Sex, Drugs, and ADHD: The Effects of ADHD Pharmacological Treatment on Teens' Risky Behaviors

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Abstract

In the U.S., 8% of children are diagnosed with ADHD and 70% are taking medications, yet little evidence exists on the effects of ADHD treatment on children's outcomes. We use a panel of South Carolina Medicaid claims data to investigate the effects of ADHD drugs on the probability of risky sexual behavior outcomes (STDs and pregnancy), substance abuse disorders, and injuries. To overcome potential endogeneity, we instrument for treatment using physicians' preferences to prescribe medication. Our findings suggest that pharmacological treatment has substantial benefits for the diagnosed children. It reduces the probability of contracting an STD by 3.6 percentage points (7.7 percentage points if we include STD screening), reduces the probability of having a substance abuse disorder by 12.5 percentage points, reduces the probability of injuries by 3.1 percentage points per year, and associated with them Medicaid costs decrease by $338.2.

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1 Introduction

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common chronic mental conditions affecting children. In the U.S., 11% of children age 4-17 (6.4 million) are estimated to have an ADHD diagnosis and almost 70% of them report taking medication for the condition (e.g. Visser et al. (2014) and NSCH-2011/12). However, little evidence exists on the effects of ADHD treatment on children's outcomes.

The two most recently published studies produce mixed evidence on the effects of ADHD treatment. Currie et al. (2014) find that taking stimulant medication is associated with a deterioration in academic outcomes and relationship with parents. In contrast, Dalsgaard et al. (2014) show that treatment is associated with fewer hospital visits and a reduction in the number of interactions with the police.

Our paper has three major contributions to this literature. First, we are investigating the effects of ADHD medication treatment on a novel set of outcomes. They are adverse events associated with risky sexual behavior (teenage pregnancies and STDs), substance abuse, and the incidence of injuries. The occurrence of injuries allows us to evaluate short-term effects of ADHD treatment, while substance abuse and risky sexual behavior outcomes speak for the long-term effects of medication. Second, we investigate the effects of treatment on Medicaid costs related to the adverse health and behavioral outcomes. Besides being a policy-relevant question, Medicaid spending allows us to evaluate the impact of ADHD drugs on the severity of adverse outcomes. Finally, we provide innovative supporting evidence in favor of using provider propensity to prescribe as a valid instrument for medical treatment. Variants of this instrument were employed in the work by Dalsgaard et al. (2014) and Duggan (2005), as discussed in Section 5.

We use a panel data set of South Carolina Medicaid claims paid out in 2003-2013. In these data, up to 23% of children per birth cohort are diagnosed with ADHD. About 80% of them are taking prescriptions for the condition. Consistent with the national trend, our data also show a steep increase in Medicaid spending on ADHD prescription drugs. Between 2003 and 2013 spending on ADHD prescription drugs rose by 296% in 2013 dollars. This increase in spending is a consequence of both the increase in the number of prescriptions filled and the prices of the drugs. The number of patients who take ADHD medications rose by 68% and the number of prescriptions per person went up by 18% suggesting that the overall trend is driven by the extensive margin.[1]

[1]There is some evidence of ADHD being increasingly misdiagnosed (e.g. Evans et al. (2010), Elder (2010), and Schwandt and Wuppermann (2015) among others). This question is out of scope of this paper. If there are false positive cases of ADHD diagnosis in our sample, our estimates of the effect of ADHD treatment on adverse outcomes can be interpreted as a lower bound of the actual effect of medication.

Our results suggest that pharmacological treatment reduces the probability of every adverse health and behavioral outcome identifiable in the data. Our preferred specification shows that if a patient is treated with ADHD medication the probability of contracting an STD decreases by 3.6 percentage points (7.7 percentage points if we include STD screening), having a substance abuse disorder decreases by 12.5 percentage points, getting injured by 3.1 percentage points each year and annual injury spending decreases by $338.2.[2] Finally, the probability of teenage pregnancy decreases by 3.7 percentage points, though the effect is not statistically significant.

