

The Relationship between Juvenile and Adult Crime*

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Abstract

Previous studies find a positive relationship between juvenile and adult criminal involvement. Using data on males from the Delinquency in a Birth Cohort II study, we investigate whether this correlation is due to unobserved characteristics that increase the probability of both juvenile and adult crime, or whether it is due to true state dependence in crime. Distinguishing between state dependence and heterogeneity is important from a policy perspective. For example, if youthful crime causes adult crime, then policies that reduce a juvenile's criminal behavior will also reduce criminal behavior as an adult. Using a treatment effects model, we find evidence of both state dependence and heterogeneity in the relationship between juvenile and adult crime. The causal influence of delinquency on adult crime is largest for white males and males with fewer years of schooling. The findings suggest that preventive policies that divert juveniles from crime are a viable policy tool for reducing the overall rate of crime.

1. INTRODUCTION

Despite the fall in the rate of violent and property crimes since the early 1990's, the incarceration rate in the U.S. has continued to rise. Over the past decade, the number of Americans incarcerated under State and Federal jurisdiction increased by 60% to reach a level of over 1.3 million individuals by the year 2000. This translates to a rate of 478 people imprisoned for every 100,000 Americans. Of course, imprisonment is not the only form of punishment. If one includes those in jail, on probation, and on parole, almost 6.5 million people were under correctional supervision in 2000.¹ During the nineties, the number of inmates under the sentence of death has also continued to grow. By the end of the decade, there were 1,948 white and 1,514 African American prisoners on death row.

For many, the lower crime rates during the 1990's serve to vindicate the use of incarceration as the major crime fighting strategy. While incarceration as a solution to the crime problem has an intuitive appeal, it is expensive. Donohue and Siegelman (1998) estimate the annual cost per inmate to be \$36,000 in (1993 dollars). Using this figure, the economic cost of incarcerating the 1.3 million individuals currently in prison in the U.S. is almost forty-seven billion dollars annually.

The magnitude of the expense associated with incarceration has lead several researchers to question whether it is a cost effective means of achieving further reductions in crime (Freeman, 1996; Donohue and Siegelman, 1998; Greenwood et al., 1996). Both Donohue and Siegelman, and Greenwood provide evidence that interventions which reduce the extent of crime by youth may be preferred to an increased use of incarceration on a cost-benefit basis. Underlying this conclusion are assumptions about the extent to which the reductions in criminal behavior of

¹ These statistics come from the U.S. Department of Justice, Bureau of Justice Statistics, Key Crime & Justice Facts at a Glance, available at <http://www.ojp.usdoj.gov/bjs/glance.htm>.

young program participants persist throughout their adult life.² Clearly, whether preventive policies are a cost effective alternative to incarceration depends on the extent to which a reduction in criminal behavior while undertaking a program leads to a reduction in criminal behavior in subsequent years. In this paper, we consider the related issue of the extent to which crime during youth leads to crime in adulthood.

While there is substantial evidence that criminal behavior exhibits persistence, there is little research that directly examines the mechanism that generates this persistence. If past criminal activities affect current criminal behavior by altering preferences, prices, or constraints relevant to future choices, then true state dependence is said to exist. Alternatively, persistence in crime may simply reflect a correlation over time of unobserved factors affecting criminality, or individual specific heterogeneity. Establishing which of these two mechanisms cause the observed persistence in criminal behavior has substantial implications for policy. If state dependence exists, then interventions that reduce criminal acts of youths will also reduce their criminality in adulthood. In this case, crime prevention programs may be preferred to the further pursuit of incarceration on a cost-benefit basis. If however, the correlation between criminal behavior at different points in time reflects unmeasured personal characteristics, such as the individual's rate of time preference or degree of risk aversion, then policies targeting youths will have no impact on their offending behavior as adults. In this case, interventions that reduce the criminal involvement of youths do not provide a policy alternative to incarceration for reducing adult crime.

² For example Donohue and Siegelman assume that the crime reduction experienced by program participants at the time the program was evaluated is permanent whereas Greenwood et al. assume that the effectiveness of programs decays over time.

To disentangle the roles of state dependence and heterogeneity in explaining the persistence of criminal behavior, this paper uses data from the Delinquency in a Birth Cohort II study. These data were collected for the purpose of examining delinquent and criminal activities of a birth cohort, and contain juvenile and adult arrest records as well as key determinants of criminality for a sample representative of the general youth population of Philadelphia. We make use of the arrest information to establish whether there is evidence of true state dependence in the relationship between juvenile and adult crime.

The rest of the paper is laid out as follows. In the next section this research is placed in the context of the existing literature. Section 3 outlines the conceptual framework and estimation strategy. Section 4 describes the data used in the analysis. The results from estimation are presented in section 5, and section 6 discusses the implications of the findings.

