"A Cure for Crime? Psycho-Pharmaceutical Sales and Crime Trends"

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Abstract:

In this paper we consider possible links between the advent and diffusion of a number of new psychiatric pharmaceutical therapies and crime rates. We describe recent trends in crime and review the evidence showing mental illness as a clear risk factor both for criminal behavior and victimization. We then briefly summarize the development of many new pharmaceutical therapies for treatment of mental illness, which diffused during the "great American crime decline." We examine limited international data, as well as more detailed American data to assess the relationship between crime rates and rates of prescriptions of two main categories of psychotropic drugs—antidepressants and stimulants, while controlling for other factors which may explain trends in crime rates. Our goal is to see if increases in prescriptions are associated with changes in crime rates. Any observed reduction in crime as a result of higher prescription rates would suggest that expansions in mental health treatment may have substantial benefits for society as a whole beyond improved health.

In the early 1990s, the United States experienced a decade long decline in crime rates that was widespread and large by historical standards (Zimring (2007)). This trend was especially pronounced for the violent crime rate, which peaked in 1992, with the rate of decline slowing and perhaps stopping in the early part of this decade. Property crime has also fallen since the early 1990s. There is a vast literature attempting to explain the declining crime rates.[1] Previous work by economists has focused on a variety of factors that affect the costs of crime, opportunity costs, and the number of persons in the population at risk of criminal behavior. For example, there is a large amount of evidence that the increase in the number of police on the street lowered urban crime rates, even if evidence about particular policing strategies is less clear (Cook (2008) and Levitt (2004)). It appears, too, that crime rates did not recede in response to the economic growth of the 1990s, but the waning of the crack cocaine epidemic was a factor (Levitt (2004); Raphael and Winter-Ebmer (2001)).

While much has been learned about recent trends in crime rates, it is clear, too, that many of the social, economic, and policy determinants of crime have had little effect. Zimring (2007) notes that the marked decline in crime rates occurred during a period when the social and economic conditions were not much changed. Consequently, analysts have examined the role of other, less obvious, factors as possible explanatory factors. These include the decline in youth at risk of criminal behavior because of an increase in access to abortions in the 1970s following the *Roe v. Wade* decision (Donohue and Levitt (2001)), and a decline in exposure to environmental lead, which has been linked to developmental problems and aggression (Reyes (2007)).

So far ignored in the attempt to explain this recent drop in crime has been a period of dramatic technological advances in the treatment of mental illness. As we summarize below, mental illness is a clear risk factor both for criminal behavior and for victimization. The decline

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[1] See Cook (2008) for a recent review.

in crime rates occurred during a period when many new pharmaceutical therapies became available to treat mental illness resulting in exceptionally large increases in medical treatment of mental illness. For example, during the last two decades the use of antidepressants and antipsychotics has become increasingly common following a series of drug innovations in the late 1980s and early 1990s. The new drugs were marked improvements over the previous therapies in terms of side effects and efficacy, and their use has subsequently become widespread. Anti-depressants and anti-psychotic medications are now the 6th and 7th largest therapeutic classes of drugs sold globally (IMS Health, 2006), and there were enough newer anti-depressants sold in the U.S to treat every man woman and child with a daily dose for almost two months.

There is some evidence suggesting the dispersion of such treatment may have affected crime rates. The first are simple time series comparisons: Crime rates/victimization for adults peaked just after the introduction of the first of these new psycho-pharmaceutical therapies, and have declined since. Further, crime rates/victimization for juveniles peaked a bit later, then fell until 2004, and rose in 2005; Sales of new psycho-pharmaceuticals to juveniles lagged those to adults, and fell sharply after the FDA's 2004 "black box" warning of risks of suicide for young persons treated with newer classes of antidepressants. Beyond these corresponding time-series, recent research has shown the potential for improvements in mental health and reduction in criminal behavior as a result of mental health treatment adherence, including adherence to prescription drug routines. However, much of this literature has been conducted on small samples or specific vulnerable populations.

The purpose of our paper is to examine the link between prescriptions for psychotropic drugs and crime rates in a broad study of the U.S. and that moves beyond simple time series

comparisons. Specifically, we examine the relationship between crime rates and rates of

prescriptions of two main categories of psychotropic drugs—antidepressants and stimulants,

while controlling for other factors which may explain trends in crime rates. Our goal is to see if

increases in prescriptions are associated with changes in crime rates. Any observed reduction in

crime as a result of higher prescriptions rates would suggest that expansions in mental health

treatment may have substantial benefits for society as a whole beyond improved health.

Background

Recent trends in crime

For those that study crime, the 1990s were remarkable. During the decade, violent crime

rates fell from a post-war peak with a speed that was both rapid and unforeseen. The importance

of the decade for criminologists is not just the break in trend, but that many questions linger

about its causes. One source for gauging trends in crime rates over time is data reported to the

U.S. Federal Bureau of Investigation through its Uniform Crime Reports (UCR) program. The

UCR is a voluntary program compiling criminal offenses reports to local policing agencies.[2] In

Figure 1, we plot rates of violent and property crime (per 100,000 residents) for the period 1960

to 2007.[3]

Violent crime (including murder, rape, robbery and assault) increased fairly steadily from

the beginning of the series until reaching a peak in 1993. Violent crime rates then fell rapidly, in

a period of 7 years reverting back to rates not observed since the early 1970s. Since 2000, the

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[2] An obvious concern is that because this reporting is voluntary, the results might be hard to compare over time or
across jurisdictions. However, the view of most analysts is that police departments are diligent and forthright in
reporting data (e.g. Cook (2008)). In any case, the marked decline witnessed in the 1990s is also apparent in the two
other principal sources of data on crime rates, the U.S. Department of Justice's National Crime Victimization Survey
and the Center for Disease Control's National Vital Statistics program, which tracks death by cause, including
homicide.

[3] No data are available from New York City from 1960 to 1964. Though this is only one jurisdiction, it is clearly an
important omission to the first five years of these series.

rate of decline in violent crime has slowed and perhaps stopped. Property crime rates increased

more rapidly in the early part of the period, but peaked earlier, too. Like violent crime, property

crime rates fell rapidly in the 1990s, and somewhat more slowly since 2000.

Figure 1

Source: Authors' calculations using FBI Uniform Crime Reports data.
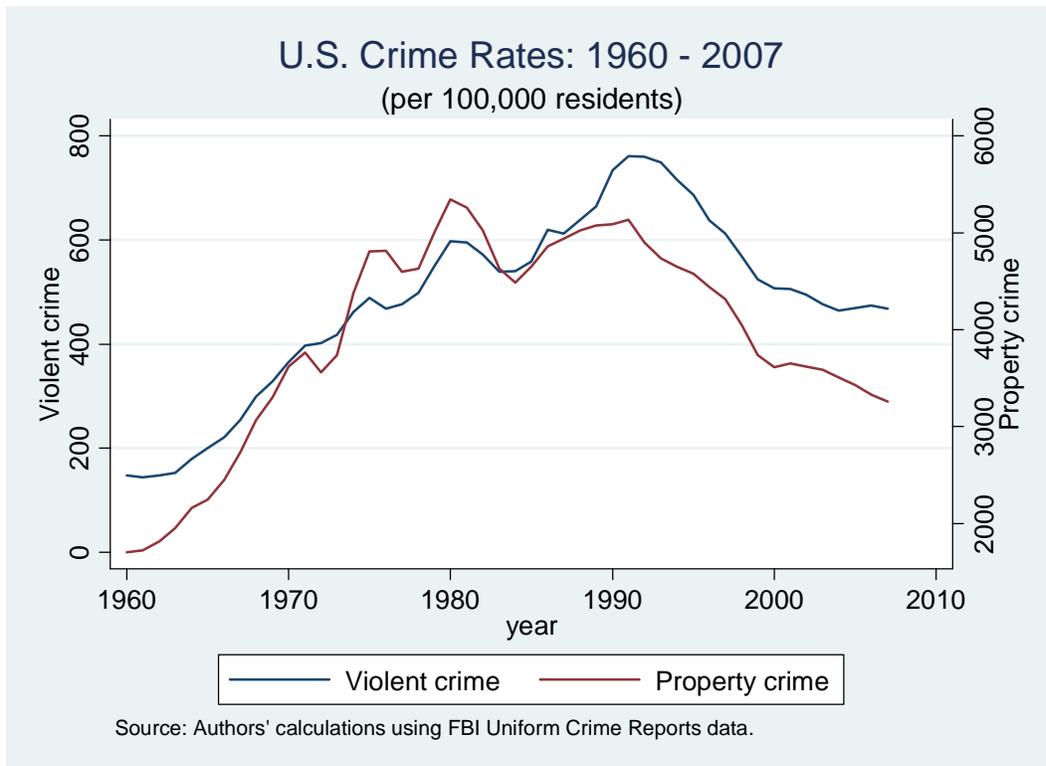
The fall in crime rates in the 1990s was not only steep, it was broad. Using both the UCR