2 Background and previous research

2.1 ADHD and ADHD-associated adverse events

The American Psychiatric Association defines ADHD as a brain condition present if either six or more of the inattention symptoms or six or more hyperactivity-impulsivity symptoms "have persisted for a least 6 months to a degree that is maladaptive and inconsistent with developmental level."[3] Inattentive symptoms include difficulty holding attention on tasks, following instructions, and distractibility among others. Hyperactivity and impulsivity criteria include excessive talking, difficulty waiting, and fidgeting. Causes of ADHD are not fully understood but genes are recognized as a major determinant of the condition.

ADHD may adversely impact major life activities from childhood to adulthood. In a detailed review of medical literature, Barkley (2006) emphasizes that if left untreated, ADHD could have severe consequences and be distressing not only for children who suffer from the condition but also for their families, friends, and teachers. ADHD children tend to have problems with self-control and discount the future more heavily than their unaffected peers. This makes them more injury-prone[4] and more likely to engage in risky behaviors such

[2] In 2013 dollars.

[3] The American Psychiatric Association publishes the Diagnostic and Statistical Manual of Mental Disorders (DSM), where it sets criteria for the classification of mental disorders. It is the standard classification of mental disorders used by mental health professionals in the United States. The most current version is DSM-5 published in May 2013, a revision of DSM-IV-TR that came out in 2000.

[4] Inattentiveness, difficulty in assessing potential outcomes, and motor incoordination are frequent causes of accidental injuries (e.g. fractures) for patients with ADHD. Besides having more frequent injuries, these children also tend to have more severe injuries than their peers (Barkley (2006), Swensen et al. (2004), and Marcus et al. (2008)). In a recent study, Dalsgaard et al. (2015) show that children with ADHD have a higher risk of injuries, but it declines in patients treated with stimulant medications.

as: dangerous driving,[5] substance abuse,[6] and risky sexual behaviors.[7] Children growing up with ADHD were found to be more likely to experience teen pregnancy, sexually transmitted diseases (STDs), depression, and personality disorders as adults.

These adverse health and behavioral outcomes can be explained in the theoretical framework of investment in child well-being. Every child is born with a multidimensional endowment of abilities. They include cognitive (e.g. IQ, memory) and noncognitive skills (e.g. self-control, patience, time preference)(Conti and Heckman (2014)). Due to their genetic condition, children who suffer from ADHD have a relatively low initial stock of noncognitive skills. The literature on child development indicates that gaps in abilities that form early in life persist into adulthood and can explain a large array of differentials in adult outcomes. Conti and Heckman (2014) provide an extensive review of the empirical evidence on the effects of the two dimensions of child well-being, cognitive and noncognitive skills, on educational attainment, asocial and risky behaviors, and health. Heckman et al. (2006) find that both cognitive and noncognitive abilities affect wages, schooling, work experience, occupational choice, and participation in a range of adolescent risky behaviors. These results have important policy implications, but most interventions do not directly target children's noncognitive abilities. The Perry Preschool experiment may be an exception; it did not result in IQ improvements but instead had a beneficial impact on many child outcomes. Heckman et al. (2006) argue that these beneficial impacts were achieved by altering social skills.

In this paper, we focus on a variety of adverse consequences of ADHD: injuries, substance use, and risky sexual behavior. Injury events allow us to evaluate the short-term effects of ADHD treatment, while the risky behavior related events speak for the long-term

[5] One of the strongest findings in the medical literature is that ADHD adolescents are more likely be involved in a car accident and they are more often at fault in such accidents (Barkley (2006), Weiss and Hechtman (1993)).

[6] Looby (2008) provides a review of major studies on the association of ADHD and substance use and abuse, including alcohol, tobacco, and drugs. Some of them find that teens with ADHD are on average more likely than individuals without ADHD to smoke, use and abuse alcohol and drugs, and develop health problems related to these activities. However, others conclude that there are additional related conditions that contribute to the likelihood of these adverse events, e.g. conduct disorder symptoms and association with deviant peers. Despite a disagreement on the relationship between ADHD and substance use, Looby (2008) review suggests that ADHD treatment reduces the risk of substance use disorders in children with ADHD. Using a meta-analysis, Wilens et al. (2003) also find that stimulant medications reduce the risk for subsequent drug and alcohol use disoders.