2. BACKGROUND

Little research empirically investigates the relationship between past and current criminal activity.³ Of those studies that do, some take a correlation approach, while others engage in structural modeling of criminal behavior. Beginning with the former, Witte and Tauchen (1994) and Williams and Sickles (2002), using the 1945 and 1958 Philadelphia cohort studies respectively, find that having an extensive juvenile record increases the probability of being arrested as an adult. In a study based on data from the National Longitudinal Survey of Youth, Grogger (1998) finds a positive association between arrest in previous years and current period self-reported crime. While these three studies provide evidence of persistence in crime

³ Leung (1994) and Barse (1995) develop theoretical models that address the temporal pattern of the age-crime profile. Leung assumes no recidivism. Barse assumes that the hazard rate of arrest depends on arrest history and that risk aversion increases with age. Flinn's (1986) theoretical model examines dynamic criminal choice in a time allocation framework assuming that accumulation of human capital occurs at work. Time spent in crime reduces time spent working and therefore diminishes the stock of human capital. Flinn's theoretical model and numerical example suggests that human capital formation decreases future crime by increasing wages, and hence the opportunity cost of time spent in crime.

controlling for a range of factors, they shed no light on the respective roles of state dependence and heterogeneity in explaining this persistence.

Several papers have investigated the existence of rational criminal choice, where agents anticipate future consequences of participating in crime. Lochner (1999) develops a theoretical dynamic model of the decision to work, invest in human capital, and commit crime. In his model, education serves as a criminal deterrent by raising the future private returns to work. Lochner's empirical work is based on the National Longitudinal Survey of Youth. He uses self-reported information as his measure of criminal involvement. However, as this information is available for a single year only, he is unable to empirically disentangle the effects of state dependence from heterogeneity.

In a related vein, Imai and Krishna (2001) use the 1958 Philadelphia birth cohort study to estimate a dynamic model of crime in which current criminal activity has the potential to affect future wages and the probability of employment adversely. For computation reasons, Imai and Krishna only consider the decision to engage in crime, and not the decision to participate in legitimate labor market activities. In addition to explicitly considering the role of heterogeneity, they assume that arrest history, but not human capital, affects wages and employment probabilities. Both heterogeneity and state dependence, measured by arrest history, are reported to play important roles in the patterns of criminal behavior. Although past arrest only has a small impact on current labor market outcomes, the expected impact on future employment has a strong deterrent effect on current criminal decisions.

Williams and Sickles (2001) develop a dynamic model of criminal choice that focuses on the role of stigma of arrest as a deterrent to crime. Current period decisions affect future outcomes by a process of social capital accumulation. In order to account for the influence of

social norms on the decision to participate in crime, Williams and Sickles' model assumes that social capital provides a flow of services associated with a good reputation and social acceptance, and that the stigma of arrest reduces an individual's social capital stock. Their results, based on the 1958 Philadelphia birth cohort study, provide evidence of state dependence in the decision to participate in crime. They also find that the initial level of social capital stock is important in determining the pattern of criminal involvement in adulthood.

Overall, this literature on crime finds that criminal behavior is persistent over time. Evidence from structural modeling is consistent with rational, forward-looking criminal behavior that exhibits state dependence. In order to establish that this evidence of state dependence is in fact a characteristic of the process generating the data, and not simply an artifact of the structure imposed on the data by the structural models, this paper takes a simpler approach to investigating the role of state dependence and heterogeneity in the relationship between delinquency and adult crime.

3. METHODOLOGY

Adult criminality is often a continuation of juvenile delinquency. This may be because involvement in juvenile crime has a direct impact on future involvement in crime. Possible means by which this could occur include scarring, whereby delinquency leaves an individual with fewer legitimate opportunities; or human capital accumulation, whereby time spent engaging in crime as a juvenile increases his criminal human capital and criminal networks at the expense of human capital and networks in the legitimate labor market. A history of juvenile delinquency may also alter preferences. For example, past criminal involvement may reduce the

stigma and hence psychological costs of adult arrest, making adult crime more likely.⁴ If the experience of juvenile delinquency alters preferences, prices, or constraints relevant to future choices, then true state dependence is said to exist. Alternatively, juvenile delinquency could be correlated with adult criminality because unobserved individual-specific heterogeneity such as the individual's rates of time preference, attitude to risk, or neighbourhood influences, increases the probability of criminal behavior in both youth and adulthood.

