

CAN RATIONAL CHOICE BE CONSIDERED A GENERAL THEORY OF CRIME? EVIDENCE FROM INDIVIDUAL-LEVEL PANEL DATA*

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In the last few decades, rational choice theory has emerged as a bedrock theory in the fields of economics, sociology, psychology, and political science. Although rational choice theory has been available to criminologists for many years now, the field has not embraced it as other disciplines have. Moreover, rational choice scholars have fueled this skepticism of the theory's generality by modeling offender decision making that is one-sided—large on the costs of crime (sanction threats), short on the benefits of crime. In this article, we directly assess the generality of rational choice theory by examining a fully specified model in a population that is often presumed to be less rational—adolescents from lower socioeconomic families who commit both instrumental (property) and expressive crimes (violence/drugs). By using a panel of N = 1,354 individuals, we find that offending behavior is consistent with rational responses to changes in the perceived costs and benefits of crime even after eliminating fixed unobserved heterogeneity and other time-varying confounders, and these results are robust across different subgroups. The findings support our argument that rational choice theory is a general theory of crime.

Rational choice theory (RCT) has made important contributions to the social sciences and has become a prominent theoretical model within sociology, economics, psychology, and political science. Although there has been and continues to be considerable interest in RCT within criminology, many criminologists harbor great skepticism about it, particularly its rationalist assumption and its ability to offer a general theory of crime (DeHaan and Vos, 2003; O'Grady, 2014; Pratt et al., 2006). A repeated criticism against RCT with respect to its generality has been that a theory that emphasizes the rational weighing of the costs and benefits of actions may be perfectly applicable to financial market decisions but not to criminal behavior, and even if applicable to crime, the theory is limited to explaining instrumental kinds of criminal acts such as property crimes and simply is not relevant for actions that are laden with strong affect such as violent crimes. Another

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consistent criticism of the theory is that it is overly narrow in its conceptual scope: that it is a simplistic model that includes only the financial costs and gains from offending. In criminology, rational choice theory has been closely aligned with deterrence theory, and so specification of RC theoretical models have frequently only included a limited range of variables—those focused on formal and informal sanctions.

Other criticisms are more parochial. Sociologically trained criminologists (a large share of the field) are frequently hostile to rational choice theory because it seems “too economic” and fails to take seriously the kinds of theoretical constructs that are at the heart of social theories of crime (Matsueda, 2013). This theoretical short-sightedness has also been passed on to those testing RC theory. In many cases, when it has been put to a test, it has consisted of only formal sanction variables (sticks) to the neglect of the many other factors that comprise the utility function of individuals (carrots). Many of the perceived problems that have been identified with rational choice theory in criminology, then, are of its own making¹ but needlessly so. Rational choice theory is a conceptually broader theory than both proponents have made it out to be and critics have taken it to be. Although formal sanctions are without a doubt an integral part of the theory, the perceived costs of crimes consistent with the theory include a much wider array of informal penalties and the perceived benefits include much more than financial remuneration. In fact, rational choice theory includes theoretical constructs that easily harmonize with several social theories of crime such as social control, routine activities, labeling theory, and others. In short, criminologists’ understanding of rational choice theory has been myopic and the specification of rational choice models in the existing empirical literature has been sparse given its theoretical richness.

Our aim in this article is to examine the conceptual generality of RCT by testing a more inclusive specification of the theory, one that includes a comprehensive collection of carrots and sticks, in a sample of individuals that has demonstrated involvement in a mixture of both serious instrumental and violent offenses. We hope to demonstrate that many of the criticisms directed at the theory are off the mark mainly because critics have a far too narrow understanding of it and that the theory is far more inclusive than its critics realize. In the sections that follow, we will lay out our specification of the rational choice theory of crime by drawing on the economic model of crime by Gary Becker (1968) and show how that model differs in several important ways both from deterrence theory (in being far more general) and from the RCT model examined in previous criminological research, and that it includes variables that sociological criminologists should feel at home with. We then describe the intent of the present study, our sample, measures, and empirical strategy. We conclude with a discussion of the implications of our findings for the study of rational choice theory in criminology.

1. Skepticism about the theory’s capacity to explain all crime was even expressed by Cornish and Clarke (1986: 1–2), two of the initial translators of rational choice ideas into criminology: “Its [RCT] starting point was an assumption that offenders seek to benefit themselves by their criminal behavior; that this involves the making of decisions and of choices, however rudimentary on occasion these processes might be; and that these processes exhibit a measure of rationality, albeit constrained by limits of time and ability and the availability of relevant information. It was recognized that this conception of crime seemed to fit some forms of offending better than others.”

DETERRENCE VERSUS RATIONAL CHOICE THEORY

Although the introduction of rational choice theory into criminology is most often attributed to Cornish and Clarke's (1986) *The Reasoning Criminal*, the foundation of our rational choice model of offending is to be found in Gary Becker's (1968) journal article "Crime and Punishment: An Economic Analysis." In this seminal work, Becker laid out a relatively simple premise, that a rational offender weighs a risky choice in which he or she will engage in the commission of a crime if the expected utility from committing the crime is greater than the expected utility from refraining from committing the crime. Although Becker's article has had wide influence on public policy in the nearly 50 years since it was published (see the discussion in Nagin, 2013), it has been somewhat less influential in contemporary criminological research than one might reasonably expect and, as a result, has attracted surprisingly few direct empirical tests. Importantly, one can make a distinction between the wealth of empirical tests of *deterrence*, which are primarily aimed at testing components of Becker's (1968) theory such as the association between sanctions and/or perceptions of risk with offending (Chiricos and Waldo, 1970; Loughran et al., 2011; Paternoster et al., 1983), and the more complete theory of *rational choice*, which provides a richer depiction of criminal decision making as predicted by Becker's (1968) model. In this article, we provide a comprehensive test of Becker's theory by using individual-level panel data on active and serious offenders for whom we observe detailed information on beliefs about risks, costs and benefits, and offending behavior.

The key inputs of the choice calculus in Becker's (1968) model include p , the offender's probability of detection; f , the severity of the sanction one faces if apprehended; and Y , the utility benefits one accrues after the successful commission of the crime without apprehension.² In particular, Becker imagined the following equation, which describes a potential offender's utility as a function of the costs and benefits of crime:

$$EU = pU(Y - f) + (1 - p)U(Y) \quad (1)$$

According to equation 1, if an offender commits a crime and is apprehended, he or she experiences utility associated with the criminal gain net of losses as a result of the criminal sanction. On the other hand, if the offender commits a crime and is not apprehended, he or she experiences utility associated with the criminal gain only. Deriving the first-order conditions of equation 1 leads to several predictions regarding the three main behavioral variables of rational choice—namely, that crime will rise in Y and will fall in both p and f . Given this framework, any test of rational choice theory must necessarily include each of these three components. Instead, what scholars have largely produced are studies aimed at only testing specific, constituent parts of rational choice theory, or what can be thought of as studies of deterrence. We now discuss how the empirical literature has been mainly concerned with testing the former.

2. Becker's (1968) model does not include celerity, although subsequently economists have argued for the primacy of time preferences in recent work (Lee and McCrary, 2009), and only a few criminologists have directly tried to test for celerity effects (Loughran, Paternoster, and Weiss, 2012; Nagin and Pogarsky, 2004).

DETERRENCE—RISKS AND COSTS

The probability of detection (p) has been the variable most traditionally studied in the criminological literature on rational choice. This literature has made two primary contributions. First, a policy-oriented literature has considered the responsiveness of crime to various criminal justice interventions that have plausibly raised the objective probability that an offender is apprehended for having committed a crime. This literature has documented evidence in favor of a negative relationship between crime and increases in police manpower (Evans and Owens, 2007; Lin, 2009; Marvell and Moody, 1996), “hot spots” policing (Braga, 2001; Sherman and Weisburd, 1995; Weisburd, 2005), “problem-oriented” policing (Braga et al., 2001; Braga et al., 1999; Weisburd et al., 2010), and exogenous shifts in police redeployments (DiTella and Schargrodsky, 2004; Draca, Machin, and Witt, 2011; Klick and Tabarrok, 2005). Although this literature has identified robust evidence of a reduced form relationship between the intensity of policing and criminal activity, the extent to which such studies have provided a credible test of deterrence theory is debatable. In particular, the findings in this research have been equally consistent with an important role for incapacitation effects (Chalfin and McCrary, 2014; Durlauf and Nagin, 2011; Nagin, 1998). Moreover, by examining aggregate data, this literature has not spoken to the deterrability of specific types of offenders.