[7] Adolescents with untreated ADHD have difficulty controlling their impulses and planning ahead. These teens also tend to struggle with low self-esteem and for that reason, teenage girls often seek affirmation of boys through sexual attention (Arnold (1996)). Adolescent girls' symptoms of ADHD often worsen due to the hormonal changes at puberty (Resnick (2005)). Their condition makes them more likely to become sexually active earlier than their peers, have more partners on average, and use birth control inconsistently (Kessler et al. (1997), Payne (2014)).

treatment effects.

2.2 Prior Studies

While the majority of patients are taking ADHD medications, little is known about the effects of available treatments on health, behavioral, and school outcomes, especially in the long run. One of the major attempts to estimate the long-term effects of ADHD treatment in a clinical setting was funded by the U.S. National Institute of Mental Health in the early 1990s. The Multimodal Treatment of Attention Deficit Hyperactivity Disorder (MTA) randomly assigned 579 ADHD-diagnosed children age 7-9.9 years old to 14 months of treatment management. The study finds that medication treatment alone and medication treatment combined with behavioral therapy reduces the core symptoms of ADHD – inattention and hyperactivity, yet there was little or no difference in academic performance, social skills and parent-child relationships. Molina et al. (2009) investigates the effects for these randomized treatment groups 6-8 years following intervention. They find that the groups do not differ significantly on any repeated measures or new measures of outcomes: contacts with the police and arrests, delinquent behavior, social skills and academic performance.

Currie et al. (2014) take advantage of a policy change in Quebec which expanded insurance coverage for prescription medications to estimate the effect of ADHD treatment on emotional functioning and academic outcomes. Using data from the 1994-2008 National Longitudinal Survey of Canadian Youth, they find that stimulant medication treatment is associated with a decrease in academic outcomes such as grade repetition, math scores, and the probability of having any post-secondary education for girls, a deterioration in relationship with parents, and an increase in the probability of depression.

Dalsgaard et al. (2014) exploit the idiosyncratic differences in physician preferences to prescribe pharmacological treatment to analyze the effects of ADHD treatment on hospital visits and criminal behavior. Consistent with the previous research (e.g. Duggan (2005)), they find that prescribing practices vary significantly across medical care providers. This implies that two children with identical symptoms and characteristics have a different probability of being diagnosed and treated with medications depending on their physician's preferences. Using Danish registers data and provider probability to prescribe as an instrument, Dalsgaard et al. (2014) find that treatment receipt is associated with fewer hospital visits and fewer police interactions.

We contribute to the existing literature in three ways. First, we look at a novel set of ADHD-related adverse outcomes: teenage pregnancies, incidence of STDs, and substance abuse disorders in addition to injuries. To our knowledge, this paper and its dynamic model companion (Chorniy (2015)) are the first to directly study the effects of ADHD treatment on these outcomes.

Second, we take advantage of Medicaid costs reported in the data to estimate the impact of ADHD medication on the severity of the condition. Medical treatment may be effective in reducing the severity of adverse events even if the likelihood of having one is still unchanged.

Medicaid costs are also useful for policy recommendations. In South Carolina, out-of-pocket costs for Medicaid enrollees under 19 years old are zero or negligible. This distorts the patients' incentives and puts the burden of cost-benefit analysis on policymakers. Medicaid investment in ADHD treatment might be balanced via a reduction in its spending on the ADHD-associated events. We briefly examine this question in the current work and leave the detailed study to future research.

Finally, we provide innovative supporting evidence in favor of using provider propensity to prescribe as a valid instrument for medical treatment. Its variants were employed in the work by Dalsgaard et al. (2014) and Duggan (2005). Our data allow us to construct a more precise measure of provider preferences and test whether it is correlated with provider quality and whether there is evidence of provider shopping. For robustness, we also provide comparative results across a variety of instruments and treatment definitions.