A treatment effects model is used to empirically disentangle the role of state dependence from unobserved heterogeneity in explaining the correlation between juvenile and adult crime. This model allows us to determine whether juvenile delinquency (the "treatment") affects the outcome variable adult crime directly, controlling for the potential endogeneity of selection into juvenile crime. We also explore whether the effect of juvenile delinquency differs across various groups in the population. In particular, this paper considers whether delinquency has a differential impact on the probability of adult arrest by race and years of education.

3.1. The Treatment Effects Model

Suppose that latent juvenile criminal activity, denoted y_1^* , depends on a vector of observable characteristics x_1 , such as race, family structure, history of physical or sexual abuse, parent's education, whether the respondent's mother participated in paid employment, and whether the respondent dropped out of school, and unobservables ε . Latent adult criminal activity, denoted y_2^* , is assumed to depend upon the observable characteristics x_2 , such as the variables contained in x_1 , marital status, the number of children the respondent has, years of schooling attained, juvenile delinquency ($JA=1$ if arrested as a juvenile and $JA=0$ otherwise), and

⁴ Freeman (1991) has suggested that arrest amongst black youths is so common as to have eroded any stigma associated with arrests. The Ethnographic work of Anderson (1999) identifies an alternative "street" culture, in which prestige is associated with arrest.

unobservables v .⁵ Assuming ε and v are potentially correlated standard normal random variables the model is:⁶

$$\begin{aligned} y_1^* &= \beta_1 x_1 + \varepsilon \\ y_2^* &= \beta_2 x_2 + \alpha_1 JA + v \\ (\varepsilon, v) &\sim \text{Bivariate Normal}(0,0, \sigma_\varepsilon, \sigma_v, \rho_{\varepsilon v}) \end{aligned} \quad (1)$$

We explore whether there are differential effects of delinquency on adult criminality on the basis of race and educational attainment. Juvenile arrest may affect the probability of adult participation in crime differently for whites and non-whites, for example, if there is greater scarring or stigma associated with arrest for one group compared to the other. The impact of delinquency on adult arrest may differ by level of education if education provides a pathway out of crime. To allow for these possibilities, we include interaction terms between race (is non-white) and years of schooling with the indicator for juvenile arrests in the equation for the probability of adult arrest. The addition of these terms leads to the following model:

$$\begin{aligned} y_1^* &= \beta_1 x_1 + \varepsilon \\ y_2^* &= \beta_2 x_2 + \alpha_1 JA + \alpha_2 (JA \times \text{race}) + \alpha_3 (JA \times \text{years of schooling}) + v \\ (\varepsilon, v) &\sim \text{Bivariate Normal}(0,0, \sigma_\varepsilon, \sigma_v, \rho_{\varepsilon v}) \end{aligned} \quad (2)$$

While criminal activity is not observed directly in the data, we do observe information about arrests. During youth, we observe whether an individual has no arrests, one arrest, or two or more arrests. We denote this categorical variable y_1 , where $y_1=0$ if the individual is not

⁵ We are interested in determining the impact of participation in criminal activities as a juvenile on the probability of engaging in crime as an adult. However, actual criminal behavior is not observed and so we use an indicator for juvenile arrest to measure juvenile criminal involvement. While juvenile arrest is an imperfect measure, we argue that it is reasonable to expect that an individual who is actively involved in delinquent behavior will be arrested at some point during his youth.

⁶ Since the underlying continuous variables y_1^* and y_2^* cannot be observed themselves and only categorized versions of these variables are observed, the variance of these variables cannot be estimated. Therefore σ_ε and σ_v are normalized to one.

arrested as a juvenile, $y_1=1$ if the individual is arrested once as a juvenile, and $y_1=2$ if the individual is arrested more than once as a juvenile.⁷ We also observe whether an individual is arrested as an adult, which we denote y_2 , where $y_2=0$ if the individual is not arrested as an adult, and $y_2=1$ if the individual is arrested as an adult.⁸

Let y_1 and y_2 be related to latent juvenile and adult criminal activity, y_1^* and y_2^* ,

according to the following rules:

$$\begin{aligned} y_1 &= 0 \text{ if } y_1^* \leq 0 \\ y_1 &= 1 \text{ if } 0 < y_1^* \leq c \\ y_1 &= 2 \text{ if } y_1^* > c \end{aligned} \quad \text{and} \quad \begin{aligned} y_2 &= 1 \text{ if } y_2^* > 0 \\ y_2 &= 0 \text{ otherwise} \end{aligned}$$

where, c is a threshold parameter to be estimated together with the other parameters.