and data from the U.S. Department of Justice's National Crime Victimization Survey, Levitt

(2004) reports that crime rates fell in all categories of violent and property crimes. He also

illustrates that crime fell in all regions of the country, and in cities large and small, and that rates

fell fastest in metropolitan areas, though they fell in rural areas, too.

Several factors are believed to have contributed to the rapid and broad decrease in crime

rates. One factor that appears to have been important is the growth in the size of the collective

police force, even if the jury is still out on particular policing strategies (Levitt (2004) and Evans

and Owen (2007)). Also contributing to the decline was a run up in the proportion of the population incarcerated, and hence unavailable to engage in criminal activity in the community (Levitt (2004) and Zimring (2007)). Another factor that was likely affecting violent crime rates during this period was the waning crack cocaine epidemic. There is substantial agreement that the growing market for crack in the 1980s created and sowed substantial violence in urban neighborhoods where it was sold and consumed (Blumstein (2000); Levitt and Venkatesh (2000) and Grogger and Willis (2000)). Consequently, several analysts have suggested that a shrinking market for crack has contributed to reduced violence, especially in urban areas (Levitt (2004) and Zimring (2007)).

The period of falling crime rates in the 1990s is just as interesting for what is does not explain--the advent of what one prominent analyst has called a renewed "golden age" in urban centers like New York and Chicago, once so affected by high crime rates (Cook (2008), p. 3)). Most notably, the economic growth of the period contributed substantively little to the decline in property crime rates, and not at all to declining violent crime (Levitt (2004)). There is also no evidence that gun control laws, such as the Brady Act, have reduced homicide (Ludwig and Cook (2000)), or that laws permitting registered gun owners to carry concealed weapons have reduced crime (Duggan (2001)).

The collection of factors that do not explain the decline of the 1990s includes those generally thought to be especially important, including economic conditions and demographic change. That crime rates could fall so quickly during a period when these important phenomena changed slowly (and to no real effect), has led two prominent analysts to conclude that a central lesson of the decade is that large changes in crime rates can occur without much change in the "social fabric" (Zimring (2007), p. 206) or "underlying socioeconomic conditions" (Cook

(2008), p. 24). That marked changes in rates of crime can occur in period of relative socioeconomic stasis has led analysts to suggest a variety of changes in factors that provide answers. These include the well-known, though not universally accepted, contention that increased use of abortions in the 1970s reduced the number of young persons in the 1990s at risk of criminal behavior (Donohue and Levitt (2001; 2003), and Joyce (2004)). Another is a possible link between decline in exposure to environmental lead and crime (Reyes (2007)).

Mental Illness and crime

Our work fits squarely in this line of research looking for alternative explanations. We raise the possibility that the diffusion of vastly improved treatments for various mental illnesses in the community reduced underlying behavioral antecedents to crime. Mental illness (MI) and crime are frequently linked in the scholarly literature as well as in the mass media and the public's perception. Research in this area is largely comprised of correlational studies showing a link between MI and crime (or violence). These studies most commonly take one of two approaches to demonstrate the relationship: The first examines rates of mental illness among prison populations (e.g., Teplin, 1990; Silver et al. 2008). The vastly higher rate of mental illness in prison populations is reflected in a Bureau of Justice Statistics (BJS) survey of inmates in federal, state, and local prisons conducted in 2002 and 2004, reporting that 22 percent all inmates had a history of a serious mental health problem in the year before arrest or since admission. This compares to a prevalence rate of approximately 11 percent in the general U.S. population (BJS 2006).

Evidence using registers data from other countries finds results quite similar to the BJS estimates. For example, Wallace et al. (1998) link data from Australian court records to psychiatric-case registers. They estimate that 25 percent of Australian inmates had been

previously treated for a psychiatric disorder. Obviously, they do not identify the number untreated. They report that those treated had most commonly been diagnosed with depression, bipolar disease and schizophrenic disorders, particularly with comorbid substance abuse.

The second strand of correlational studies on mental illness and crime examines rates of violence, arrest, or incarceration among those who suffer from mental illness (e.g., Hodgins 1992; Swanson et al. 2002). For example, White et al. (2006) find that persons with severe mental illness were vastly times more likely to be incarcerated in the past 6 months than comparable people in the general population. Fewer studies consider violence, crime and mental illness in the broader population (e.g., Cuellar et al. 2007; Swartz and Lurigio 2007). One source for evidence of this type is studies that follow birth cohorts. The Dunedin Study has followed all children born in Dunedin New Zealand between April 1, 1972 and March 31, 1973. Estimates from Dunedin suggest that those with mental illness were more than twice as likely to be violent (Arsenault et al (2000)). While persons with one of the disorders examined comprised one-fifth of the birth cohort, this group accounted for half of the violent crimes committed by the Dunedin cohort (Arsenault et al (2000)). Brennan et al (2000) use data from the Danish national register, and follow persons born between 1944 and 1947. They estimate that persons with a previous psychiatric hospitalization were between 2 and 8 times more likely to engage in criminal violence, even conditioning on demographic, social, and economic characteristics, and substance abuse.

The existing studies differ in terms of the types of crimes and illnesses studied, as well as in the confounding factors that are considered in the research. This is important as Swartz and Lurigio (2007) show that co-occurring substance use partially confounds the relationship between mental illness and crime. Using a large, nationally representative non-institutionalized

sample, these authors show that the positive relationship between serious mental illness and arrests only holds for violent crimes once alcohol and drug use is taken into account. They find no effect for property or drug-related offenses. By contrast, a new population-based study by Elbogen et al. (2009) finds that only co-morbid mental illness and substance use disorders are associated with the perpetration of violence, with the largest effects for substance-related violence. These authors do not examine non-violent crimes.

There are a number of reasons why we might observe the positive correlation between MI and crime. The correlation could be causal, although the direction of causality is not clear. The impairment of proper brain functioning may cause a person to engage in violent or other types of criminal behaviors. However, prior or current imprisonment itself may cause mental illness and lead to the observed positive correlation. Conversely, the relationship may be spurious and a result of observed or unobserved third factors such as substance abuse, environment, financial strain, family stress, traumatic events, past violence or victimization, unemployment, and the like. In a review of the literature, Link and Stueve (1995) conclude, "… the association appears to be causal. Several alternative explanations—methodological and substantive—have been investigated, but none receives consistent support. It is possible, however, that mental illness only leads to violent behavior under certain conditions."(p. 197)

There are a number of reasons to believe that the symptoms of mental illness contribute to violent and other criminal behavior. Persons with severe mental illness may suffer from delusions, impulse control, narcissism, problems controlling affect, and altered risk perceptions that can lead to violent behaviors (Nestor, 2002). Link and Stueve (1995) believe that violence may occur when the symptoms of the illness cause the perception of threats, or the illness causes the weakening of self-control.