3 Data

We use a large panel data set of South Carolina Medicaid claims that spans 11 years from 2003 to 2013. It includes 145,264 children and teenagers who had at least one ADHD-related claim between 3 and 18 years old during this time period. This sample makes up approximately 20% of the children population in the state.

Our data include basic demographic information collected to determine Medicaid eligibility and a complete set of health services utilization records for all individuals: hospital, outpatient, and pharmacy claims.[8] It is supplemented by several variables from the enrollees' birth certificates including mother's age, race, and education. Following earlier research work that used Medicaid or other administrative claims data (e.g. Frank et al. (2004)), we compile

[8]Medicaid has two components: traditional fee-for-service (FFS) and services provided through managed care organizations (MCO). Due to the differences in reporting requirements, the complete information on all services provided to a patient are only available for those enrolled in the FFS plan. However, mental health is one of the "carved-out" conditions that is covered by the FFS component even if an individual is enrolled into a managed care plan. We use all available claims and when possible and perform robustness checks by excluding MCO enrollees.

a set of ICD-9 diagnosis codes[9] and CPT procedure codes[10] to identify individuals who have ADHD, cases of pregnancy, STDs, substance use and abuse disorders,[11] and injuries[12] from the insurance claims data. Administrative data are not well-suited for distinguishing two consecutive independent events of the same kind from continuous care for the same event. For this reason, we focus on the first occurrence of each type of adverse events: teenage pregnancy, STD contraction, STD screening, and substance use and abuse disorders. While we use the first observed adverse event to identify the incidence of adverse outcomes, we track all Medicaid spending related to these events across time[13].

We use pharmacy claims to track all prescription medications that were filled by a patient. Each record has a dispense date, National Drug code (NDC),[14] quantity purchased, dispense fee, and the amount paid by Medicaid. We use our previous work (Chorniy (2015)) to identify drugs that are typically prescribed to patients with ADHD and to construct our instrumental variable (Section 4).

To estimate our model, we put a number of restrictions on the original data set. First, we use individuals who are consistently eligible for Medicaid for a year or more. Nearly 48% of the enrollees have at least one lapse in eligibility that exceeds two months, with the median lapse in coverage of eight months. For lapses in eligibility that last under three months, we assume that patients are enrolled but receive no medical treatment.[15] For inconsistent eligibility periods that result in longer lapses in coverage, we only keep medical history prior to the lapse.

Second, we exclude individuals for whom we are unable to identify their first ADHD diagnosis. Based on the earlier literature (e.g. Crawford and Shum (2005)), we exclude patients who had their first ADHD-related visit within 180 days from their first appearance in the sample and patients who fill a prescription prior to their first observed ADHD-related

[9] The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes are used by Medicaid for reporting purposes in the years covered by our sample. A hospital claim may have up to 9 diagnosis codes and an outpatient claim may have up to 4 codes.

[10] The Current Procedural Terminology (CPT) codes are used to indicate services provided to a patient. A hospital claim may have up to 100 procedure codes and an outpatient claim may have up to 8 codes.

[11] For substance use and abuse disorders we use a methodology developed in Bouchery et al. (2012).

[12] The ICD-9 codes for injuries were borrowed from Marcus et al. (2008).

[13] We disregard any out-of-pocket expenditures in this study. In 2013, most eligible individuals faced a small copay per doctor visit ($3.30), per prescription ($3.40 for adults over 19 years old and zero otherwise), and per hospital stay ($25).

[14] NDC is an 11-digit classification issued by the Food and Drug Administration (FDA) for all the approved drugs. Under this system, different package and dosage sizes of the same drug molecule have separate NDCs.

[15] Once eligibility for Medicaid is established, the health insurance coverage is available for an enrollee for a 12-month period (unless the enrollee becomes ineligible during this time), after which the eligibility needs to be reconfirmed. An eligible individual who received services prior to the actual enrollment can be covered retroactively for up to two months prior to the month when eligibility was established.

provider visit. Finally, we eliminate children with missing demographic information and individuals for whom we are unable to calculate provider propensity to prescribe. Our final sample includes 58,685 ADHD individuals.