A second type of literature has considered the responsiveness of crime to individual-level risk perceptions. The primary contribution of this wide-ranging literature has been to demonstrate the usefulness of individual subjective perceptions, as opposed to objective clearance rates, as measures of individual risk, dating back to the work of Waldo and Chiricos (1972). Recent work with samples from the general population (Lochner, 2007), high-risk youth (Matsueda, Kreager, and Huizinga, 2006), and serious offenders (Anwar and Loughran, 2011) has demonstrated that subjective risk perceptions are dynamic and rationally updated to be reflective of new information. Much of this literature has been primarily concerned with the relationship between subjective risk perceptions and offending, and scholars have typically observed a weak, negative association that is usually interpreted as evidence of a slight deterrent effect of increased risk perceptions (see Apel, 2013, for an overview of this literature).

However, these certainty studies have largely ignored several important components of Becker’s (1968) more general rational choice model. First, although consensus strongly exists in the criminological literature that the certainty of punishment is the greater deterrent mechanism than severity (Paternoster, 2010), the criminological literature has failed to demonstrate empirically that increases in p yield a greater reduction in offending than a comparably measured increase in f . Second, and more importantly, most criminological studies have been concerned with risk *perceptions*, or one’s subjective belief about the true probability of detection, but often these studies have failed to make a distinction between or even mention risk *preferences*, or an individual’s tendency to prefer a less (more) risky option net of the expected value. Becker (1968: 178, emphasis added) highlighted this latter idea as an explanation for the certainty effect being stronger than the severity effect: “The widespread generalization that offenders are more deterred by the probability of conviction than by the punishment when convicted turns out to imply in the expected utility approach that offenders are risk *preferrers*, at least in the relevant region of punishments.” Stated differently, the wealth of studies that have compared the association of perceptions and offending without considering preferences for risk have

been generally incomplete, perhaps providing insight as to why the empirical relationship between the two measures is often weak.

The second component of Becker's (1968) model that has received considerable empirical investigation is the severity of punishment f . Studies of specific deterrence typically have conceptualized severity in terms of (longer) imprisonment spells, generally finding a null or sometimes criminogenic effect on future offending (Nagin, Cullen, and Jonson, 2009). Variability in methodological validity aside,³ these studies have failed in several ways to test more formally a fuller version of rational choice theory, instead testing only a narrow conceptualization of deterrence. First, most studies have failed to account for the simultaneous interplay between severity and certainty. In particular, the research typically has assumed that the timing of shocks to the sanctions regime is as good as random insofar as it does not coincide with a broader effort to address crime through interventions that change the certainty of capture. Such assumptions are difficult to substantiate and have become the focal point for numerous controversies in the extant literature, the most prominent of which is the large and contentious literature on the deterrent effect of capital punishment (Chalfin, Haviland, and Raphael, 2013; Donohue and Wolfers, 2005; Durlauf and Nagin, 2011). Second, criminological theory has emphasized that possible costs to crime can include not only formal sanctioning such as imprisonment or fines but also informal sanctions such as the social costs of reputational embarrassment and shame (Grasmick and Bursik, 1990; Williams and Hawkins, 1986; Zimring and Hawkins, 1973). In other words, multiple sets of costs to crime must be considered when describing an offender's choice calculus.

REWARDS TO OFFENDING

It is the third component of Becker's (1968) model, the benefits from crime Y , which highlights the most compelling distinction between deterrence studies and the broader concept of rational choice, and it is through this that rational choice becomes a conceptually broad, general theory of crime. As a result of severe data constraints, the literature on deterrence and offender decision making, even that which considers both certainty and severity, has tended to ignore the benefit side of the offender's decision calculus. The implicit assumption is that the perceived distribution of criminal benefits has remained unchanged, which seems to be difficult to justify on theoretical grounds. However, even if this assumption is met in a given data set, failing to consider whether changes in the benefits of crime lead to changes in offending leaves us with an incomplete test of rational choice theory. Typically, the benefits or rewards of crime are conceptualized as a monetary return to criminal activity. Such returns might include the "loot" from a theft or profits from the sale of illegal drugs, each of which can be lucrative (Loughran et al., 2013; McCarthy and Hagan, 2001; Nguyen et al., 2015). Of particular importance is the *net benefit* of crime—that is, the returns to crime above and beyond the opportunity cost of time spent in criminal activity, typically operationalized by using a potential offender's legal wage or, alternatively, measures of local labor market conditions more broadly (Ehrlich, 1973; Freeman, 1996; Grogger, 1998). Considering the net wage of crime emphasizes that

3. Nagin, Cullen, and Jonson (2009) highlighted the issues with selection bias in studies such as these, and they commented on the degree to which certain classes of studies are perhaps better equipped to yield internally valid estimates.

crime is costly not only because it is risky but also because it involves time that could otherwise be put to alternative use. Moreover, although public policy can potentially intervene to make legal work more rewarding, it is less clear how social planners can alter the rewards of illicit activities.

Although few studies have documented the responsiveness of crime to the gains of illicit activity, the idea that offenders are potentially deterred by better legal employment opportunities has been largely tested in the empirical labor economics literature with numerous recent studies finding robust evidence of a negative relationship between wages and employment rates and crime (Lin, 2008; Machin and Meghir, 2004; Raphael and Winter-Ebmer, 2001). As in the criminological literatures on the importance of certainty and severity, empirical tests of legal labor market opportunities offer only incomplete and suggestive evidence in favor of rational choice theory.

An equally important consideration is that conceptualizing the benefits of crime in monetary terms provides only a limited understanding of the motivations underlying criminal activity. Indeed, according to Becker's (1968) model, the benefits from crime can be conceptualized in multiple ways beyond formal monetary returns, including perceived intrinsic or social benefits such as increased social standing or the pleasure and enjoyment solely derived from breaking society's rules (Katz, 1990).⁴ Indeed, such an articulation of the benefits of crime is more broadly applicable to violent crimes that often lack an explicitly instrumental motive, but "kicks" are an element of property crimes as well (Katz, 1990). For example, Nagin and Paternoster (1993) operationalized benefits from offending as "how much thrill or kick" an individual got from engaging in different types of offending. Furthermore, multiple studies have suggested that offenders are sensitive to rewards (Loughran et al., 2013; Pezzin, 1995). Any more comprehensive test of rational choice theory must therefore include components of criminal rewards against costs and risks to crime. Perhaps the best summary statement of a rational choice theory of criminal offending, one that clearly reveals its inclusion of a wide sweep of variables in addition to sanctions and sanction threats, was made by Matsueda (2013: 287), who argued that "the utility from crime is a function of the returns to crime plus income from conventional activity (each weighted by the probability of getting away with crime), plus the returns to crime and conventional activity minus the punishment for crime (each weighted by the probability of getting caught and punished)."

In summary, the extant literature on testing a rational choice theory of crime has several shortcomings that prevent us from making larger generalizations about the prominence of rational choice theory in predicting criminal activity. First, deterrence studies test only partial components of the theory, such as the relationship between risk perceptions and offending, or the specific deterrent effect of imprisonment, and such studies do not allow for comparisons between different components such as comparable changes in both. Second, many of the key concepts often are narrowly defined (e.g., imprisonment) and not fully operationalized in accordance with broader criminological theory. Third, most tests of deterrence fail to consider the reward side of an offender's decision calculus. *It is*

4. Also consider Bentham's (1789: 2) much more widely inclusive definition that signals the utility of psychic benefits: "that property ... whereby it tends to produce benefit, advantage, pleasure, good, or happiness." Becker (1968: 10) too used the term "psychic" to describe the affective gains of offending: " Y_i is his income, monetary plus psychic [utility] from an offense."

probably not unreasonable, therefore, to think that many of the criticisms directed at rational choice theory as not yet ready to be a general theory may be in part a result of the stunted way in which the theory has been conceptualized and tested as well as misunderstood.