Because the symptoms and functional impairments of mental illness are thought to be important factors shaping criminal behavior, researchers commonly focus on various illnesses separately.[4] Research regarding schizophrenia and criminal behaviors is probably the most prevalent in the literature. Symptoms of the disease include hallucinations, delusions, apathy, deficits in social functioning and cognitive impairment (Minzenberg et al. 2008). It is these characteristics that are believed to contribute either directly or situationally to violent and non-violent crimes. (Aseneault et al., 2000; Brennan et al. 2000).

There are also possible links to crime for other illnesses such as major depressive disorder (MDD). Symptoms of MDD include a depressed mood, diminished pleasure in daily activities, insomnia or hypersomnia, feeling of worthlessness or guilt that may be delusional, diminished ability to think or concentrate, indecisiveness, and recurring thoughts of death (APA 2000). Depression in children and adolescents may manifest itself differently. Children and adolescents are more likely than adults to have irritable moods, anxiety, delusions, and engage in disruptive and aggressive behaviors (Brimaher et al. 1998). It is not clear that adults with MDD are more crime prone than others because of the symptoms of MDD or because of co-morbid problems (such as substance abuse), and indeed the literature linking MMD specifically to crime shows mixed results (Swartz and Lurigio 2007; Elbogen 2009). However, the manifestation of the symptoms in children and adolescents provides a clearer mechanism for the link between the disease and juvenile criminal behaviors.

Attention-Deficit/Hyperactivity Disorder (ADHD) is another prevalent mental illness that may be linked with crime and violent behaviors, especially among youth. Estimates of the

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[4] While differences by disease are likely important, Swartz and Lurigio (2007) find that all types of mental illness they examined are associated with an increased risk of violent behavior. In their study, illnesses such as major depression, generalized anxiety disorder, nonaffective psychosis, and panic disorders all are positively related with the probability of arrest for violent crimes.

prevalence of ADHD range from 6 to 9 percent in youth and 3 to 6 percent in adults (Kates 2005). ADHD is characterized by inattention, hyperactivity, and impulsivity. The increased impulsivity may lead to fights (Halperin et al. 1995). Youth with ADHD typically have a low frustration tolerance, have temper outbursts, and their relationships with family and school authorities may be combative due to the youth's poor academic achievement (APA 2000). These characteristics make these youth a greater risk for crime and arrest than similar populations without the disorder (Barkley et al. 2004). Adults with ADD are also thought to be more prone to poor outcomes including work instability, incarceration, and substance abuse (Kates 2005).

One additional aspect of the relationship between crime and mental illness that cannot be ignored is the mental health status of the victim. Recent research on individuals suffering from severe mental illnesses shows rates of victimization that are much higher than that of the general population (Silver et al. 2005; Teplin et al. 2005; White et al. 2006; Hodgins et al. 2007). Here, mental illness may result in impaired judgment and perception of reality, poor planning, and impulsive behavior, all of which may make the sufferer an "easy target" or more prone to victimization (Teplin et al. 2005) Another hypothesis suggests that people with mental illnesses may behave in ways which anger others and lead to violence (Silver et al. 2005). In a review article, Choe et al. (2008) report much higher rates of victimization over perpetration in populations of mentally ill patients. These authors conclude, "Victimization is a greater public health concern than perpetration." (p 153).

Treatment and therapeutic advances

While there is clear evidence of a strong relationship between mental illness and violent criminal behavior and victimization, this would help us understand recent changes in crime rates only if there were changes in the prevalence or presentation of mental illness in the community.

There is no evidence of a change in the prevalence of mental disorders that would coincide with the recent decline in crime. But, there have been large and potentially important changes in the rates of treatment and the treatments available, both of which are likely to affect the symptoms and behavior of the mentally ill in the community.

The best available evidence on changes in prevalence and treatment comes from comparison of the results of the National Comorbidity Survey (NCS) with those of the National Comorbidity Survey Replication (NCS-R). The NCS was a nationally representative sample of non-institutionalized Americans 18 to 54, which collected data on the prevalence of mental disorders in the previous 12 months, and over the lifetime. The NCS was conducted between 1990 and 1992, during the very peak of post-war crime rates in the U.S. Between 2001 and 2003, the NCS-R replicated the NCS design, permitting researchers to examine changes by comparing a similar cohort a decade after the original NCS. Kessler et al (2005) report no change in the prevalence of a mental disorder between the surveys, with 29.4 percent of the NCS sample suffering a non-substance or substance abuse disorder in the early 1990s, and hardly changing to 30.5 percent by 2001-03.

While there was no change in prevalence, there was a marked increase between the NCS and NCS-R in the proportion of those with mental illness getting treatment. Kessler et al (2005) estimate that among persons with a mental disorder percent receiving treatment increased from 20.3 percent to 32.9 percent. This means that nearly 10 million more prime age adults were receiving mental health treatment at the end of the rapid decline in crime than at the beginning. Importantly, it appears that nearly all of this expansion was from treatment with pharmacotherapy. During this period, the share of the population that received outpatient psychotherapy remained unchanged (Olfson et al., 2002). Alternatively, Wang et al. (2006)

report a large increase in the use of physicians as the source of mental health care among Americans, with large declines in care from other therapists.

In addition to the substantial expansion at the extensive margin, mental health treatment changed dramatically during the 1990s. In particular, the pharmaceutical therapies available for treatment of the most prevalent disorders changed in important ways. The best known was the change in the treatments available for depressive disorders. There are four broad categories of antidepressants: Monoamine oxidase inhibitor (MAOIs); Tricyclic antidepressants (TCAs); Selective serotonin reuptake inhibitors and Serotonin-norepinephrine reuptake inhibitors (SSRIs and SNRIs); and a fourth group that is commonly referred to as the newer generation antidepressants (NGAs). The first SSRIs were approved by the FDA in the late 1980s. The introduction of these drugs represented a new era of antidepressant prescriptions since these drugs were easier to administer, reduced the likelihood of overdose, and offered fewer negative side effects than the previously approved MAOIs and TCAs (USDHHS 1999). Nierenberg et al. (2008) discuss the efficacy of different types of antidepressants including SSRIs and TCAs in the treatment of MDD. After reviewing both controlled clinical trials and studies in broader populations they conclude, "Antidepressants work for many patients, decreasing their suffering and improving their lives."(p 434). Coyle et al. (2003) reach a similar conclusion for the efficacy of SSRIs in treating MDD in children and adolescents. These authors also place emphasis on cognitive-behavioral therapy as a useful part of mental health treatment. It should be noted that not everyone agrees with the efficacy of antidepressants. Ioannidis (2008) argues that the short term benefits are rather small and the long term benefits are understudied. There is also the possibility that antidepressants increase the risk of suicidal thoughts and behaviors. We

refer the reader to Markowitz and Cuellar (2007) for a complete discussion of this issue and the FDA's black box warning on antidepressants.