Table 1 shows summary statistics on individual, mother, and home environment characteristics. Boys comprise 66% of the sample; whites and blacks are represented nearly equally. On average, children are first diagnosed with ADHD at 8 years old, and half of them are diagnosed by age of 7. Nationwide, among children age 4-17 years whose parents reported "mild" ADHD symptoms the median age of diagnosis is 7.0 years old, 6.1 years for those with "moderate" symptoms, and 4.4 years for "severe" cases of ADHD (Visser et al. (2014)). Given that the population we are looking at is slightly older, our statistic is generally consistent with that reported in the NSCH-2011/12.

The families predominantly consist of a single adult and two children. Their reported net monthly income is $574 on average. Data on mother's characteristics from the in-state birth certificates are matched to 73% of children in our sample. The majority of mothers in the sample have at least some high-school education (37%) or a high school diploma (40%).

In addition to the entire cohort of children on Medicaid who are diagnosed with ADHD in SC between 2003-2013, we have a supplemental random sample of children on Medicaid who were never diagnosed this condition.[16] We use this sample to test the validity of our identification strategy (see Section 5). Summary statistics for this group of children are shown in the appendix (Table 11 and Table 12).

Table 2 reports summary statistics on ADHD medical treatment and ADHD-related adverse outcomes that we observe in the sample. Nearly all ADHD-diagnosed children have hyperactive symptoms rather than inattentiveness. In our primary specification, we define pharmacological treatment as one or more prescriptions filled after the diagnosis (74% of patients). For a robustness check, we follow Dalsgaard et al. (2014) and define treatment as six or more prescriptions filled in a given year. Using this approach, only 52% of our diagnosed children receive treatment. The estimation results are reported in Table 10. Prescription medications are on average less expensive than ADHD-related physician visits. The former cost Medicaid $419 per patient/year, and the latter cost Medicaid $587 per patient/year, all in 2013 dollars.

On average, we observe every Medicaid enrollee for eight years. During this time, 1,811 of them become pregnant before age 19; 3,288 contract an STD, and an additional 2,184 are tested for an STD condition. For 5,864 teens we observe at least one claim that indicates a substance abuse disorder. The most frequent outcome that we observe yearly are injuries.

[16] It includes eligibility information, hospital, and outpatient claims for the undiagnosed children and teens younger than 19 years old with higher weights assigned to relevant birth cohorts.

Of all ADHD-diagnosed children, 80% of children and teens have at least one injury while in the sample.

In order to take into account the severity of adverse events, we calculate the total Medicaid spending using the respective claims. The average annual cost of treatment for an STD condition is $400 ($354 per patient if we include all patients who were screened for an STD). The annual cost of a substance abuse condition, including spending on the prescribed medication is $1,499 per patient. Finally, the average cost of injuries per person per year are $704. These expenditures vary widely across patients with the upper tail costing Medicaid thousands of dollars.[17]

Table 1: Summary Statistics: Individual and Family Characteristics

	N obs.	**Mean**	**Median**	**SD**	**Min**	**Max**
Individual characteristics						
Age 1st in sample	58,685	4.12	3.00	4.04	0	18
Age at 1st ADHD diagnosis	58,685	7.98	7.00	3.46	3	18
Male	58,685	0.66			0	1
Race: White	58,685	0.47			0	1
Black	58,685	0.43			0	1
Hispanic	58,685	0.02			0	1
Family & home environment						
Monthly family net income	58,685	573.94	408.80	584.93	0	5,189
Number of adults	58,685	1.03	1.00	0.59	0	3
Number of children	58,685	2.00	1.91	0.96	0	6
Ever in foster care	58,685	0.09			0	1
Ever had disability	58,685	0.15			0	1
Mother's characteristics						
Age when gave birth	42,488	23.41	22.00	5.47	11	48
Educ: Less than HS	42,488	0.05			0	1
Some HS	42,488	0.37			0	1
HS diploma	42,488	0.40			0	1
Some college	42,488	0.13			0	1
College degree or higher	42,488	0.05			0	1

Notes: The sample includes every SC Medicaid enrollee who was diagnosed with ADHD between 3 and 18 years old in 2003-2013 and who was eligible for Medicaid at least one year after this event. Family characteristics are averaged per patient/eligibility year. Foster care and disability rates are calculated based on Medicaid enrollment categories. Mother characteristics are reported based on in-state birth certificate information matched to Medicaid records. They are available only for a subsample of the 42,488 patients. Mother's age and educational attainment are recorded at the time of the child's birth. "HS" stands for high school education level.