This treatment effects model can be estimated by maximum likelihood using data on a random sample of individuals. The data used in this study, however, are generated by a stratified random sample, where stratification is based on the number of juvenile arrests. This variable appears in the model as a dependent variable. Manski and Lerman (1977) and Manski and McFadden (1981) show that a simple weighting of the observations and a correction of the covariance matrix are sufficient to deal with this type of endogenously stratified data. The weights are calculated by dividing the population proportions by the sample proportions. The covariance matrix is calculated as HGH , where H is the negative inverse of the hessian of the

⁷ The empirical joint distribution of juvenile and adult arrests given in Table 1 suggests there is a qualitative difference in being arrested once or more than once as a juvenile. This is confirmed by a Wald test of equality in the threshold parameters for one and more than one arrest in an ordered probit model for juvenile arrest. Unfortunately, there is insufficient information in the data to precisely estimate the separate effects of being arrested once or more than once as a juvenile on the probability of adult arrest. For this reason, only a single indicator for juvenile arrest is included in the model of adult arrest.

⁸ We actually have official arrest records for all juvenile and adult arrests up to age 26. However, as arrest is an imperfect measure of criminal involvement, we prefer to construct ordinal rather than cardinal dependent variables, with the aim of reducing any bias introduced from using the arrest data.

(weighted) log-likelihood and G are the summed outer products of the first derivatives of the (weighted) log-likelihood.

4. DATA

4.1. Description of the Delinquency in a Birth Cohort II Study

This research is based on data from the Delinquency in a Birth Cohort II study (Figlio, Tracy and Wolfgang, 1991). The criteria for being included in the study are being born in 1958 and living in Philadelphia between the ages of ten and eighteen years. Once cohort members were identified using the Philadelphia school census, the U.S. Bureau of Census and school records, data collection by Figlio and his team occurred in two phases.

The first phase involved obtaining the complete official criminal history of the cohort. The criminal careers, as recorded by the police, and juvenile and adult courts, for all 27,160 members of the cohort were collected between 1979 and 1984.⁹ The second stage of the Study entailed a retrospective follow-up survey for a sample from the cohort. Figlio et al. employed a stratified sampling scheme (stratifying by gender, race, socio-economic status, juvenile arrest history) to ensure that they captured the most relevant background and juvenile arrest characteristics of the cohort, and yield a sample size sufficient for analysis. The combination of information from the official arrest records on juvenile and adult arrest, and the background and demographic information collected in the retrospective survey makes these data uniquely suited to studying the relationship between juvenile and adult criminal behavior.

⁹ The information for juveniles was obtained from the Philadelphia police, Juvenile Aid Division (JAD). Once individuals reach the age of 18, police encounters are recorded on regular police forms (rap sheets) and reported to the FBI. Information about adult arrests was obtained from the Philadelphia Police Department, the Common and Municipal Courts, and the FBI, ensuring arrests both within and outside the boundaries of Philadelphia are included in the data set.

Descriptive statistics of the data used in the analysis are provided in appendix 1. We limit the sample to males because of the infrequency of adult arrests for the female sample – only 6 arrests are observed for women – resulting in a sample size of 575 men. The unweighted statistics are based on sample averages. The weighted statistics take the stratified nature of the sample into account and reflect statistics for the underlying population.

4.2 Measuring Criminal Behavior

The data contain both self-reported information on criminal activity and official arrest records. The self-reported information was collected as part of the retrospective follow-up survey in 1988 and respondents are asked to report the number of times they undertook a set of criminal activities during broad age categories (up to 11 years of age, 12-18, 19-24, over 24 years of age). As retrospective information is subject to recall error, telescoping and other forms of biases, we use the official arrest data to measure criminal involvement.¹⁰

To limit the extent of biases introduced by using official arrest records to measure criminal activity, we measure juvenile criminal behavior with an indicator equal to 0 if the respondent was not arrested as a juvenile, 1 if they had a single juvenile arrest and 2 if they had more than one arrest as a juvenile. The sample represents a population in which 71% were not arrested as a juvenile, 13% were arrested once as a juvenile, and 16% were arrested more than once as a juvenile. Adult criminal behavior is measured by an indicator equal to 1 if the respondent was arrested at least once as an adult, and zero otherwise. The sample represents a population in

¹⁰ Although official police measures of criminal are limited and may also be biased, research has shown that the correlates of criminal behavior using official records and self-reported information are quite similar when more sophisticated self-report inventories and survey administration procedures are followed (Farrington 1973; Hindelang, Hirschi, and Weiss 1979; Tracy 1987).

which 12% of males have at least one adult arrest by the age of 26.¹¹

Table 1 presents a cross tabulation of the frequency of juvenile and adult arrest for the sample (using the sampling weights). As can be seen from the table, of those arrested once as a juvenile, 12% (9/74) were arrested as an adult and of those arrested more than once as a juvenile 38% (35/92) were arrested as an adult. By comparison, 6% (24/409) of those who were not arrested as a juvenile were arrested as an adult. This suggests that there is a positive association between juvenile and adult arrest, although it does not provide any insight into whether the relationship is causal.