TESTS OF RATIONAL CHOICE THEORY

To our knowledge, only a few studies in criminology have examined the rational choice model to provide a test of Becker's (1968) rational choice theory by using individual-level data.⁵ Witte (1980), in using a sample of released prisoners in North Carolina, found that increases in certainty and severity reduced participation in future crime, although a percent increase in certainty had a comparatively larger impact than a percent change in severity. Second, she found that although higher (legal) earnings did deter future crime, the effect was weak. In contrast, Myers (1983), in using a sample of federal releases, found only a slight severity effect and a positive relationship between certainty and future crime. Piliavin et al.'s (1986: 101) work most closely parallels our own. In arguing for a broader rational choice model of crime, they urged that "[a] more fruitful approach to the issue of deterrence would examine the relationship between formal sanctions and crime from within an explicit theoretical framework." Piliavin and colleagues estimated a rational choice theoretical model that included factors as accrued legal and illegal earnings, as well as the perceived formal and informal costs of punishment, but did not include indicators of what Becker (1968) would consider the "psychic" gains of criminal offending. Nevertheless, they found that for three diverse samples of offenders (adult criminals, adult addicts, and youths), offending was related to the anticipated rewards of offending (and to the presence of criminal opportunities) but not to the perceived costs. Pezzin (1995) and Uggen and Thompson (2003) both applied versions of Becker's (1968) human capital theory to criminal offending. By using the National Longitudinal Survey of Youth, Pezzin (1995) found that those with greater criminal earnings were more likely to continue offending over time, whereas those with higher legal earnings were more likely to terminate their offending. By focusing on the factors explaining illegal income, Uggen and Thompson (2003) found that illegal earnings were positively related to arrest experiences, drug use, and criminal opportunities, whereas they were inversely related to conventional embeddedness (employment and ties to a spouse or partner). Both sets of findings confirm the importance of a major component of a rational choice theory of crime—the returns to illegal and legal employment. As with Piliavin et al. (1986), however, neither of these two studies examined other components of the rational choice model such as the perceptions of informal costs and the anticipated psychic rewards of crime. More recently, Matsueda, Kreager, and Huizinga (2006) articulated and tested a rational choice model of theft and violence. Appealing to Becker's (1968) model, Matsueda, Kreager, and Huizinga (2006: 96) argued that individuals will engage in crime when the "expected utility from committing crime is greater than expected utility from not committing a crime." In examining the responses to the Denver Youth Survey, they found partial support for a rational choice model of crime. Offending was inversely related to the perceived risk of arrest and

5. Several other studies have tested the model at a macro level by using panel data (Cherry and List, 2002; Cornwell and Trumbull, 1994).

positively related to psychic costs, such as the perceived excitement and coolness of the crime and the perceived opportunities to offend. Although it was a comprehensive rational choice model, Matsueda, Kreager, and Huizinga had no measures of the informal costs of offending or of the trade-off between legal and illegal earnings.

Although these studies are important in that they have provided informative tests of Becker's (1968) RCT theory, they nonetheless each have several limitations. First, no one study included a full panoply of the perceived informal costs and nonfinancial rewards of offending. Second, in some studies, offending was measured in terms of official, not self-reported, offending. Third, many of the key measures in several studies were either aggregated or unobservable altogether (e.g., the subjective probability of detection or returns to offending). Finally, and most importantly, the data in some of these studies were cross-sectional, which means that potentially important unobserved heterogeneity was left unaccounted for. Multiple criminological theories posit that time-stable, unobserved population heterogeneity could be an important confounder driving the findings of these studies (Gottfredson and Hirschi, 1990; Nagin and Land, 1993). Moreover, the lack of panel data prevents a deeper understanding of how changes in preferences over time within individuals contribute to their changing choice calculus. Finally, in arguing for a greater inclusion of rational choice into criminological theory, McCarthy (2002: 437) articulated the need for more acute tests of the theory with finer, longitudinal measures, when noting the following:

[S]ociological criminologists must move beyond the assumption that all offenders share the same preferences. . . . Individual preferences vary over time . . . crime provides an array of returns, and people differ in their assessments of crime's costs and benefits. Future theory and research must begin by specifying the preference orderings that contribute to offending and then explicate how particular contexts or structural configurations encourage people to choose crime as a means of satisfying their preferences.

THE PRESENT STUDY

This study aims to provide a more inclusive test of criminological rational choice theory as it is conceived of in Becker's (1968) economic model of criminal offending by using individual-level panel data from a sample of juvenile and young adult serious offenders in two U.S. cities. The nature of the data provides us with several advantages over the tests discussed earlier. First, we observe individual-specific measures of multiple dimensions of costs and rewards to crime, including social and personal costs, along with subjective beliefs about detection probability. Second, we observe detailed self-reports of offending variety and frequency, which we can disaggregate by crime type. Third, the panel data allow us to eliminate fixed, unobserved heterogeneity as a possible confounder. Fourth, we can test for heterogeneity in responsiveness to costs, risks, and rewards in several ways, including type of offending behavior—property versus violent.

Our intention, therefore, is first to construct a comprehensive rational choice model of offending and then to test empirically that model within a group of disadvantaged adolescent offenders of both property and violent crimes to gauge how general RCT theory is. If the hypotheses of the theory are supported within a group where it is least likely to be

applicable, because the population of individuals is thought to be less rational, then we think it can lay claim to being a general theory. To provide an even more comprehensive test of the generality of the RCT model, recall that Becker's (1968) RCT theory also considers the possibility that there is important heterogeneity in how responsive certain individuals are to costs and rewards. Therefore, we also test the idea of "differential rational choice," the idea that different subsets of economically disadvantaged offenders may be more or less responsive to changes in risks, costs, and benefits. Specifically, we consider differences based on gender and race but also based on what might be thought of as criminal propensity (Gottfredson and Hirschi, 1990). Competing theoretical arguments debate whether those individuals high in criminal propensity are either less (Gottfredson and Hirschi, 1990; Wilson and Herrnstein, 1985) or more (Pogarsky, 2002; Thomas, Loughran, and Piquero, 2013; Wright et al., 2004) likely to be influenced by considerations of the cost and benefits of offending. We create an indicator for high-criminal-propensity individuals based on several baseline risk factors for persistent offending to push the notion of the generality of RCT further.

DATA AND METHODS

SAMPLE

We analyze data from the Pathways to Desistance study, a longitudinal investigation of the transition from adolescence to young adulthood in serious adolescent offenders (Mulvey, 2012). Study participants are adolescents who were found guilty of a serious offense (almost entirely felony offenses) in the juvenile or adult court systems in Maricopa County (Phoenix), AZ, or Philadelphia County, PA. These youth were 14 to 17 years of age at the time of enrollment into the study. A total of 1,354 adolescents are enrolled in the study, representing approximately one in three adolescents adjudicated on the enumerated charges in each locale during the recruitment period (November 2000 through January 2003). The study sample comprises mainly non-White (44 percent African American and 29 percent Hispanic) males (86 percent), who were, on average, 14.9 years old at the age of their first petition, with an average of three petitions prior to the baseline interview. In addition to being from urban areas, the sample is mostly poor (54 percent of the respondents reported family income at \$25,000 or less, and 70 percent reported family income \$35,000 or less).

In this analysis, we use data collected at ten consecutive follow-up interviews, the first six of which correspond to 6-month observational periods over 36 months, whereas the last four correspond to yearly observation periods for a total of 84 months. In each period, we observe, for each individual, the self-reported number and types of crimes he or she commits, if any, during the observation period, along with detailed information regarding the risks, costs, and rewards to offending, which will be defined.

MEASURES

We use three primary types of measures: 1) data on self-reported criminal activity, 2) data on the perceived costs and benefits of crime, and 3) survey data describing each individual's experiences and circumstances. In particular, the indices of costs and rewards were adapted for the Pathways study based on previous work by Nagin and Paternoster

(1994). For each of these measures, a full list of included items and relevant psychometric properties is available at the study website: <http://www.pathwaysstudy.pitt.edu>.