[17] All spending amounts are adjusted to 2013 dollars.

Table 2: Summary Statistics: Medical Treatment and Adverse Outcomes

	N obs.	Mean	Median	SD	Min	Max
Medical diagnosis & treatment						
1st diagnosis: hyperactive type	58,685	0.74			0	1
inattentive type	58,685	0.24			0	1
1+ Rx filled (ever)	58,685	0.79			0	1
1+ Rx filled within a year (1st diag)	58,685	0.72			0	1
6+ Rx filled within a year (ever)	58,685	0.52			0	1
Annual cost of ADHD visit	58,685	586.75	152.10	1819.20	1	151,980
Annual cost of ADHD Rx	46,355	419.33	265.38	466.81	1	7,897
Years in sample	58,685	7.94	8.00	2.73	1	11
Outcome: Risky sexual behavior						
1. Teen Pregnancy						
Age at 1st pregnancy	1,811	16.67	17.00	1.75	11	19
Race: White	1,811	0.53			0	1
Black	1,811	0.43			0	1
2. STD						
Age at 1st STD	3,288	14.46	14.00	2.49	11	19
Age at 1st STD (incl. screening)	5,472	14.80	15.00	2.33	11	19
Male	3,288	0.42			0	1
Race: White	3,288	0.57			0	1
Black	3,288	0.35			0	1
Annual cost of STD	3,288	399.84	152.32	1129.51	4	19,728
Annual cost of STD+test	5,472	353.88	181.80	777.86	2	19,728
Outcome: Substance Abuse						
Age at 1st substance abuse	5,864	15.12	15.00	2.11	11	19
Male	5,864	0.64			0	1
Race: White	5,864	0.51			0	1
Black	5,864	0.42			0	1
Annual cost of substance abuse	5,864	1498.32	430.45	3640.24	1	113,834
Outcome: Injuries						
Ever injured	58,685	0.80			0	1
Age at injury	46,730	9.07	8.50	3.72	3	19
Male	46,730	0.67			0	1
Race: White	46,730	0.50			0	1
Black	46,730	0.40			0	1
N of injury claims	58,685	0.37	0.27	0.44	0	12
Annual cost of injuries	46,730	704.37	247.10	4072.36	2	501,616

Notes: The sample includes every SC Medicaid enrollee who was diagnosed with ADHD between 3 and 18 years old in 2003-2013 and who was eligible for Medicaid at least one year after this event. Alternative treatment definitions are used for the robustness checks in Section 10. Annual costs of treatment and adverse events are given in 2013 dollars per patient/year conditional on treatment or the occurrence of an adverse event. They are based on the Medicaid reimbursement. The out-of-pocket patient costs are nearly zero for the population in our sample.

4 Empirical Model

4.1 Lifetime Effects of ADHD Treatment

We use a linear probability model to estimate the effects of ADHD medical treatment on the incidence of adverse health and behavioral outcomes over the adolescence of teens who are diagnosed with the condition. In this experiment, we compare the outcomes of treated and not treated ADHD children. We model outcomes as shown in Equation 1.

$$Y_i^{outcome} = X_i\beta + \alpha_i Treatment_i + \varepsilon_i \tag{1}$$

where Y represents one of the adverse outcomes that are common for an individual i diagnosed with ADHD: STD contraction and STD screening, substance abuse, and teenage pregnancy. X is a vector of covariates that includes observed individual characteristics (race, gender, birth year), location (county of patient's residence), net monthly family income, patient age and duration of eligibility. $Treatment$ takes a value of one if the individual fills at least one ADHD prescription after being diagnosed with the condition, as described in Section 3.