4.3. Individual Determinants of Crime

One advantage of the Delinquency in a Birth Cohort II study is that it contains detailed information on family background, educational attainment, and adult family formation variables that predict criminal activity in youth and adulthood. In terms of determinants of juvenile delinquency, we have information on the respondent's family structure while growing up, such as whether both parents were present, the number of siblings the respondent has, and whether the mother worked in paid employment outside the home; characteristics of the respondent's parents such as their education; self-reported information on physical and sexual abuse; and whether the respondent was still in school at age 16 and age 17. In terms of determinants of adult criminality, in addition to their juvenile history, we have information on the respondent's educational attainment, marital history, and number of children.

It is noteworthy that we do not include any measures of criminal deterrence, such as the probability of being arrested or legal sanctions, in the model. This is because the dependent

¹¹ Many of the control variables, such as whether the respondent's mother worked outside the home or whether he grew up with a father, are asked in reference to the period before the respondent turned 14. As these variables do not exhibit any time variation, we do not treat our data as panel. Rather, we consider individuals within a two period framework. In the first period, they are juveniles and in the second, they are adults.

variables, which are indicators for juvenile and adult arrest, aggregate criminal behavior across different types of crime and across time.

Criminal justice statistics regularly reveal that African Americans and the poorly educated are over-represented in the criminal justice system. Similarly, as can be seen from in Table 2, the prevalence of juvenile and adult arrest is much higher amongst the non-whites (predominately African American) in the 1958 Philadelphia birth cohort data. While non-whites are twice as likely to be arrested as juveniles, they are almost five times as likely to be arrested as adults. Table 2 also shows that the prevalence of juvenile and adult arrest is disproportionately high among the less educated members of the Philadelphia birth cohort. The association between race, education, and crime is explored in this paper by allowing a differential effect of juvenile arrest on adult arrest by race and years of education.

5. RESULTS

Table 3 contains the results from estimating the treatment effects models discussed in Section 3.¹² In addition to the results for the basic treatment effects model (Model 2), Table 3 reports models that investigate whether participation in crime during youth has a differential effect on participation in crime in adulthood by race and level of educational attainment. Model 3 adds an interaction term between juvenile arrest and race (is not white) to the basic treatment effects model, Model 4 adds an interaction term between juvenile arrest and years of schooling to the basic model, and Model 5 adds both interaction terms to the basic model. Model 1 reports the results from estimating the basic model (no interaction terms) treating juvenile arrest as exogenously determined ($\rho=0$). The results for Model 1 demonstrate the bias arising from

¹² Functional form is sufficient for identification in the bivariate probit model. Nonetheless, identification of the effect of juvenile arrest on adult arrest is strengthened by the exclusion of indicators for dropping out of school (before the age of 17, and at 17 years of age) on the probability of adult arrest. The exclusion restrictions were verified by testing the significance of these variables in the adult arrest equation.

confounding heterogeneity and state dependence when considering the effect of juvenile arrest on the probability of adult arrest. Because the focus of this paper is determining the underlying factors accounting for the positive correlation between juvenile and adult arrest, only the results for the adult arrest equation of the model are reported and discussed in Table 3. A full set of results for Model 5, including the results for the equation for juvenile arrest, is reported in Appendix 2.

5.1. The Role of State Dependence and Heterogeneity

As can be seen from the results for Model 1 in Table 3, if the potential correlation between unobserved characteristics causing juvenile and adult arrest is unaccounted for, juvenile arrest is found to have a significant and positive effect on the probability of adult arrest, even after controlling for a range of socioeconomic, demographic and background factors. However, looking across the row containing the estimated correlation coefficient (ρ) for Models 2 through 5, there is significant evidence that the unobserved characteristics contributing to juvenile and adult crime are positively correlated. Further inspection of the results for Models 3 through 5 indicates that the interaction terms between race and juvenile arrest and years of education and juvenile arrest are significant when added either individually (as in Model 3 and Model 4) or together (as in Model 5).

In order to evaluate these models, Model 5 can be compared to Models 2, 3 and 4 on the basis of a likelihood ratio (LR) test. The p-values comparing these models to Model 5 are given in the final row of Table 3. As can be seen from Table 3, the null hypothesis that the coefficients on the two interaction terms excluded from the Model 2 are jointly zero is rejected at conventional levels of significance. Similarly, the null hypothesis that the coefficient on the

interaction term omitted from Model 3 and 4 is zero is rejected with a p-value of 0.0123 and 0.0042 respectively. On the basis of these tests, Model 5 emerges as the preferred model.