Stimulants are used for the treatment of ADHD and it is generally accepted that their use reduces the symptoms of the disorder (Ursano 2008). The Surgeon General's report on Mental Health states that these drugs are highly effective for 75 to 90 percent of children with ADHD (USDHHS 1999). While stimulants have been approved by the FDA for use for many decades, their popularity took off starting in the early 1990s. Mayes et al. (2008) attribute this growth to changes in three different public policies. The first is a 1990 Supreme Court ruling that added ADHD to the list of diseases that enabled low-income children to qualify for the Federal Supplemental Security Income program. The second occurred in 1991 when Congress expanded the Individuals with Disabilities Education Act to include ADHD. This allowed children with the diagnosis to receive special accommodations in school, specifically, more time on tests and homework. The third was the expansion of Medicaid for low income children, which allowed for increased rates of diagnosis and treatment of ADHD. These factors combined all contributed to an increased number of ADHD diagnoses and prescriptions for stimulants (Mayes et al. 2008). Another increase in diagnoses and prescriptions occurred in the late 1990s and early 2000s when pharmaceutical companies gained approval for new versions of stimulants that reduced the number of required doses, making it easier to administer the drug and for patients to adhere.

If there exists a true causal relationship from mental illness to crime/violence (either through perpetrators or victims) and treatment is effective, this suggests that public policy should look towards mental health treatment as a way to reduce crime. This idea is not new to the literature, and numerous studies have recommended exactly that (Teplin et al. 2005; Cuellar et al. 2007; Choe 2008). However, little attention has been focused on pharmaceuticals specifically

in the treatment of mental illness as a crime-fighting tool. One example is Cuellar and

Markowitz (2007). These authors examine the relationship between state spending by Medicaid

on stimulants and antidepressants and adverse outcomes related to ADHD and depression. The

outcomes include suicides, violent crimes, property crimes, and fatalities resulting from

unintentional injuries. The strategy in this paper is similar to ours here. The authors make the

case that the outcomes studied are all closely related to the mental disorders under consideration.

If more Medicaid patients receive mental health treatment in the form of pharmaceuticals, and if

these drugs are effective, then one should observed a reduction in the outcomes under

consideration. Cuellar and Markowitz find evidence that increases in both spending and

prescriptions for stimulants are related to reductions in violent crimes. They also show a

negative relationship between spending on older antidepressants (TCAs and MOIs) and violent

crime. One caveat to note is that the generalizabilty of this study is limited since the study uses

drug information for the Medicaid population and links this to outcomes variables including

behaviors by individuals who are not necessarily eligible for Medicaid. Our study improves on

the previous research by linking psychiatric drug prescription rates to crimes derived from data

that is more representative of the U.S. population.

Evidence of any causal link between the use of psychiatric medication and criminal

behavior is obviously quite difficult to come by. The randomized clinical trials typically used to

establish effectiveness of drugs would provide no information about criminal behavior. Clinical

data is limited to data collected by clinicians about physiological and symptomatic response, and

data reported by patients about factors related to efficacy and tolerability, such as physical side

effects. Patients are hardly likely to be forthcoming about reports of criminal activity. Even if a

clinician recorded credible information about criminal behavior, clinical trials are far too small to

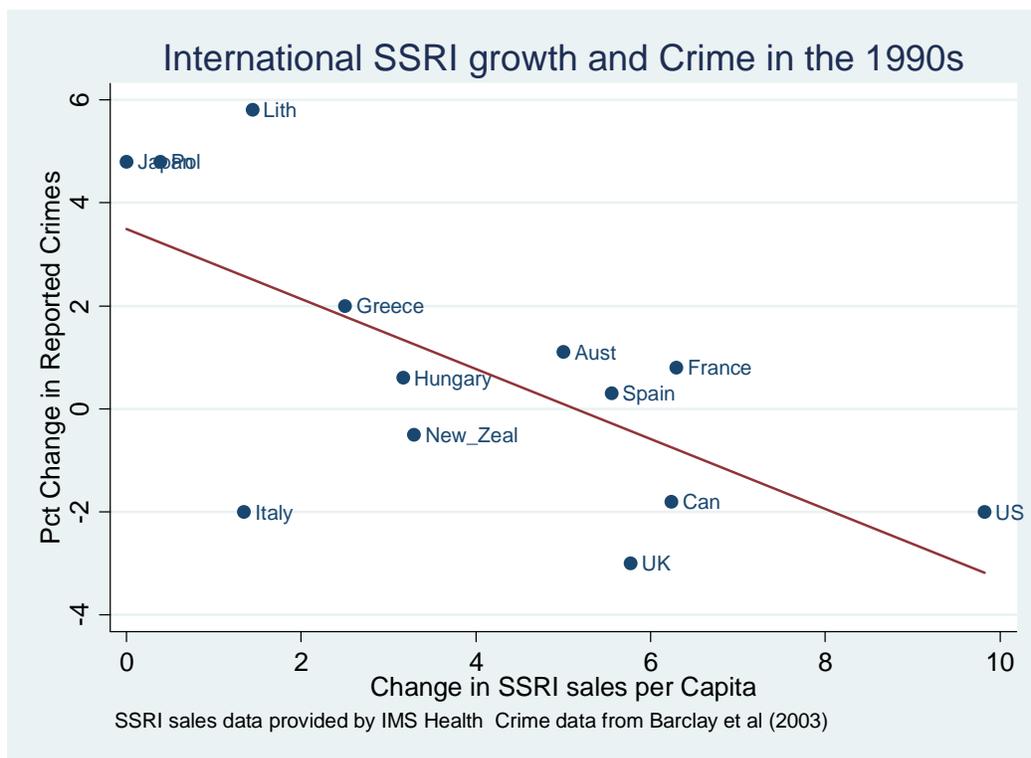detect effects that might be important in the community.

Even population based data that links exposure to treatment of the mentally ill with new psychiatric pharmacotherapies and crime is hard to come by. One limited source of evidence like this comes from international variation in drug sales and crime. International data on drug sales can be obtained from IMS Health, Inc., which collects data on quarterly drug sales by type in countries across the globe, for the purposes of market research. Though this is a highly aggregated source of variation, there were substantial differences across countries in when new drug therapies were introduced or approved by various regulatory agencies, and also in subsequent rates of sales growth (Ludwig et al., 2007). Data on crime across nations is made difficult by differences in what constitutes criminal behavior, how data are recorded and reported, and the relatively poor quality of these data in many countries (Levitt, 2004). Among the most reliable sources of such data is a statistical bulletin from UK Home Office and the Council of Europe (Barclay and Tavares, 2003), which provides data on European Union member states and select other countries.

In Figure 2, we display percent change in reported crimes in these countries during the 1990s, along with rates of growth in sales of the most widely used new class of psychiatric medication, selective serotonin uptake inhibitors (SSRI). Super-imposed on the data is a population-weighted linear fit. This simple comparison makes clear that the countries with largest declines in crime rates in the 1990s were almost exclusively those with the fastest growth in SSRI sales. Italy is the only country in the series that experienced a marked decline in crime, with a slower than average increase in drugs sales.

This series highlights two other interesting cases. The first is Japan, which saw no growth in SSRI sales in the 1990s, and was an outlier among the most developed nations in the

world with a marked increase in reported crime during this period.[5] The other notable case here

is Canada. In his insightful book, *The Great American Crime Decline* (2007), Franklin Zimring

highlights the puzzle of Canada. The puzzle is that crime rates there fell nearly as fast as they

had in the U.S., but several of the important explanations for the American experience were

absent in Canada. There were no substantial run-ups in the number of law enforcement officers

in Canada or in the size of its prison population. Canada didn't go through the ebb and flow of

the crack cocaine tide, nor did is see substantial variation in abortion rates. Figure 2 makes clear,

though, that like the U.S., Canada was among the world's leaders in the growth in treatment with

new psychiatric medication.

Figure 2

International SSRI growth and Crime in the 1990s

SSRI sales data provided by IMS Health Crime data from Barclay et al (2003)

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[5] Japan did not approve sales until 1999, 12 years after the U.S.