The parameter of interest in this equation is α. In the linear probability model framework, it can be interpreted as the average impact of ever being treated for ADHD on the likelihood of adverse outcomes in adolescence.

There are two potential concerns when estimating Equation 1. First, if $Treatment$ is correlated with ε, unobserved factors that make some individuals more likely to receive treatment also influence their health and behavioral outcomes. For example, relatively more caring parents might be more likely to pursue medical treatment for their child. These parents are also more likely to take measures to reduce the probability of adverse events associated with ADHD. In this case, our results might be biased towards finding that ADHD treatment reduces the probability of adverse outcomes. On the contrary, if perhaps children with the most severe ADHD symptoms are the ones to seek treatment and are also relatively more likely to experience adverse outcomes, the effect of medication treatment would be biased towards zero. Second, if individuals select treatment based on expected gains. In this case, the child's outcomes may determine treatment receipt.

4.2 Identification

Following Dalsgaard et al. (2014) and Duggan (2005), we instrument for individual treatment with provider propensity to prescribe. If two equally sick patients have a different prescription outcome because they saw physicians with a respectively high or low propensity to prescribe, it provides exogenous variation necessary to evaluate the causal effect of treatment.

$$\text{PP}_{dit} = \frac{\text{N patients treated}_{dt} - 1 * (\text{Treated}_{dit} = 1)}{\text{N patients}_{dt} - 1} \tag{2}$$

We define provider d's propensity to prescribe (PP) medication to an individual i in year t as the share of all his/her patients' treatment outcomes in a given year, excluding the focal individual (see Equation 2). Specifically, provider propensity to prescribe is equal to the sum of other patients prescribed medication divided by the sum of all other patients diagnosed by the same provider in the same year. The focal individual i is excluded from the calculation of propensity to prescribe. This warrants potential endogeneity concerns since the patient's characteristics are not going to be a part of the provider propensity to prescribe measure.

Since we only observed filled prescriptions, our calculated provider's propensity to prescribe a drug to an ADHD patient includes both the probability that he/she writes a prescription and the probability that the patient fills the prescription (Dalsgaard et al. (2014)). Both the probability that a provider prescribes medication to the patient and the probability that the patient fills the prescription, conditional on the provider's engagement with the patient, is relevant provider variation.[18]

Stockl et al. (2002) survey 1,000 randomly selected physicians who prescribe stimulant medication to patients between December 2001 and May 2002. They document considerable variation in physicians perception on the severity of medication side effects and their concern about the medication being used for purposes other than patient's medical needs. Similar to earlier research, we find that patients face significant variation in the probability of receiving a prescription. We show its distribution in Figure 2.