In order to interpret the effect of juvenile arrest on the probability of adult arrest for Model 5, we must consider the combined effect of interaction terms involving race and years of schooling as well as the indicator for juvenile arrest. The parameters and t-statistics for the joint effect of juvenile arrest and race, and juvenile arrest and years of education are reported in Appendix 3. The marginal effect of juvenile arrest of adult arrest by race and years of education is given in Table 4.

The effect of juvenile arrest on the probability of adult arrest is calculated as the difference in the probability of adult arrest conditional on having at least one juvenile arrest and the probability of adult arrest conditional on having no juvenile arrests. As can be seen from the first row of Table 4, for the sample as a whole, the effect of juvenile arrest is to increase the probability of adult arrest by 14 percentage points. The effect is a little larger for whites, at around 17 percentage points, and a little lower for non-whites at around 12 percentage points. The magnitude of the effect of juvenile arrest on the probability of adult arrest for individuals with 12 years of schooling is about the same as the effect of juvenile arrest for the overall sample, at 15 percentage points. However, individuals who were arrested as a juvenile and who only completed 10 years of schooling are 31.7 percentage points more likely to be arrested as an adult, compared to an individual with the same level of schooling and no juvenile arrests. The magnitude of this latter effect is attributable in part to the fact that the change in the probability of adult arrest is being evaluated in the lower tail of the distribution of years of education; only 15% of the population represented by this sample (and 23% of the unweighted sample) has no more than 10 years of education.

The results with respect to educational attainment suggest that legitimate human capital may prevent juvenile offenders from persisting in criminal behavior. However, as only the interaction term between years of education and juvenile arrest is statistically significant, and not the years of education term, if the crime preventative effect of education is working through wages as is typically hypothesized, it is only doing so for delinquents.

The importance of allowing the effect of juvenile arrest on adult arrest to vary by race and years of education is highlighted by comparing the results for Model 5 with those for Models 2, 3 and 4. Specifically, the results for all three of these models indicate that the positive correlation in unobserved characteristics determining juvenile and adult criminal behavior explains the persistence in criminal choice. The direct effect of juvenile arrest is insignificant in each of these models.

5.2. The Role of Childhood and Adult Characteristics

The results from estimating the treatment effect models contained in Table 3 are also informative about the impact of childhood and adult characteristics on the likelihood of arrest as an adult. Controlling for their direct effect on juvenile arrest, we find no evidence that growing up in a household without a father, suffering physical or sexual abuse as a child, or having a mother who worked has a significant effect on the probability of arrest in adulthood. We find that the probability of adult arrest is greater for individuals with more siblings. This suggests that coming from a larger family increases the probability of adult arrest, even after controlling for the impact of family size on the probability of juvenile arrest. In contrast, the level of education of the respondent's father has no independent effect on the probability of the respondent being arrested as an adult, after controlling for its impact on the probability of juvenile arrest. The results indicate that growing up without a mother significantly decreases the probability of adult

arrest. This result is somewhat surprising since growing up without a mother has no (significant) direct impact on the probability of juvenile arrest. In terms of variables capturing family structure in adulthood, we find that marital status has a large significantly negative effect on the probability of adult arrest, with married individuals less likely than their single counterparts to be arrested. We find no evidence, however, that having children affects the probability of adult arrest.

The latter effect is more important for whites than non-whites, and for those with lower levels of education.

5. CONCLUSION

Given the interest in using preventive strategies as an alternative to increasing reliance on incarceration, establishing the nature of the relationship between juvenile and adult criminal behavior is an important research question. This paper contributes to the literature by investigating the role of state dependence and heterogeneity in the relationship between juvenile delinquency and adult crime.

The results from estimating the joint model of juvenile and adult arrest provide evidence that unobserved characteristics that increase the probability of juvenile arrest also increase the probability of adult arrest. However, juvenile arrest also has a direct positive impact on the probability of adult arrest. In the preferred model, juvenile arrest is found to significantly increase the probability of adult arrest, with the magnitude of this increase varying by race and years of schooling. We find that the increase in the probability of adult arrest associated with juvenile arrest is greater for whites than non-whites. We also find that the impact of juvenile arrest on the probability of adult arrest is smaller for individuals with a greater number of years of schooling. For example, a juvenile delinquent with 10 years of education is 32 percentage

points more likely to have an adult arrest than a similarly educated non-delinquent, whereas a juvenile delinquent with 12 years of schooling is 15 percentage points more likely to have an adult arrest than an otherwise identical non-delinquent.

An issue not addressed in this paper is whether education can in fact be treated as exogenous to the crime decision. If characteristics that lead people to stay in school also result in them being less likely to participate in crime, then the results presented in this paper will understate the impact of education on criminal outcomes. This remains an issue for future research.