Developing more convincing tests of the relationship between drugs sales and crime obviously requires data on crime across populations that can be reliably compared over time, and more information on variation in other factors that might affect crime. To provide this we conduct a thorough analysis of crime rates in states across the US for the years 1997-2003, focusing specifically on trends in psychiatric drug prescriptions as a possible explanation for the changes crime rates over time.

Analysis

Developing more convincing analyses of the relationship between increases in psychoparmaceuticals and crime is limited by the very limited data available. In this paper, we take steps toward this end by developing a U.S. state-level panel data set that brings together data on crime with available information on the diffusion of these drugs at the state level.

The basic empirical model utilized in this paper is given by in equation 1:

1) $\quad \ln C_{jt} = \delta_0 + \delta_1 \ln A_{jt-1} + \delta_2 X_{jt} + \delta_3 \gamma_j + \delta_4 \mu_t + \delta_4 (\mu^* \tau)_{jt} + \varepsilon_{jt}$

Equation (1) specifies that the log of the crime rate (C) in state (j) for a given time period (t) is a function of the one-year lagged value of the log of psychiatric drug prescriptions (A_{jt-1}), other determinants of crime (X_{jt}), time effects (γ_t), and in some models, state effects (μ_j) and state*time interactions ($\mu^* \tau$). The principal hypothesis to be tested is whether or not the different psychiatric drugs are associated with reductions in different types of crime rates. We lag prescriptions by one year for two reasons. First, to minimize any possible reverse causality from crime/victimization to mental illness, and second, to allow for new prescriptions to take effect and possibly change behavior.

Annual crime rates come from the Uniform Crime Reports published by the U.S. Federal

Bureau of Investigation. We examine the two major categories of crimes, violent and non-

violent, as well as more specific categories as described below. Crime rates are expressed as the

number of crimes per 100,000 state residents.

Data on prescriptions come from IMS's National Disease and Therapeutic Index (NDTI).

The NDTI is a nationally representative sample of office based physicians in private practice

drawn from a universe of all physicians in the United States. The sample is a randomly drawn,

two-stage stratified cluster, where the stages are doctors and workdays. The sample of doctors is

selected by primary specialty and the 9 census divisions. All primary specialties involved in

direct patient care are included. Each physician reports information on all patients seen during

two consecutive workdays in each calendar quarter. From the patient data, we create state-level

counts of "drug appearances" (defined below) for antidepressants, anti-psychotics, stimulants,

and medications for the treatment of bipolar disorder. We also create similar counts for cox-2

inhibitors and statins. These drugs follow the same trends as the drugs for psychiatric

conditions, but should not logically be associated with crime rates as they are for the treatment of

arthritis pain and high cholesterol, respectively. We will use these drugs as a falsification test

and to provide evidence for or against the validity of our main results.

A drug appearance is a mention of a drug during a patient visit. In the NDTI data, drug

appearances include prescriptions, samples, drugs sold or given to the patient from their stock,

hospital orders, drug recommendations that were not accompanied by a prescription, and drugs

that were not issued during the current visit (i.e. no prescription, no sample and no medication

sold, but drugs were issued on a previous visit). We exclude drug recommendations and drugs

that were not issued during the current visit from the counts so that our count total represents

patients who have obtained or can obtain the drug with a prescription. Actual prescriptions represent the majority of drug appearances, as such we will use the terms appearance and prescription interchangeably.

We generate drug appearance counts for all patients and divide the counts by the total number of patient in each state and year multiplied by 1000. Therefore, our measures of drug use are the number of drug appearances per 1000 patient visits in a state for a specific year for 1997-2003, the years for which we have the NDTI data available. Means for these and all other variables are shown in Table 1.

The NDTI identifies four groups of antidepressants: 1) Tricyclics and Tetracyclics (TCAs), 2) MAO Inhibitors (MAOIs), 3) SSRIs/SNRIs, 4) newer generation antidepressants (NGAs). Examples of TCAs include *Elavil*, *Amitriptyline* and *Imipramine*. Common SSRI/SNRIs include *Zoloft*, *Lexapro*, and *Prozac*. *Wellbutrin* is the most popular newer generation antidepressant. MAOIs prescriptions are extremely rare, and therefore we have chosen to exclude MAOIs from the analyses.

The NDTI data has two limitations worth noting. First, the prescription data are from office based physicians so any prescriptions from in-patient facilities, including mental hospitals, are not included. Second, we have no way of knowing whether or not a prescription was filled or if a prescription was written after a sample was given.

All models include some other variables that may be important determinants of crime rates. These include the state real income per capita, the percentage of the state population ages 25 years and over that has obtained a bachelor's degree, and the percent of the state living in rural areas. Per capita income comes from the Department of Commerce, Bureau of Economic Analysis, educational attainment comes from the Department of Commerce, U.S. Census

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Bureau, and the rural population comes from the U.S. Census Bureau. We rely on state fixed

effects and linear state trends to account for some of the other factors that may determine crime
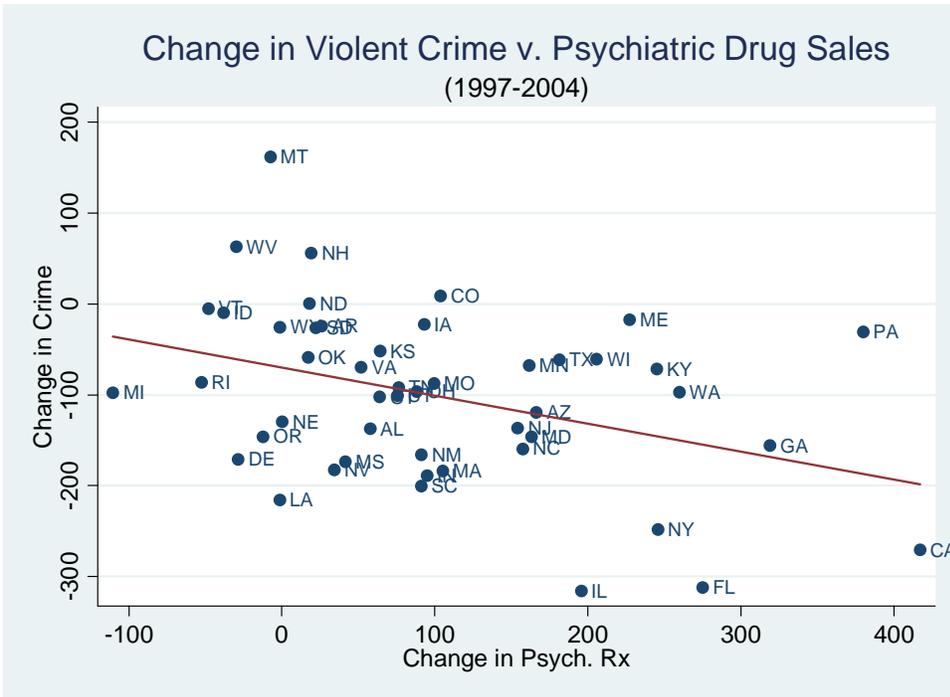
rates.

Results

In Table 1, we summarize the characteristics of our data. The data is a balanced panel,

with eight years of data on the contiguous 48 states and the District of Columbia. The average

rate of violent crime during the period was 517.7 per 100,000 residents. The average property

crime rate was 3,751.4 per 100,000. On average there were nearly 12 million patient visits per

year. The average state population is just under 6 million, so there were approximately 2

physician visits per adult, on average.[6] The rate at which psychiatric drugs appeared in patient

visits to physicians was 4.24 percent. The majority of these were for SSRIs (2.37 percent of the

total), with the remainder comprised of newer generation anti-depressants, ADHD drug, and

others.   The mean state per capita income during this period was $34,145. On average, about 20

percent of the population in a state lived in rural (non-MSA) areas, and just over 25 percent of

state residents had bachelor's degrees.

