense conviction, %	10.9	19.0	2.8
Number of felony arrests, mean (SD)	0.48 (1.17)	0.94 (1.51)	0.06 (0.29)

The sample sizes for measures of juvenile delinquency and adult criminal behavior are 1,404 and 1,473, respectively. Approximately 50% of CLS participants are female.

Table 4

Marginal Effect of One or More Years of CPC Preschool Participation on Juvenile Delinquency and Adult Criminal Behavior

Measures	Program Group	Comparison Group	Intervention Effect
Juvenile Delinquency through age 18			
Any petition to juvenile court, %	16.9	25.1	-8.2**
Any petition to juvenile court for violent offense, %	9.0	15.3	-6.3**
Number of petitions to juvenile court	0.45	0.78	-0.33*
Adult Criminal Behavior through age 26			
Any arrest, %	39.7	43.8	-4.1
Any felony arrest, %	13.3	17.8	-4.5*
Any incarceration, %	7.7	11.6	-3.9*
Any violent offense conviction, %	6.8	9.5	-2.7 ⁺
Number of felony arrests	0.32	0.44	-0.12*

**
p<.01,

*
p<.05,

⁺
p<.10.

Marginal effect estimates are from OLS, probit, or zero inflated negative binomial regression models. Estimates are adjusted for CPC school-age participation, 8 indicators of early risk status (see Table 2), gender, race/ethnicity, child welfare history, and a dummy-coded variable for missing data on risk status. CPC intervention effects on Juvenile Delinquency are from Reynolds et al. (2002).

Table 5

Marginal Effect of Juvenile Delinquency on Adult Criminal Behavior in the CLS

Criminal Behavior through age 26	One or More Juvenile Court Petitions	No Juvenile Court Petitions	Effect of Juvenile Court Petition on Probability of Criminal Behavior
Any arrest, %	70.8	36.1	34.7
Any felony arrest, %	39.3	10.6	28.7
Any incarceration, %	27.7	5.6	22.1
Any violent offense conviction, %	20.5	5.4	15.1

Marginal effects estimates are from probit regression models predicting adult criminal behavior from juvenile Delinquency. Effects are adjusted for 8 indicators of early risk status (see Table 2), gender, race/ethnicity, child welfare history, and a dummy-coded variable for missing data on risk status. All Effects are significant at the .001 level.

Table 6

Ex-ante vs. Ex-post Benefits of the CPC Preschool Program, Per Program Participant (Present Value at Age 19, 2008 Dollars Discounted at 3%)

	Ex-ante Prediction	Ex-post Benefit
CPC effect on the mean number of petitions to juvenile court	– 0.33	na
Target population crime rate	0.30	na
Fraction of adult criminal careers reduced	0.80	na
CPC effect on adult criminal behavior	–0.079	–0.118
CJS cost of an adult criminal career	\$43,553	\$43,553
Decrease in CJS costs of adult criminal career	\$3,449	\$5,139
Ratio of victimization costs to CJS costs	4.5:1	4.5:1
Criminal victimization costs	\$15,521	\$23,126
Tangible victimization costs	\$3,616	\$5,388
Intangible victimization costs	\$11,905	\$17,738
Adult CJS savings and averted victimization costs	\$18,970	\$28,264

Table 7

Ex-ante vs. Ex-post Returns of the CPC Preschool Program, Per Program Participant (Present Value at Age 3, 2008 Dollars Discounted at 3%)

	Ex-ante Prediction	Ex-post Benefit
CPC effect on adult criminal behavior	−0.079	−0.118
CJS cost of an adult criminal career	\$29,155	\$29,155
Adult CJS savings and averted victimization costs	\$12,700	\$18,922
Juvenile CJS savings and averted victimization costs	\$25,172	\$25,172
Other benefits	\$45,573	\$45,573
Average CPC program cost	\$8,839	\$8,839
Net present value	\$74,606	\$80,828
Benefits/cost	\$9.44	\$10.14