An important result from this research is that youthful criminal behavior causes adult criminal behavior. That is, since the correlation between juvenile delinquency and adult arrest is not solely due to unobserved heterogeneity, adult criminals are not simply “bad apples”. From a policy perspective, this research provides evidence that preventive programs that successfully reduce delinquency among youths can also be expected to reduce their criminal behavior as adults.

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Appendix 1— Summary Statistics

	(N=575)	
	weighted	unweighted
Indicator for juvenile arrests (=1)	0.1290	0.2383
Indicator for juvenile arrests (>1)	0.1606	0.3826
Indicator for adult arrests [†]	0.1186	0.2104
Race is non-white	0.5274	0.4609
No father in childhood home	0.1659	0.1896
Stepfather	0.0844	0.0904
No father (divorced)	0.1047	0.1113
No father (deceased)	0.0237	0.0383
No father (other)	0.0374	0.0400
Stay at home mother	0.3359	0.3704
Physically abused in childhood	0.0769	0.0713
Sexually harassed in childhood	0.0143	0.0139
No mother in childhood home	0.0301	0.0261
No mother (divorced)	0.0244	0.0157
No mother (deceased)	0.0026	0.0070
No mother (other)	0.0030	0.0035
Don't know father's education	0.0849	0.1148
Father's education <hs grad	0.3034	0.3183
Father's education is hs grad	0.3866	0.3391
Father's education > hs grad	0.0592	0.0383
Number of siblings	3.0500	3.2243
left school <16 years old	0.0392	0.0574
left school at 16 years old	0.0891	0.1635
left school at 17 years old	0.2794	0.2730
Years of schooling	12.6074	11.8609
Number of children	1.0316	1.2591
Married	0.3595	0.3948

Appendix 2 — Probability of Juvenile and Adult Arrests

Juvenile arrests	Estimated model		Marginal effects^a		
	parameter	t-value	JA=0	JA=1	JA=2
Constant	-1.1189	-6.31	0.7083	0.1306	0.1612
Race is non-white	0.3440	2.29	-0.1076	0.0329	0.0748
No father in childhood home	0.1700	0.86	-0.0544	0.0152	0.0392
Stay at home mother	0.2201	1.43	-0.0696	0.0197	0.0500
Physically or sexually abused	-0.1365	-0.55	0.0410	-0.0125	-0.0284
No mother in childhood home	0.3024	0.66	-0.0997	0.0250	0.0747
Father's education is \geq hs grad	-0.3035	-1.94	0.0947	-0.0291	-0.0656
Number of siblings	0.0688	1.98	-0.0194	0.0067	0.0127
Left school < 17 years old	0.7492	3.72	-0.2589	0.0603	0.1986
Left school at 17 years old	0.2475	1.63	-0.0775	0.0247	0.0528
Adult arrests			AA=0	AA=1	
Constant	-2.0788	-2.51	0.8864	0.1136	
Race is non-white	1.4030	5.67	-0.1069	0.1069	
No father in childhood home	0.1900	0.75	-0.0280	0.0280	
Stay at home mother	0.2816	1.28	-0.0425	0.0425	
Physically or sexually abused	0.1031	0.36	-0.0222	0.0222	
No mother in childhood home	-1.0199	-2.02	0.0997	-0.0997	
Father's education is \geq hs grad	0.1791	0.68	-0.0409	0.0409	
Number of siblings	0.1106	2.26	-0.0122	0.0122	
Years of schooling	-0.0362	-0.81	0.0567	-0.0567	
Number of children	0.0360	0.61	-0.0059	0.0059	
Married	-0.5650	-3.77	0.0812	-0.0812	
Juvenile arrests	2.7285	2.29	-0.1439	0.1439	
Juv.arr.*race	-1.0368	-4.07			
Juv.arr.*years of schooling	-0.1955	-2.94			
Rho	0.7076	3.66			
Threshold parameter	0.4907	9.81			

Note a: In the row for the constant of the juvenile equation, the predicted proportions of the sample with 0, 1 and 2 or more juvenile arrests are presented. In the row for the constant of the adult equation, the predicted proportions of the sample with and without adult arrests are presented. In the other rows the value of the relevant variable is changed from 0 to 1 (except in the row for years of schooling where the value is changed from 10 to 12 years of schooling), after which the resulting change in probability is calculated.

Appendix 3 — The Joint Effects Of Juvenile Arrest, Race and Years Of Schooling
(Derived From The Coefficients In Table 3)

	Joint effects	
Race	parameter	t-value
White, no juvenile arrest ^a		
Non-white, no juvenile arrest	1.4030	5.67
White, juvenile arrest	2.7285	2.30
Non-white, juvenile arrest	3.0947	2.55
Years of schooling		
No schooling, no juvenile arrest ^a		
1 year schooling, no juvenile arrest	-0.0362	-0.81
No schooling, juvenile arrest	2.7285	2.30
1 year schooling, juvenile arrest	2.4968	2.17

Note a: This is the person of comparison.