As a first step in assessing the relationship between the expanding access to psychiatric

medication and crime, in Figure 3 we plot changes in violent crime within states between 1997

and 2004 against changes in drug mentions during the same period.   There is a general pattern of

larger declines in violent crime rates in states with the largest expansions of psychiatric drug

mentions in clinical settings. Further, it appears that states likely to differ on a number of

dimensions have seen similar changes in drug take-up rates. For example, Kentucky and

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[6] Estimates from the National Health and Nutrition Examination Survey are that about 80 percent of Americans saw
a physician at least once in the previous 12 months. Note that our data do not allow us to distinguish between access
to physicians or treatment at the extensive versus intensive margins.

Washington saw similar increases in the expansion of psychiatric medication during the period.

But clearly this bivariate relationship is nothing more than suggestive.

Figure 3

Change in Violent Crime v. Psychiatric Drug Sales (1997-2004)

In Table 2 we present results of our basic panel models of the relationship between the

prescriptions of psychiatric medications and violent and property crime rates in a state.

Psychiatric drugs here are a combined measure of prescriptions for bipolar disease,

antidepressants, and stimulants. In each, we include the same basic specification, changing each

only in how we treat time and state effects. In the first specifications for the models predicting

violent and property crime rates, we include common year effects, but no state intercepts. In

columns 2 and 5 we add state fixed effects. In the third, we include state-specific linear trends,

to limit the possibility that any within-state increases in psychiatric medication might be due to

underlying trends that affect crime. In all models, we cluster standard errors on the state.

Models 1 and 4, in which variation in psychiatric drug appearances is across states, illustrate that treatment with these drugs occurs at higher rates in states with higher crime rates. Recall that our measure of drug appearances is lagged, so as to limit the most direct form of reverse causality here. Nonetheless, one might anticipate that states with higher than average levels of underlying causes of crime might also be places in which stress, depression, and anxiety are relatively high.

In the remaining models we include state fixed effects, so the variation of interest is within states. In models 2 and 5, we estimate that increases in psychiatric drug appearances are negatively related to both violent and property rates, but this is significant only for violent crimes. The magnitude is small: a 1 percent increase in psychiatric drug appearances is associated with a 0.04% decrease in violent crime rates. This is not surprising, since, the vast majority of treatment is provided to patients at exceptionally low risk for criminal violence.

One concern with even this small estimate is that our measure of use of psychiatric medications may be picking up changes in health care more broadly or other forms of social support, and it is these mechanisms that are associated with improved social indicators, including crime. One way to test this is to replace our measure of psychiatric drugs with a similar measure for non-psychiatric medications. To do this, we use data on two drugs that grew in a similarly rapid fashion during the 1990s: Statins (used for treatment of serum cholesterol) and cox-2 inhibitors (a non-steroidal anti-inflamatory drug, or NSAID). When we do this, the point estimate for our model for violent crime (2) is an order of magnitude smaller than the estimated effect of psychiatric medication (-0.005 vs. -0.042) and not significant.

In the final set of columns, we re-estimate the baseline models with state specific linear

trends to try and ascertain the extent to which the small effects estimated here are driven by within-state increases in psychiatric medication might be due to underlying trends that affect crime. The magnitude of the effect of drug appearances is halved to about the size of its standard error. A real limitation of this specification is the small number of data points with which to estimate state trends and detect effects. Our reading of the collected evidence here is that any effect of increases in use of psychiatric medication on crime is only apparent for violent crime, and there is it small.

By itself, this small response suggests that the advent and diffusion of new drug therapies played a limited role, at best, in recent crime trends. Of course, the expansion of these therapies was immense during the 1990s, so even a small response could have an effect. But, the potential for increased access to medical treatment to offer protective public health benefits in the form of reduced criminal behavior requires more targeted analyses. We turn now to separate analyses of different forms of criminal behavior and different classes of drugs.

In Table 3 we examine the impact of changes in drug appearances on four types of violent crime (murder, robbery, rape and assault), and two categories of property crime (larceny and motor vehicle theft). In each case, we estimate models that include common year intercepts, and state fixed effects. Since the impact of psychiatric drug mentions is larger for violent crime than property crime in Table 2, it is unsurprising that the magnitudes reported in Table 3 for specific violent crimes are generally larger than those for property crimes. Our estimates of the elasticities of the murder, robbery and assault rates are all on the order of -0.05, with the last two significant at conventional levels. The estimated response is largest of all for murder rates, but here the standard error is especially large.

If we are to believe that new psychiatric medications played any role in changes in rates

of violent crime, some empirical basis for the mechanism would need to be established. To get some sense of this, we consider separately drug therapies for different forms of mental illness in Table 4. Bipolar disorder is a disease with occasionally severe symptoms, including delusional thinking and even psychosis. But it also has relatively low incidence rates, so treatment effects are likely smaller in the population. We find negative relationships between mentions of bipolar medications and violent and property crime, but only the latter is significant. We find negative but insignificant relationships between mentions of ADHD drugs and crime. Despite popular perception about its prominence, like bi-polar disease ADHD has relatively low rates of prevalence and any effects on broader population measures of crime are surely affected by this. Consistent with this, we find that bi-polar and ADHD drugs were the least likely of the group to be discussed between patient and physicians (less than 1 percent of office visit in each case).

Depression, alternatively, is a much more prevalent disease. Further, depression has been linked to irritability, anxiety, delusions, and aggressive behavior - especially among adolescents and young adults (the age groups for which crime rates are especially high). Consistent with higher rates of exposure, we find larger effects of SSRIs and the newest class of anti-depression medication (NGAs) on crime.[7]

Discussion

This paper represents the first step in analyzing the relationship between treatment for mental illness and crime. Crime and mental illness are linked through both the perpetration and victimization sides of criminal activities. There is a sizeable body of evidence that person suffering from mental illness are both more likely to engage in criminal violence, and are

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[7] Depression medications were more than four times more likely to be mentioned than bipolar and ADHD drugs combined.

themselves more likely to be victims of crimes. We have tried to characterize the behavioral

mechanisms for these relationships, by summarizing important syndromes and how they might

contribute to behaviors leading to criminal acts and also provide the opportunity for

victimization.

While the there are various therapies used to treat of mental illness, coincident with the

decline in crime rates has been a remarkable expansion on the pharmaceutical treatments of a

mental illness. Because many of these agents are relatively effective, and better tolerated by

patients, there was a correspondingly rapid increase in treatment.[8] Of course, the psychiatric

medication can be provided in combination with talk therapy with a mental health professional

and with monitoring by physician. This aspect of treatment is absent from our analysis, but is

certainly relevant. Future research should include measures of therapeutic treatment and assess

the role of such treatment in reducing perpetration and victimization rates.

The results presented here are by no means conclusive, but nevertheless are suggestive

and quite provocative. We provide evidence that increased prescriptions for mental illness drugs

in general, and antidepressants in particular, are associated with decreases in violent crime. The

results are particularly strong for robbery and assault. On average, each one percent increase in

the total prescription rate is associated with a 0.04 percent decrease in violent crimes. To put this

in perspective, doubling the prescription rate would reduce violent crimes by 4 percent, or by 21

crimes per 100,000 population at the average rate of 518 crimes per 100,000 population. While

doubling the prescription rate seems like a large effect, it has been estimated that 28 percent of

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[8] Several analysts have made the case that the shift toward pharmacotherapy was also driven by third-party payers in
an attempt to lower treatment costs, and by manufacturers via direct-to-consumer marketing as a means to increase
demand. For a critical review of changes in treatment for mental illness during the late 20th Century, see Barber
(2008)). However, similar increases in the use of pharmacotherapy and appears to have occurred in other countries,
with different health care financing systems, including the UK and Australia (Brugha et al. (2004) (Rey et al.,
2004)).

the U.S. adult population in any year has a diagnosable mental or addictive disorder, yet only 8 percent seeks treatment (USDHHS 1999). Doubling the treatment rate would still leave a substantial portion of the ill untreated.