SELF-REPORTED OFFENDING

The number of crimes an individual commits is derived from his or her self-reported offenses (SROs) recorded in each period. This measure is a revised version of a common self-reported delinquency measure of the number of crimes committed (Huizinga, Esbensen, and Weiher, 1991). In each period, an individual is asked whether he or she committed each of these 10 crimes during the recall period and, if so, how many times. Although the data allow us to consider offending frequency, this measurement approach has potentially serious shortcomings, as shown by Sweeten (2012). As such, we also use a variety score measure (i.e., the number of different types of criminal acts in which the individual reported engaging). As a result of granularity in the data, we classify each crime into one of three broad aggregates: 1) acquisitive crimes, 2) drug crimes, and 3) violent crimes. Acquisitive crimes include the following activities: breaking into a dwelling to steal, shoplifting, buying or receiving stolen property, using a check or credit card illegally, theft of a vehicle, carjacking, taking property by force with or without a weapon, or breaking into a vehicle to steal. Drug crimes refer to the sale (but not to the consumption) of narcotics. Finally, violent crimes include forcing another person to have sex, murder, shooting at someone regardless of whether the person was struck by the bullet, assaults involving a serious injury, or participation in gang assaults. Violent crimes do not include self-reported fights.⁶

PERCEIVED RISK

At each observation period, individuals were asked how likely it is that they would be caught and arrested for each of the following crimes: fighting, robbery with gun, stabbing someone, breaking into a store or home, stealing clothes from a store, vandalism, and auto theft. Response options ranged from 0 (*no chance*) to 10 (*absolutely certain to be caught*). The mean of these seven items was calculated for each individual at each observation period. The measure displayed high internal consistency ($\alpha = .89$ at baseline).

PERCEIVED PERSONAL REWARDS

The personal rewards of crime were measured by asking each individual how much “thrill” or “rush” it is to do any of the following things: fighting, robbery with gun, stabbing someone, breaking into a store or home, stealing clothes from a store, vandalism, and auto theft. If the individuals had reported never doing any of these things, they were asked to give a rating for how much thrill or rush they thought it would be. Response options ranged from 0 (*no fun or kick at all*) to 10 (*a great deal of fun or kick*). The mean across all items was then taken for each individual at each observation period, and the item had good internal consistency ($\alpha = .88$ at baseline).

6. We note that the distinction we have drawn between violent and property crimes does not accord with that used by the Federal Bureau of Investigation’s (FBI’s) Uniform Crime Reports System. Although the FBI records robberies as violent crimes (crimes against persons), we have chosen to classify robbery as an acquisitive crime because of its largely instrumental motivation.

PERCEIVED SOCIAL COST

The social cost of crime was measured by asking each individual if the police were to catch him or her doing something that breaks the law, how likely it is that he or she would be suspended from school, lose respect from close friends, lose respect from family members, lose respect from neighbors or other adults, lose respect from a girlfriend or boyfriend, or find it harder to get a job. Response options ranged from 1 (*very unlikely*) to 5 (*very likely*). This measure might reasonably be thought of as extralegal costs. The mean across all items was then taken for each individual at each observation period, and the item had acceptable internal consistency ($\alpha = .76$ at baseline).

PERCEIVED SOCIAL REWARDS

The social rewards to crime were measured by asking each individual how much he or she agreed or disagreed with several statements about how other people might react to the three different crimes: stealing (e.g., “If I take things, other people my age will respect me more”), fighting (e.g., “If I beat someone up, other people my age will respect me more”), and robbery (e.g., “If I rob someone, people my age will be afraid to mess with me”). Response options ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). The mean across all items was then taken for each individual at each observation period, and the item had good internal consistency ($\alpha = .82$ at baseline).

LEGAL AND ILLEGAL EARNINGS

For each observation period, we observed how much money each individual reported earning from activities that were legal as well as illegal.

MODEL

We estimate a descriptive model of individual-level rational choice theory that motivates the following regression:

$$Y_{it}^J = \alpha + \beta_1 P_{it} + \beta_2 f_{it} + \beta_3 Y1_{it} + \beta_4 Y2_{it} + X'_{it}\gamma + \theta_i + \rho_t + \varepsilon_{it} \quad (2)$$

In equation 2, Y_{it}^J represents the number of crimes of type J committed by individual i in time period t . P_{it} represents an individual's perceived probability of apprehension, f_{it} represents an individual's perception regarding the severity of the criminal sanction, and $Y1_{it}$ and $Y2_{it}$ represent an individual's social and personal rewards of crime, respectively. X_{it} is a vector of time-varying control variables that address changes in an individual's circumstances that are likely to co-vary with both criminal activity and perceptual deterrence variables. Included in X_{it} are an individual's age, the proportion of the time period spent in prison or jail,⁷ whether an individual witnessed a relative be arrested, the number of different violent crimes an individual was the victim of and the number of different

7. As an additional sensitivity check, we estimated each model excluding those individuals who were incapacitated and out of the community for the entire observational period. These results, which are substantively similar, are available as part of the online supporting information in table S1. (Additional supporting information can be found in the listing for this article in the Wiley Online Library at <http://onlinelibrary.wiley.com/doi/10.1111/crim.2016.54.issue-1/issuetoc>.)

Table 1. Summary Statistics ($N = 1,354$)

Variable	Mean	Standard Deviation	Minimum	Maximum	Within-Respondent Share of Variation
A. Self-Reported Crimes					
All Crimes (Frequency)	23.58	85.13	.0	500.0	.28**
All Crimes (Variety)	.71	1.64	.0	15.0	.39**
Theft and Robbery (Frequency)	4.01	28.20	.0	500.0	.22**
Drug Crimes (Frequency)	20.09	79.60	.0	500.0	.27**
Violent Crimes (Frequency)	.60	9.14	.0	500.0	.12**
Legal Share of Earnings	.81	.37	.0	1.0	.55**
B. Model Parameters					
Certainty of Apprehension (P)	5.61	2.97	.0	10.0	.51**
Severity of Sanction (f)	3.15	.93	1.0	5.0	.42**
Social Rewards ($Y1$)	1.88	.52	1.0	4.0	.47**
Personal Rewards ($Y2$)	1.79	2.33	.0	10.0	.55**
C. Key Covariates					
Age	19.30	2.37	14.5	26.0	.23**
Proportion of Time Spent Incarcerated	.33	.42	.0	1.0	.49**
Relative Arrested	.12	.32	.0	1.0	.25**
Number of Victimizations	.20	.59	.0	5.0	.23**
Number of Crimes Witnessed	.96	1.43	.0	7.0	.38**
Gang Membership	.09	.28	.0	1.0	.61**
Male with Pregnant Partner	.06	.24	.0	1.0	.16**
Birth of a Child	.07	.26	.0	1.0	.13**

NOTES: The table reports summary statistics—the mean and the standard deviation, as well as the minimum and maximum values for each variable used in subsequent analyses. We also report the proportion of variation in each variable that is explained by respondent fixed effects (within-variation in an analysis of variance). Statistical significance refers to the p value from an F test on the respondent fixed effects.

** $p < .01$ (two-tailed).

violent crimes an individual witnessed, whether the individual reported a gang affiliation, whether the individual had a pregnant significant other, and whether the individual reported the birth of a child during the time period. Finally, θ_i and ρ_t represent individual and time period fixed effects, respectively, that account for time- and individual-invariant unobserved heterogeneity. In practice, given that individuals in the data set live in two U.S. cities—Philadelphia and Phoenix—we condition on individual and interacted city-by-time period fixed effects that allow global time trends in criminal activity to vary by site. The coefficients β_1 , β_2 , β_3 , and β_4 provide a test of each element of rational choice theory with respect to the four primary behavioral variables suggested by Becker (1968). Accordingly, a joint test of the inclusion of these four variables provides an omnibus significance test of the contribution of rational choice theory in understanding offending behavior.