Table 1: Juvenile and Adult Arrests ^a

	No Adult Arrest	Adult Arrest	Total
No Juvenile Arrest	384	24	408
Juvenile Arrest	122	44	166
Total	506	68	575

a. the data in the table are weighted to reflect population characteristics

Table 2: Juvenile and Adult Arrest by Race and Years of Education ^a

	Frequency	% with juvenile arrest	% with adult arrest
race			
white	310	20	4
non-white	265	37	19
years of education ^b			
3	4.6	0	0
7	0.5	70	69
8	8.6	36	26
9	24.7	53	22
10	46.2	46	14
11	53.2	61	24
12	257.5	26	15
13	21.3	52	4
14	34.3	27	1
15	11.7	8	1
16	88.3	6	3
17	5.8	16	0
18	5.9	9	0
19	1.4	0	0
20	5.7	6	0
21	5.5	0	0
full sample	575	29	12

a. the data in the table are weighted to reflect population characteristics

b. data on educational attainment was collected as part of the follow-up survey in 1988, when respondents are 30 years old.

Table 3 Estimates of the Treatment Effect Model for the Probability of Adult Arrest

Adult arrests	Model 1		Model 2		Model 3		Model 4		Model 5	
	Parameter	t-value	Parameter	t-value	Parameter	t-value	Parameter	t-value	Parameter	t-value
Constant	-1.4450	-2.66	-0.7036	-1.08	-1.3414	-1.93	-1.2994	-1.63	-2.0788	-2.51
Race is non-white	0.6967	3.99	0.7088	4.49	1.3462	5.64	0.7547	4.62	1.4030	5.67
No father in childhood home	0.1796	0.59	0.2483	0.98	0.2503	0.99	0.1864	0.73	0.1900	0.75
Stay at home mother	0.2135	0.86	0.2799	1.31	0.2654	1.22	0.2833	1.31	0.2816	1.28
Physically or sexually abused	0.1196	0.31	0.0452	0.16	0.0557	0.19	0.0859	0.30	0.1031	0.36
No mother in childhood home	-1.3363	-2.61	-1.1399	-2.21	-1.0506	-2.10	-1.1196	-2.17	-1.0199	-2.02
Father's education is \geq hs grad	0.4398	1.64	0.1970	0.66	0.1875	0.70	0.1812	0.63	0.1791	0.68
Number of siblings	0.0872	1.59	0.1031	2.17	0.1132	2.29	0.1001	2.12	0.1106	2.26
Years of schooling	-0.0866	-1.92	-0.0982	-2.22	-0.0933	-2.06	-0.0506	-1.28	-0.0362	-0.81
Number of children	0.0511	0.65	0.0461	0.77	0.0399	0.68	0.0414	0.69	0.0360	0.61
Married	-0.6847	-3.86	-0.5817	-3.80	-0.5987	-3.94	-0.5562	-3.76	-0.565	-3.77
Juvenile arrests	0.8789	3.92	-0.4127	-0.56	0.4280	0.66	1.7725	1.30	2.7285	2.29
Juv.arr.*race	-----	-----	-----	-----	-1.0061	-4.08	-----	-----	-1.0368	-4.07
Juv.arr.*years of schooling	-----	-----	-----	-----	-----	-----	-0.1887	-2.61	-0.1955	-2.94
Rho	-----	-----	0.7214	2.41	0.7093	3.40	0.7206	2.55	0.7076	3.66
Threshold Parameter	0.4903	10.03	0.49	9.72	0.4905	9.91	0.4905	9.48	0.4907	9.81
Loglikelihood value	-580.7880		-574.1774		-570.2552		-571.2075		-567.1200	
p-value for the LR test			0.0001		0.0123		0.0042			

Table 4—The Marginal Effect of Juvenile Arrests on the Probability of Adult Arrest by Race and Years of Schooling

	Effect of juvenile arrests ^b	
	AA=0	AA=1
On average in whole sample	-0.1439	0.1439
By race		
White	-0.1710	0.1710
Non-white	-0.1247	0.1247
By years of schooling		
People with 10 years of schooling	-0.3167	0.3167
People with 12 years of schooling	-0.1489	0.1489

Note a: These are the effects of juvenile arrests on the probability of adult arrests, measured by the difference in the probability of adult arrests conditional on having juvenile arrests and the probability of adult arrests conditional on having no juvenile arrests.