We started this paper asking if advances in mental health treatment were partly responsible for the dramatic decline seen in crime rates beginning in the 1990s. Using annual data for the U.S. we provide evidence of a negative relationship between crime and psychotropic drugs, but lack the magnitude to explain much of the variation in crime rates for the U.S. Nevertheless the negative relationship is also evident in some preliminary evidence from other countries around the world that also experienced similar trends in drug sales and crime rates. These are the first pieces of evidence, and clearly, more research is needed. From a policy perspective, however, the importance of this research cannot be understated. Improved access to mental illness treatment has the potential to dramatically improve the lives of those afflicted and those around them.

References

American Psychiatric Association , Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR) American Psychiatric Association: Arlington, VA , 2000.

Arseneault, Lousie; Terrie E. Moffit; Avshalom Caspi; Pamela J. Taylor, and Phil A. Silva. 2000. "Mental Disorders and Violence in a Total Birth Cohort: Results from the Dunedin Study," *Archives of General Psychiatry*. V. 57, pp. 979-86.

Barber, Charles. 2008. *Comfortably Numb: How psychiatry is medicating a nation*. (New York: Pantheon).

Barkley, Russell A; Fischer, Mariellen; Smallish, Lori; Fletcher, Kenneth. Young adult follow-up of hyperactive children: antisocial activities and drug use. *Journal of Child Psychology, Psychiatry and Allied Disciplines*. Vol 45(2) Feb 2004, 195-211

Blumstein, Alfred. 2000. "Disaggregating the Violence Trends." In Alfred Blumstein, and Joel Wallman (eds.), *The Crime Drop in America*. New York: Cambridge University Press, 13-44.

Brennan, Patricia A.; Sarnoff A. Mednick; Sheilagh Hodgins. 2000. "Major Mental Disorders and Criminal Violence in a Danish Birth Cohort," *Archives of General Psychiatry*. V. 57, pp. 494-500.

Brimaher, B.; D.A. Brent; and R.S. Benson. "Summary of the Practice Parameters for the Assessment and Treatment of Children and Adolescents with Depressive Disorders." *Journal of the American Academy of Child and Adolescent Psychiatry*, Nov. 1998, p 1234-1238.

Brugha TS, Bebbington PE, Singleton N, Melzer D, Jenkins R, Lewis G, Farrell M, Bhugra D, Lee A, Meltzer H. 2004. Trends in service use and treatment for mental disorders in adults throughout Great Britain. *The British Journal of Psychiatry*. 185: 378-84.

Choe, Jeanne Y.; Linda A. Teplin; Karen M. Abram. "Perpetration of Violence, Violent Victimization, and Severe Mental Illness: Balancing Public Health Concerns." *Psychiatric Services*, February 2008 Vol. 59 No. 2 153-164.

Cook, Philip J. 2008. "Assessing urban crime and its control: An overview," NBER Working Paper # 13781.

Coyle, Joseph T. ; Daniel S. Pine, Dennis S. Charney, Lydia Lewis, Charles B. Nemeroff, Gabrielle A. Carlson, et al. "Depression and Bipolar Support Alliance Consensus Statement on the Unmet Needs in Diagnosis and Treatment of Mood Disorders in Children and Adolescents." *J. Am. Acad. Child Adolesc. Psychiatry*, 2003;42(12):1494–1503.

Cuellar, Alison E. and Sara Markowitz. "Medicaid Policy Changes in Mental Health Care and their Effect on Mental Health Outcomes." *Health Economics*, Policy and Law, 2:1 (January 2007) 23-49.

Cuellar, Alison Evans; Lonnie M. Snowden; Toby Ewing. "Criminal Records of Persons Served in the Public Mental Health System." *Psychiatric Services*. January 2007 Vol. 58 No. 1 114-120.

Donohue, John, and Steven Levitt. 2001. "The Impact of Legalized Abortion on Crime," *Quarterly Journal of Economics*, 116(2), pp. 379-420.

Duggan, Mark. 2001. "More guns, more crime," *Journal of Political Economy*. V. 109(5), pp. 1086-1114.

Elbogen, Eric B., and Sally C. Johnson. "The Intricate Link Between Violence and Mental Disorder: Results From the National Epidemiologic Survey on Alcohol and Related Conditions." *Arch Gen Psychiatry*. 2009;66(2):152-161.

Evans, William N. and Emily Owens, "COPS and Crime." *Journal of Public Economics*, February 2007, 91(1-2), 181-201.

Grogger, Jeff, and Michael Willis. 2000. "The emergence of crack cocaine and the rise in urban crime rates," *Review of Economics and Statistics*, v. 82, pp. 519-29.

Halperin JM, Newcorn JH, Matier K, Bedi G, Hall S, Sharma V. Impulsivity and the Initiation of Fights in Children with Disruptive Behavior Disorders. *Journal of Child Psychology, Psychiatry, and Allied Disciplines*. 1995; 36: 1199-1211.

Hodgins, S. "Mental Disorder, Intellectual Deficiency, and Crime. Evidence from a Birth Cohort. *Arch. Gen. Psychiatry*. 1992, 49: 476-483.

Ioannidis, John PA. "Effectiveness of antidepressants: an evidence myth constructed from a thousand randomized trials?" *Philosophy, Ethics, and Humanities in Medicine* 2008, 3:14, 1-9.

James Doris J. and Lauren E. Glaze, Mental Health Problems of Prison and Jail Inmates. U.S. Department of Justice, Office of Justice Programs, Bureau of Justice Statistics, Special Report, September 2006, NCJ 213600.

Kates, Nick. "Attention Deficit Disorder in Adults: Management in Primary Care." *Canadian Family Physician*. Vol 5. January 2005.

Kessler, Ronald C.; Olga Demler; Richard G. Frank; Mark Olfson; Harold Alan Pincus; Ellen E. Walters; Philip Wang; Kenneth B. Wells; Alan M. Zaslavsky. 2005. Prevalence and Treatment of Mental Disorders: 1990 to 2003." *New England Journal of Medicine*. v. 352, pp 2515-23.

Levitt, Steven D. 2004. "Understanding why crime fell in the 1990s: Four factors that explain the decline and six that do not." *Journal of Economic Perspectives*. v.18(1), pp. 163-90.

Levitt, Steven D., and Sudhir Venkatesh. 2000. "Am economic analysis of a drug-selling gang's finances," *Quarterly Journal of Economics*. v. 115, pp. 755-89.

Link, Bruce G. and Ann Stueve. "Evidence Bearing on Mental Illness as a Possible Cause of Violent Behavior." *Epidemiologic Reviews* Vol. 17, No. 1, 172-181.

Mayes, Rick, Bagwell, Catherine and Erkulwater, Jennifer (2008) "ADHD and the Rise in Stimulant Use Among Children." *Harvard Review of Psychiatry*, 16:3, 151-166.

Markowitz, Sara and Alison E Cuellar "Antidepressants and Youth: Harmful or Helpful?" *Social Science and Medicine*, 64:10 (May 2007) 2138-2151.

Minzenberg, Michael J.; Jong H. Yoon; Cameron S. Carter. "Schizophrenia" in *The American Psychiatric Publishing Textbook of Psychiatry*, Fifth Edition. Edited by Robert E. Hales, M.D., M.B.A., Stuart C. Yudofsky, M.D., and Glen O. Gabbard, M.D. 2008 American Psychiatric Publishing, Inc.