EMPIRICAL STRATEGY

Although we have motivated the model by using least-squares regression, in practice, the distribution of the primary dependent variables in our data is most consistent with a count regression model. Our analysis, therefore, uses Poisson regression (Osgood, 2000). Although a review of table 1 indicates that the mean and variance are substantially different for each of our three crime types and that formal tests for overdispersion indicate

that it is present, we nevertheless elect to use Poisson regression over negative binomial regression for two reasons.

The first reason is practical—as our models contain between 500 and 1,000 individual fixed effects, we require an estimator that will return consistent estimates of the behavioral parameters of interest. Although fixed effects are estimated consistently in a linear panel data model, nonlinear models pose a substantial challenge to estimating fixed-effects parameters. To the extent that the fixed effects are related to the time-varying independent variables in the model, nonlinear models may yield incorrect estimates of the deterrence parameters of interest as a result of the problem of incidental parameters (Allison and Waterman, 2002; Kalbfleisch and Sprott, 1970). Although parameter estimates arising from a negative binomial regression with fixed effects will differ depending on whether an unconditional or a conditional maximum likelihood function is used, the likelihood function in Poisson regression is equivalent to that of the multinomial logit model, and accordingly, the unconditional and conditional likelihood functions yield identical parameter estimates (Allison and Waterman, 2002; Cameron and Trivedi, 1998). The second and more compelling reason is simplicity as robustness checks using a conditional fixed-effects negative binomial model (Hausman, Hall, and Griliches, 1984) return results that are qualitatively extremely similar to those obtained via Poisson regression, which suggests that overdispersion is not much of an issue. We include the main results of this sensitivity analysis for comparison.

Prior to presenting results, it is worth considering the limitations that are inherent in our modeling exercise and, given these limitations, how the parameters β_1 , β_2 , β_3 , and β_4 are best interpreted. Our approach to testing an individual-level model of deterrence is not directly motivated by a natural experiment and, as such, is necessarily descriptive. Although we condition on a rich vector of covariates and include a powerful set of fixed effects to account for various types of fixed unobserved heterogeneity, the four behavioral parameters cannot be said to arise from any sort of experimental manipulation, natural or otherwise. Indeed, there are presumably many reasons why an individual might change his or her perceptions regarding the risk and rewards of criminal activity; for example, engaging in criminal activity provides information to respondents about the risk and rewards of crime (Anwar and Loughran, 2011; Lochner, 2007; Matsueda, Kreager, and Huizinga, 2006) at a level of temporal granularity that our data simply cannot capture (i.e., updating occurs at a frequency that is greater than every 6 months). Ultimately, we discuss the estimated parameters as associations rather than as causal effects, which we argue are still of fundamental interest. Conditional on the usual assumptions regarding omitted variables, the regression described in equation (2) provides insight into which behavioral parameters are more highly correlated with criminal activity, regardless of whether crime is sensitive to the variable or the variable is sensitive to criminal activity.

RESULTS

SAMPLE CHARACTERISTICS

Table 1 reports the selected descriptive statistics for each variable used in subsequent models. For each variable, we report the mean and the standard deviation, as well as the minimum and maximum values. We also report the within-respondent share of the variation to provide the reader with a sense for the degree to which each variable varies within,

as opposed to between, individuals. As our subsequent models condition on respondent fixed effects, we ultimately retain only the within-individual share of the overall variation.

Panel A considers each dependent variable we examine. Overall, over a given reporting period, the average individual in our sample reports having committed 23.58 crimes, which is an average of 2.82 crimes per month. The data are highly skewed with 73.38 percent of respondent time periods yielding zero reported crimes. Likewise, 27 percent of the sample reports never having committed a crime, while just 2.5 percent of the sample reports having offended in all ten time periods in our data. With respect to the upper range of the data, we have elected to top code very high values of reported crime at 500. This translates to approximately 20 crimes per week, which we view as not implausible for drug crimes, as well as for petty acquisitive crimes such as shoplifting. On average, respondents report having committed 4.0 thefts, 20.0 drug crimes, and just .6 violent crimes per 6-month period. Intuitively, most variation in the criminal activity is between rather than within individuals, implying a prominent role for the fixed effects in purging the model of unobserved unit-specific heterogeneity.

With respect to the share of earnings obtained legally, the data show that, overall, 81 percent of reported earnings have a legal source. The prominence of legal earnings varies by age with respondents younger than 17 years of age reporting that 73 percent of earnings are legal, whereas adults report that 82 percent of earnings are legal. With respect to cross-sectional heterogeneity, 47 percent of the panel report legal earnings but never report any illicit earnings, whereas slightly less than 5 percent of the sample reports illicit earnings but no legal earnings. Overall, 42 percent of the sample reports both legal and illicit earnings at some point during the 4-year period, whereas 6 percent report no earnings data at all.

Panel B of table 1 reports descriptive statistics for the key model parameters prior to z score standardization. Each of the following analyses employs standardized forms of these key model parameters to facilitate comparative tests and ease of interpretation. Overall, approximately half of the variation in the model parameters is within-individual variation and the remaining half is between-individual variation. The degree to which perceptions shift over time for a given individual is perhaps surprising and provides a rich degree of variation with which to identify the association between perceptual variables and crime.

Finally, Panel C reports descriptive statistics for each covariate we condition in our primary models. Overall, for the average time period in the sample, individuals are slightly older than 19 years of age. Respondents are as young as 14.5 and as old as 26.0. Given the high degree of criminal involvement in the sample, it is perhaps not surprising that individuals spend approximately one third of their time incarcerated in prison or jail. With respect to individual experiences, 12 percent of the sample has a relative who is arrested in a given time period and the typical individual reports being the victim of .2 different violent crimes per recall period (or 2.0 different violent crimes over the ten recall periods). These individuals also report having consistently witnessed violent crimes, on average, one type of violent crime witnessed per recall period. In a given time period, 9 percent of the sample reported being a member of a gang with most of the overall variation occurring between rather than within individuals. In a given time period, 6 percent of the respondents are males with a pregnant girlfriend or spouse and 7 percent of respondents report that either they or a significant other have given birth to a child.

Table 2. Model-Based Tests of Rational Choice Theory

Variable	(1) All Crimes (Variety)	(2) Theft and Robbery	(3) Drug Crimes	(4) Violent Crimes	(5) Legal Share of Earnings
Certainty of Apprehension (<i>P</i>)	-.138** (.025)	-.238** (.078)	-.150** (.044)	-.165* (.080)	.018** (.006)
Severity of Sanction (<i>f</i>)	-.010 (.022)	.064 (.072)	-.073 (.047)	-.044 (.131)	.002 (.006)
Social Rewards (<i>Y1</i>)	.173** (.026)	.202* (.082)	.100† (.051)	.336** (.069)	-.021** (.006)
Personal Rewards (<i>Y2</i>)	.152** (.022)	.233** (.084)	.093† (.049)	.062 (.089)	-.025** (.007)
Joint Tests of Model Parameters					
Chi-squared statistic on model parameters	142.5**	37.0**	22.6**	45.8**	—
<i>F</i> statistic on model parameters	—	—	—	—	8.7**
Chi-Square Tests on Individual Restrictions					
<i>P</i> = <i>f</i>	14.6**	6.5*	1.3	.8	3.3†
<i>P</i> = - <i>Y1</i>	1.0	.1	.6	5.8*	.1
<i>P</i> = - <i>Y2</i>	.2	.0	.8	.6	.4
<i>f</i> = - <i>Y1</i>	22.0**	5.0*	.2	5.9*	5.2*
<i>f</i> = - <i>Y2</i>	18.8**	6.2*	.1	.0	5.8*
<i>Y1</i> = <i>Y2</i>	.4	.1	.0	3.9*	.2
Cross-sectional <i>n</i>	965	752	675	551	1,252

NOTES: Estimates presented are regression coefficients, and cluster-robust standard errors that account for within-respondent dependence are reported in the parentheses below the coefficient estimates. In columns (1)–(4), we report the results of a Poisson regression of the variety or frequency of crimes a respondent reports having committed during the recall period on four behavioral parameters implicit in rational choice theory. The *z* score of each behavioral parameter is used for ease of interpretation. Column (5) reports the results of a least-squares regression on the proportion of earnings that are earned in the legal sector during the recall period on the same four behavioral parameters. All models condition on the respondent's age, the percentage of a respondent's time spent in custody, as well as additional control variables and interacted site-by-period and respondent fixed effects.