Olfson, M., S.C. Marcus, B. Druss, and H.A. Pincus. 2002. National trends in the use of outpatient psychotherapy. *The American Journal of Psychiatry*. 159(11): 1914-20.

Raphael, Steven and Rudolph Winter-Ebmer. 2001. "Identifying the Effects of Unemployment on Crime," *Journal of Law and Economics*. v. 36, pp. 259-83.

Rey, J., G. Walter, and M. Giuffrida. 2004. Policy, structural change and quality of psychiatric services in Australia: the views of psychiatrists. *Australian Psychiatry*. 12(2): 118-122.

Reyes, Jessica Wolpaw (2007) "Environmental Policy as Social Policy? The Impact of Childhood Lead Exposure on Crime," *The B.E. Journal of Economic Analysis & Policy*: Vol. 7 (1)

Silver, Eric; Louise Arseneault; John Langley; Avshalom Caspi; and Terrie E. Moffitt, "Mental Disorder and Violent Victimization in a Total Birth Cohort." *Am J Public Health*. 2005;95:2015-2021

Silver, Eric; Richard B. Felson; Matthew Vaneseltine. "The relationship between mental health problems and violence among criminal offenders." *Criminal Justice and Behavior*, Vol. 35 no. 4, April 2008 405-426.

Swanson, JW, Swartz MS, Essock, SM, et al. "The social-environmental context of violent behavior in persons treated for severe mental illness." *American Journal of Public Health*, 2002, 9 (2): 1523-1531.

Swartz, James A, and Arthur J. Lurigio. Serious Mental Illness and Arrest The Generalized Mediating Effect of Substance Use. *Crime & Delinquency* Volume 53 Number 4 October 2007 581-604.

Teplin LA, The Prevalence of Severe Mental Disorder Among Male Urban Jail Detainees: Comparison with the Epidemiologic Catchment Area Program. *American Journal of Public Health* 1990, 80 (6), 663-673

Teplin Linda A.; Gary M. McClelland; Karen M. Abram; Dana A. Weiner. "Crime Victimization in Adults With Severe Mental Illness, Comparison With the National Crime Victimization Survey." *Arch Gen Psychiatry*. 2005;62:911-921.

U.S. Department of Health and Human Services. (1999). Mental Health: A Report of the Surgeon General—Executive Summary. Rockville: U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Center for Mental Health Services, National Institutes of Health, National Institute of Mental Health.

Ursano, Amy M.; Paul H. Kartheiser; L. Jarrett Barnhill. "Disorders Usually First Diagnosed in Infancy, Childhood, or Adolescence" in *The American Psychiatric Publishing Textbook of Psychiatry*, Fifth Edition. Edited by Robert E. Hales, M.D., M.B.A., Stuart C. Yudofsky, M.D., and Glen O. Gabbard, M.D. 2008 American Psychiatric Publishing, Inc

Wang, P.S., Demler, O., Olfson, M., Pincus, H.A., Wells, K.B., Kessler, R.C. (2006). Changing profiles of service sectors used for mental health care in the United States. *American Journal of Psychiatry*, 163(7), 1187-1198.

White, Mary Castle; Linda Chafetz; Gerri Collins-Bride; John Nickens. "History Of Arrest, Incarceration and Victimization In Community-Based Severely Mentally Ill." *Journal of Community Health*, Vol. 31, No. 2, April 2006.

Zimring, Franklin E. 2007. *The Great American Crime Decline.* (New York: Oxford University Press).

Table 1

Descriptive Statistics

Variable	Mean	Std. Dev.
Violent Crime Rate (per 100,000)	517.74	180.95
Property Crime Rate (per 100,000)	3,751.45	883.76
Per capita income ($)	34,145.19	4516.08
Pct. Population Rural	20.78	12.59
Pct. Population with B.A.	25.88	4.27
Psychiatric Drugs per 1,000 Dr. Visits	42.50	14.72

N= 392

Table 2
State-level Panel estimates of Psychiatric Drugs on Violent and Property Crime

	Violent Crime Rate			Property Crime Rate		
	1	2	3	1	2	3
ln(Psychiatric drugs per patient visit)	0.0359	**-0.0421**	-0.0191	0.008	-0.0028	0.0048
	0.0971	0.0183	0.021	0.0512	0.0131	0.015
Total # of patient visits	0.000006	0.000005	-0.000001	**-0.00001**	-0.000003	**0.000002**
	0.00003	0.00001	0.000001	3.62E-06	0.000002	0.000001
Income	-0.00001	0.00001	0.000003	**-0.00003**	**-0.00002**	-0.00001
	0.00002	0.00001	0.00002	8.30E-06	4.77E-06	0.000001
% population in rural areas	**-0.0261**	0.009	**0.442**	**-0.01303**	0.0156	**0.515**
	0.007	0.0166	0.208	0.0026	0.01	0.179
% population with BA	-0.02	0.0017	-0.004	0.0105	0.00034	0.002
	0.018	0.008	0.005	0.0065	0.00034	0.002
State Population (millions)	0.0148	-0.033	0.026	**0.0319**	0.025	0.039
	0.0252	0.0038	0.056	0.0126	0.028	0.041
Year fixed effects?	Yes	Yes	No	Yes	Yes	No
State fixed effects?	No	Yes	Yes	No	Yes	Yes
State-specific linear trends?	No	No	Yes	No	No	Yes
N	343	343	343	343	343	343
R-squared	0.3847	0.9829	0.9915	0.4299	0.9714	0.9845

Table 3
State-level Panel estimates of Psychiatric Drugs on Crime: By Type of Crime

Dependent variable (logged)

	Murder	Robbery	Rape	Assault	Larceny	Motor Veh. Theft
ln(Psychiatric drugs per patient visit)	-0.0634	**-0.048**	0.0099	**-0.056**	-0.0035	0.0159
	0.0379	0.0221	0.02	0.0248	0.0115	0.0227
Total # of patient visits (1000s)	-0.001	-0.001	-0.0002	-0.001	**0.0025**	**-0.006**
	0.004	0.002	0.002	3.00E-03	0.0012	0.0025
Income (1000s)	0.0053	0.0112	-0.0127	0.0158	**-0.0267**	**0.0246**
	0.0146	0.0085	0.0079	0.01	0.0044	0.009
% population in rural areas	-0.0131	0.0034	**0.0258**	0.0024	**0.0177**	**0.0039**
	0.0164	0.0095	0.0088	0.0107	0.005	0.01
% population with BA	0.0117	0.0025	0.0032	0.0031	-0.002	0.0055
	0.0074	0.0043	0.004	0.0049	0.0022	0.0044
State Population (millions)	0.054	-0.016	**-0.062**	-0.034	0.018	0.055
	0.049	0.029	0.027	0.032	0.015	0.03
N	343	343	343	343	343	343
R-squared	0.9519	0.9899	0.9251	0.9734	0.9563	0.9716

Table 4
Summary of Results of Psychiatric Medication on Crime: by Type of Medication
Outcome:

Psychiatric Drug Category:	ln(Violent Crime rate)	ln(Property Crime rate)
ADHD	-0.0086	-0.0019
	0.0092	0.0073
Bipolar medication	-0.0041	**-0.0126**
	0.0092	0.0048
NGA (New) antidepressant	**-0.0315**	0.0048
	0.0126	0.0079
SSRI	-0.0258	-0.0084
	0.0277	0.0113

All models control for state per capita income, population, proportion of population college educated, proportion in rural areas, state and year fixed effects, and number of patient visits to physicians

Robust standard errors below.
Coefs in bold significant, $p < 0.05$