†*p* < .10; **p* < .05; ***p* < .01 (two-tailed).

MAIN ANALYSIS

The top panel of table 2 presents Poisson regression estimates for the model presented in equation (2) for each of several different crime types. Column (1) presents estimates for a variety of all crimes committed in the recall period. Columns (2), (3), and (4) present estimates for income-generating crimes (theft and robbery), drug crimes, and violent crimes, respectively. For these three outcomes, we report estimates by using frequency rather than variety given the limited amount of crimes in each category.⁸ Finally, in column (5), we present least-squares estimates for the share of total earnings that derive from legal (as opposed to illicit) sources. Estimates and robust standard errors clustered on the respondent are reported for the four behavioral parameters implicit in rational choice theory. Beginning with column (1), we estimate that a 1 standard deviation increase in an individual's perceived certainty of apprehension is associated with a .14 decline in the natural logarithm of types of crime, which is a 13 percent reduction. Likewise, a 1 standard deviation increase in perceived severity is associated with a 1 percent reduction in offending,

8. We also estimated results by using variety scoring for the crime-specific outcomes. These results are substantively similar and are available as part of the online supporting information in table S2.

although the parameter is not precisely estimated. With respect to the perceived benefits of crime, a 1 standard deviation increase in the social and personal rewards of crime is associated with a 19 percent and 16 percent increase in offending, respectively.

Given that the average individual reports committing .71 different infractions in a recall period, the models predict that a 1 standard deviation increase in certainty is associated with $\sim .09$ fewer types of crimes, whereas a 1 standard deviation increase in social or personal rewards is associated with $\sim .13$ and $\sim .11$ additional types of crimes, respectively. Thus, although three of the four behavioral parameters are significantly associated with changes in offending, the magnitudes of these parameters are best characterized as important but not as large relative to baseline.

Column (2) presents results for instrumental crimes that we characterize as theft and robbery. Here we see that a 1 standard deviation increase in certainty reduces log crime by $-.24$ (21 percent), whereas a 1 standard deviation increase in social rewards and personal rewards increases log crime by $.20$ (22 percent) and $.23$ (26 percent), respectively. Interestingly, the coefficient on severity is close to zero and falls in the opposite direction, indicating that perceived changes in the severity of sanctions are not associated with changes in acquisitive crimes, a finding that may be rationalized by the fact that such crimes are rarely punished. Overall, given that the average individual in the sample reports committing four acquisitive crimes per 6-month period, a 1 standard deviation increase in certainty and a 1 standard deviation decrease in perceived personal rewards would reduce theft by $.84$ and 1.04 crimes per year, respectively. Again, assuming that 2 percent of a city's population is sensitive to such changes, these parameter estimates translate to annual decreases in theft of approximately 1,700–2,100 in a city of 100,000 residents.

Column (3) reports results for drug crimes. Here, a 1 standard deviation increase in certainty reduces the number of drug crimes by 14 percent. Likewise, both personal and social rewards are drivers of drug crime ($p < .10$), a finding that accords with ethnographic research on young drug offenders (Venkatesh, 2008; Wright and Decker, 1994). For drug crimes, some evidence exists that the severity of the sanction is more important, although the parameter estimate is not significant at conventional levels of significance. Column (4) reports the same results for violent crimes. Here the finding is that violent crimes are, to a large degree, driven by perceived social rewards. A 1 standard deviation increase in the perceived social rewards is associated with a 40 percent increase in criminal activity.

Finally, in column (5), we report results for a least-squares regression of the share of earnings obtained in the legal sector on the same regressors included in models (1)–(4). The evidence is consistent with a rational reallocation of time spent in legal versus illicit activities in response to changes in perceptions of the benefits of criminal activity. In particular, a 1 standard deviation increase in certainty is associated with a 1.8 percentage point increase in the legal share of earnings, whereas the perceived rewards of crime are associated with a 2.0 to 3.0 percentage decrease in this variable. Interestingly, the negative coefficient on social rewards implies that offenders are, other things equal, willing to trade off legal earnings for social status. As in models (1)–(4), little evidence exists of a relationship between criminal activity and perceived sanction severity.

Overall, the pattern of the results suggests that offenders behave in a rational way with respect to perceived changes in the costs and benefits of crime. In this population, which many assume to be motivated more by irrational, emotional factors, both the benefits and costs of behavior seem to matter, and the rational consideration of costs and benefits characterize both property and expressive crimes such as violence and drug offenses alike.

Below the coefficient estimates in table 2, we provide a formal omnibus test for the significance of rational choice theory, operationalized as a joint test of the model's four key parameters. For the Poisson regression models in columns (1)–(4), this was done by using a likelihood ratio test with a critical value of χ^2 with four degrees of freedom of 9.49. In column (5), we use an F test that, in a large sample, and given four parameters has a critical value of 2.37. For all five dependent variables, we can reject the null hypothesis that rational choice has no predictive power at $\alpha = .01$, indicating that offenders are at least somewhat responsive to risks, costs, and rewards.

The final rows of table 2 present the results of tests of the set of pairwise linear restrictions on the equality of individual model parameters for the rational choice measures. These tests allow us to draw inferences regarding whether offenders are, in fact, more responsive to certainty than to severity or whether they are more responsive to the perceived rewards of crime than to its costs. Because the theoretically expected signs on the estimates vary with certainty and severity expected to generate negative coefficients and the social and personal rewards measures expected to generate positive coefficients, for four of the six pairs of tests, we test whether one parameter estimate is equal to -1 times the other parameter estimate. We first consider the equality of certainty (p) and severity (f) as this comparison has generated considerable discussion in the extant literature (Nagin, 2013; Paternoster, 2010). Although both parameter estimates are negative, for all crimes, we can reject ($p < .01$) that the two estimates are equal, providing direct evidence that offenders are, in fact, *more responsive to certainty than they are to severity*. This is also true for acquisitive crimes ($p < .05$). However, given the precision of our estimates, we cannot make this claim for drug crimes where severity seems to feature more prominently in offender decision making. Likewise, for violent crimes that are more uncommon in the data, a considerable degree of uncertainty remains regarding the relative magnitudes of these parameters.

Several other results are worth noting. First, for four of the five dependent variables, we cannot distinguish the relative importance of social versus personal rewards of crime. The exception is for violent crimes where we conclude individuals seem to be more responsive to social rather than to personal rewards. Second, for acquisitive and violent crimes, we can conclude that the social rewards of crime are more strongly associated with offending than with sanction severity. For acquisitive crimes, we also can conclude that personal rewards are more strongly associated with offending than with severity.

HETEROGENEITY

For the full sample of individuals, table 2 provides strong descriptive evidence in favor of offender rationality in this sample. A natural extension is to consider whether these findings differ for theoretically important subgroups. Table 3 reports results by using a variety of all crimes as the dependent variable for seven subgroups within our sample: high-risk individuals, low-risk offenders, males, females, and White, Black, and Hispanic offenders. We highlight three primary conclusions. First, in each case, we can reject the null hypothesis that rational choice has no predictive power at $\alpha = .01$, which suggests that the model yields some predictive validity across each subpopulation.⁹ Second, although

9. We also conducted similar analyses for each subgroup by using the other dependent variables (i.e., theft/robbery, drug crimes, violent crimes, and share of legal earnings). In the interest of brevity, we omit these results but note they are available as part of the online supporting information in

Table 3. Model-Based Tests of Rational Choice Theory: Subgroup Analyses for All Crimes Variety Score

Variable	(1) High Risk	(2) Low Risk	(3) Males	(4) Females	(5) Whites	(6) Blacks	(7) Hispanics
Certainty of Apprehension (<i>P</i>)	-.101* (.047)	-.153** (.028)	-.124** (.026)	-.302** (.077)	-.226** (.053)	-.081* (.038)	-.136** (.046)
Severity of Sanction (<i>f</i>)	.005 (.037)	-.016 (.028)	-.012 (.023)	.074 (.091)	.020 (.050)	-.016 (.033)	-.009 (.042)
Social Rewards (<i>Y1</i>)	.120** (.037)	.197** (.034)	.169** (.026)	.225* (.100)	.156** (.049)	.135** (.040)	.218** (.049)
Personal Rewards (<i>Y2</i>)	.144** (.034)	.160** (.027)	.146** (.022)	.115 (.092)	.158** (.045)	.147** (.038)	.159** (.038)
Joint Tests of Model Parameters							
χ^2 statistic on model parameters	41.7**	107.2**	120.1**	26.5**	63.2**	31.7**	47.5**
χ^2 Tests on Individual Restrictions							
<i>P</i> = <i>f</i>	3.2 [†]	11.4**	10.8**	9.4**	12.8**	1.7	4.0*
<i>P</i> = - <i>Y1</i>	.1	.9	1.4	.3	.8	.9	1.7
<i>P</i> = - <i>Y2</i>	.6	.0	.4	2.5	.9	1.6	.1
<i>f</i> = - <i>Y1</i>	6.4**	14.8**	19.0**	4.6*	5.4*	4.9*	10.2**
<i>f</i> = - <i>Y2</i>	8.1**	12.1**	16.0**	2.0	6.6*	6.9**	5.8*
<i>Y1</i> = <i>Y2</i>	.2	.7	.4	.5	.0	.1	.9
Cross-sectional <i>n</i>	318	647	870	95	208	391	325

NOTES: Estimates presented are regression coefficients, and cluster-robust standard errors that account for within-responder dependence are reported in parentheses below the coefficient estimates. In columns (1)–(7), we report the results of a Poisson regression on the variety of all crimes a respondent reports having committed during a recall period on four behavioral parameters implicit in rational choice theory. Each column presents a separate subgroup analysis according to risk, gender, or race. The *z* score of each behavioral parameter is used for ease of interpretation. All models condition on the respondent’s age, the percentage of a respondent’s time spent in custody, as well as additional control variables and interacted site-by-period and respondent fixed effects.

[†]*p* < .10; **p* < .05; ***p* < .01 (two-tailed).

our sample of females is small (95 cross-sectional), women seem to be highly sensitive to changes in the certainty of apprehension. A 1 standard deviation increase in certainty is expected to reduce offending by ~26 percent. At the same time, women seem to be less sensitive to the personal rewards of crime. Instead, they are highly responsive to perceived changes in the social rewards, providing some evidence that women’s participation in criminal activity is more tied to the perceptions of their peers. Third, and perhaps most importantly, we observe the relative homogeneity of the results by race. Although several individual parameter estimates seem to differ by subgroup, overall, the model seems to be equally predictive for White, Black, and Hispanic respondents.¹⁰

Tables 4 and 5 provide tests of differential deterrence across both crime types and subgroups. Table 4 presents *p* values from tests of cross-equation restrictions for each of

tables S3–S6. To summarize, including all crimes outcome, five dependent variables and seven subgroups generated 35 unique tests of offender rationality. In 28 out of 35 tests, we rejected the null hypothesis that rational choice has no predictive power at the $\alpha = .05$ level. Only 3 of the 35 tests yield an insignificant test statistic at $\alpha = .10$.

10. An exception is acquisitive crimes for Black respondents (not shown in the current output although available as part of the online supporting information). For these respondents, the model does not have predictive power. In particular, certainty of capture seems not to matter with crime largely driven by perceived personal rewards.

Table 4. Tests of Cross-Equation Restrictions

Variable	(2) Theft and Robbery	(3) Drug Crimes	(4) Violent Crimes
A. Certainty of Apprehension (<i>P</i>)			
Theft and Robbery	—	.33	.87
Drug Crimes	.33	—	.51
Violent Crimes	.87	.51	—
B. Severity of Sanction (<i>f</i>)			
Theft and Robbery	—	.11	.83
Drug Crimes	.11	—	.47
Violent Crimes	.83	.47	—
C. Social Rewards (<i>Y1</i>)			
Theft and Robbery	—	.29	.01**
Drug Crimes	.29	—	.21
Violent Crimes	.01**	.21	—
D. Personal Rewards (<i>Y2</i>)			
Theft and Robbery	—	.15	.76
Drug Crimes	.15	—	.16
Violent Crimes	.76	.16	—
Cross-sectional <i>n</i>	752	675	551

NOTES: Table tests cross-equation restrictions for the four key parameters in our model of rational choice. Each entry refers to the *p* value arising from a χ^2 test of the null hypothesis that a given parameter is equal across Poisson regression models for different crime types. These are tests of the equality of the parameters in different columns of table 2. For example, Panel C reports that we can reject ($p < .01$) that the social rewards parameter is equal in the theft and violent models.

** $p < .01$ (two-tailed).

Table 5. Tests of Cross-Group Differences—All Crimes (Variety)

Variable	(1) Certainty of Apprehension (<i>P</i>)	(2) Severity of Sanction (<i>f</i>)	(3) Social Rewards (<i>Y1</i>)	(4) Personal Rewards (<i>Y2</i>)	Cross- sectional <i>n</i>
High risk / Low risk	.34	.65	.13	.71	965
Male / Female	.03*	.36	.59	.74	965
White / Black	.03*	.55	.74	.85	591
White / Hispanic	.20	.66	.37	.99	533
Black / Hispanic	.36	.90	.19	.82	716

NOTES: Table tests whether each of the four key parameters of our models of rational choice in table 3 differs by subgroup. For each pair of subgroups (e.g., male and female respondents), each entry refers to the *p* value arising from a χ^2 test of the null hypothesis that the two subgroups have equal parameter values for the all crimes variety outcome.

* $p < .05$ (two-tailed).

the four model parameters and each of the three crime types we consider. For any two crime types, the null hypothesis is that the parameter is equal for each crime type. For example, we might wish to know whether the certainty parameter is larger for acquisitive crimes than it is for drug crimes. Panels A, B, and D present evidence that, with respect to certainty, sanction severity, and personal rewards, we cannot reject the equality of any of the cross-equation parameter estimates. Thus, evidence that sanction severity is more strongly associated with some crimes than with other crime types is best regarded as speculative. The only evidence of differences we observe across crime types is that social rewards seem to be more important for violent crimes as compared with theft/robbery crimes. In sum, the rational choice model of offending that we have specified seems to be equally similar for different kinds of offenses.

Table 6. Model-Based Tests of Rational Choice Theory: Robustness Checks

Variable	(1) Poisson without Interaction ($P \times f$)	(2) Poisson with Interaction ($P \times f$)	(3) Negative Binomial Specification	(4) Ordinary Least Squares Specification
Certainty of Apprehension (P)	-.138** (.025)	-.141** (.025)	-.139** (.022)	-.103** (.020)
Severity of Sanction (f)	-.010 (.022)	-.019 (.023)	-.009 (.017)	-.012 (.015)
Interaction ($P \times f$)	—	-.026 (.020)	—	—
Social Rewards ($Y1$)	.173** (.026)	.171** (.026)	.195** (.025)	.079** (.019)
Personal Rewards ($Y2$)	.152** (.022)	.153** (.022)	.153** (.021)	.170** (.027)
Cross-sectional n	965	965	965	965

NOTES: In columns (1) and (2), we report the results of a Poisson regression of the variety of all crimes a respondent reports having committed during a recall period on four behavioral parameters implicit in rational choice theory. The z score of each behavioral parameter is used for ease of interpretation. Column (1) presents estimates from the baseline model reported in column (1) of table 2. In column (2), we add an interaction term between P and f to the baseline model. Columns (3) and (4) test the robustness of our choice of Poisson regression. In column (3), we report estimates for a negative binomial regression estimated via conditional maximum likelihood. Column (4) reports estimates using ordinary least squares. In all cases, standard errors are clustered at the level of the respondent with the exception of the negative binomial model where the standard errors are bootstrapped.

** $p < .01$ (two-tailed).

Table 5 reports p values arising from formal tests of the equality of the model parameters across subgroups for all crime varieties. Column (1) reports results for certainty, whereas columns (2), (3), and (4) report results for severity and the social and personal rewards of crime, respectively. Overall, we again see little difference across subgroups, indicating the relative ubiquity of the model across these different groups. With the notable exception that Whites seem to be more responsive to certainty than Blacks, we observe no difference in the remaining parameters across race. Moreover, little evidence exists that offenders who were identified at baseline as posing an especially high risk of delinquency operate differently than low-risk offenders. The other exception is we find evidence that men and women differ in their responsiveness to certainty.¹¹

SENSITIVITY ANALYSIS

Finally, we consider whether the main results reported in table 2 are robust to certain specification choices. This set of results is reported in table 6 with the results of column

11. Although we are careful to avoid making causal claims in this analysis, we do wish to acknowledge the issue of temporal ordering of our measures, whereby the offending outcomes and rational choice measures were observed contemporaneously. As a robustness check, we estimated an additional set of the model specifications by using the variety score outcome in which we used lagged versions of the key rational choice measures (i.e., measured at time $t - 1$) for the full sample and each subsample. In 6 of the 8 models, we could reject a null hypothesis that rational choice has no predictive power at the $\alpha = .05$ level. Only 1 of the 8 tests yielded an insignificant test statistic at $\alpha = .10$.

1 in table 2 reproduced in column 1 of table 6 to ease comparisons. First, we consider a specification by using a variety of all crime for the full sample where we include the interaction between certainty and severity, to test whether the effect of severity is greater when certainty is greatest. This interaction directly falls out of Becker's (1968) model and has been suggested by extant literature. Results from the specification are reported in column (2). Although the sign of the coefficient on the interaction term ($-.026$) is in the theoretically expected direction, it fails to reach statistical significance. As such, evidence of a multiplicative relationship between certainty and severity is merely suggestive.

Second, we considered the robustness of our estimates to our choice of a Poisson estimator. Column (3) reports results for the full sample by using conditional negative binomial regression. With the exception of the larger difference in magnitude of the coefficient on the social rewards, the results are similar with differences between coefficients across specification of .001. Column (4) reports estimates of ordinary least squares. Although the coefficients have a different interpretation and, as such, are not directly comparable, they yield a qualitatively similar story, again suggesting our choice of Poisson estimation is justifiable.¹²

CONCLUSION

Although scholars promoting rational choice theory have made important contributions to work in other social sciences, there has been some reluctance to accept it warmly within criminology. We think that the reluctance of many criminologists to embrace a rational choice model is that it has been misunderstood by critics who frequently claim that the rationalist assumptions of the theory are unreasonable for criminal behavior and that its conceptual net is cast too narrow, including only the formal costs and benefits of offending. Part of this mythos about rational choice theory must also, however, be understood to have been reinforced by the way the theory has been empirically specified even by its proponents. Empirical models of so-called rational choice theory have only rarely moved beyond the consideration of what are really deterrence variables, and although some have tested more expansive versions of the theory (Matsueda, Kreager, and Huizinga, 2006; Piliavin et al., 1986), even these versions have omitted some important factors that are integral to rational choice theory. Our intent in this article is to pick up on a strain of thought first articulated by Piliavin et al. in 1986: "Unfortunately, despite numerous calls for a general theory of deterrence, nearly all of the empirical research on the issue takes as its framework 'a vague congerie of ideas with no unifying factor other than their being legacies of two major figures in moral philosophy, Cesare Beccaria and Jeremy Bentham' (Gibbs, 1975: 5) ... [a] more fruitful approach to the issue of deterrence would be to examine the relationship between formal sanctions and crime from within an explicit theoretical framework" (p. 101). Our ambition was to specify and test empirically a comprehensive rational choice model of crime and, in so doing, illustrate that the explanatory parts of the model are consistent with more sociological theories of

12. We performed several additional robustness checks that included removing time-varying control variables. Without the full set of controls, the certainty and social and personal rewards parameters are larger in magnitude, stressing the importance of the control variables we have chosen. Nevertheless, although the magnitudes vary, the results are again qualitatively similar.

crime and that it does not require that human beings act as *homo economicus*—strictly financial agents solely interested in the best price of things.

With this motivation, several key findings emerged from our analysis. First, we found general support that individuals seem to be responsive to rational choice perceptions and that this held across different types of crimes, including aggressive crimes. Moreover, these perceptions still held explanatory power even after taking account of time-stable unobserved heterogeneity between individuals, as well as multiple time-varying confounders. Second, we found that even when conditioning on observable heterogeneity in terms of gender, race, and high- and low-offending risk, each of these subgroups was still responsive to these perceived risks, costs, and rewards. Third, we observed a large degree of homogeneity in terms of the magnitudes of the parameters across these subgroups, which suggests that there was little difference in how factors operate across different subgroups.

We find that these adolescents with a history of serious criminal offending act in accordance with the anticipated rewards and costs of offending and that this is as true for drug and violent offenses as it is for property crimes. We also found that these adolescents rationally reallocate their time in response to the expected changes in the benefits of legal and illegal activity. Although consistent with much previous research, the rewards of behavior generally carry somewhat greater weight than the costs, both are important influences on the youths' conduct. Finally, we find evidence of rational response to the contingencies of behavior across youths with different risk levels of criminal propensity, for both genders, and for Black, White, and Hispanic youth.

In sum, we think we have posed a difficult test for the generality of rational choice theory, but a test it has passed. Our results would seem to confirm unambiguously our assertion that rational choice theory is as general a theory of crime as are social learning, social control, and strain theories. Moreover, our results, taken together with the prior work of Anwar and Loughran (2011); Matsueda, Kreager, and Huizinga (2006); and Piliavin et al. (1986), provide a substantial counterweight to the blunt conclusion reached by Pratt et al. (2006: 5) that “the effects of the variables specified by deterrence theory on crime/deviance are, at best, weak—especially in studies that employ more rigorous research designs.” Moreover, our results also would seem to provide strong support for the core tenets of both situational crime prevention (Clarke, 1983) and a more recent theoretical model put forth by Nagin, Solow, and Lum (2015). We, however, caution RC scholars to be careful in making sure that their empirical models are faithful to the complexity of rational choice theory and that they include the full set of incentives and disincentives for legal and illegal conduct. Finally, we emphasize that often the failure of individuals to act in a fully rational manner is not necessarily an indictment of the entire theoretical paradigm of rational choice, but instead, it can provide important insight into heuristic devices and predictable deviations from rational behavior that may be useful in tweaking the theory.

Our results also reveal an important consideration for future studies of criminal deterrence, the bulk of which often have tended to offer hypotheses that typically are laid out in terms of a null hypothesis of no association between sanction cost/risk and offending. Any evidence in which this type of null hypothesis can be rejected tends to be taken as support for deterrence. Although such tests are perhaps weakly formed as is, our findings would suggest that the strong sensitivity of potential offenders to rewards to offending, both monetary and intrinsic, can easily offset any such weak deterrent effects of sanctions

and must be contemporaneously considered. As such, we advocate that future studies of offender decision making evolve beyond the somewhat narrow, current focus on costs and risk and bridge into deeper study of offending rewards and motivation, including studies of time preference, as it is clear that rewards and costs to crime are temporally distinct outcomes.

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

Table S1. Model-Based Tests of Rational Choice Theory: Variety Score Nonzero Exposure Time

Table S2. Model-Based Tests of Rational Choice Theory: Variety Score Sensitivity Check

Table S3. Model-Based Tests of Rational Choice Theory: Subgroup Analyses for Theft And Robbery (Frequency)

Table S4. Model-Based Tests of Rational Choice Theory: Subgroup Analyses for Drug Crimes (Frequency)

Table S5. Model-Based Tests of Rational Choice Theory: Subgroup Analyses for Violent Crimes (Frequency)

Table S6. Model-Based Tests of Rational Choice Theory: Subgroup Analyses for Legal Share of Earnings

STATA SYNTAX RECORDS FOR TABLES IN TEXT