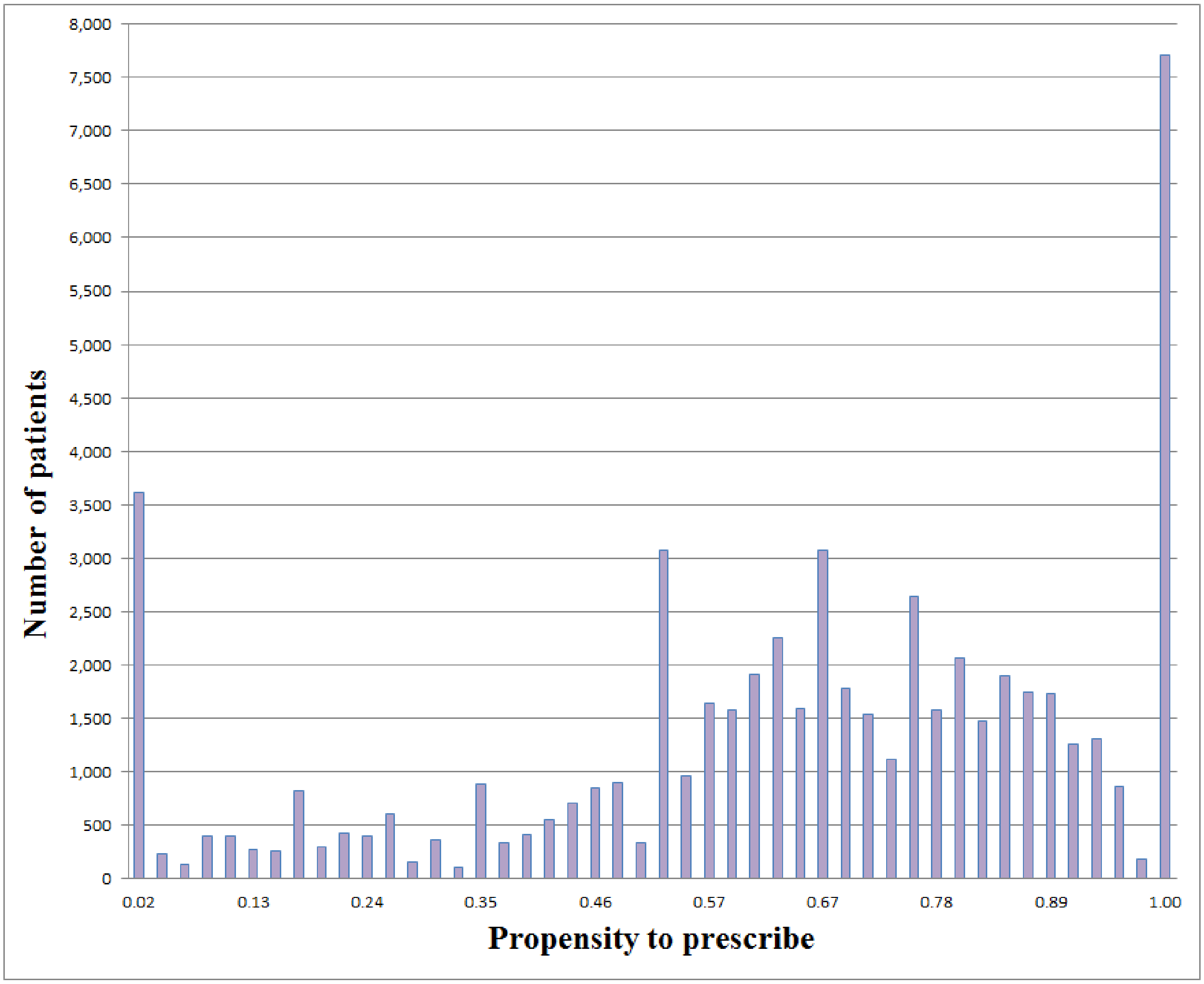
The first stage is given by Equation 3:

$$Treatment_i = \delta PP_i + X_i\gamma + \nu_i \tag{3}$$

where PP_i is a patient-specific probability to receive a prescription from the diagnosing provider; X_i is a vector of controls from the Equation 1. The second stage is given by Equation 4:

[18] In the earlier literature, physician prescribing practices were found to vary with the reimbursement mechanism (Dickstein, 2014) and their individual preferences (Hellerstein (1998))

Figure 1: Distribution of Provider Propensity to Prescribe



Notes: The figure shows the distribution of the probability that a patient receives a prescription from a particular physician in the year she was diagnosed based on the sample of 58,685 ADHD-dagnosed patients enrolled in SC Medicaid in 2003-2013. Provider propensity to prescribe varies from zero to one.

$$Y_i^{outcome} = \alpha \widehat{Treatment}_i + X_i\beta + \varepsilon_i \tag{4}$$

where $\widehat{Treatment}_i$ is the predicted treatment from Equation 3. Estimation of Equation 4 will be consistent provided that PP_i influences treatment and is uncorrelated with the error term ε_i. We provide supporting evidence of our identification strategy in Section 5.

4.3 Yearly Effects of ADHD Treatment

Another way to look at the effects of ADHD treatment on adverse events is by taking advantage of the panel feature of our data set. It allows us to control for patient's age, year-specific trends, and other observed time-varying factors. The empirical model is specified in the Equation 5 below.

$$Y_{it}^{outcome} = \alpha \widehat{Treatment}_i + X_i\beta + Z_{it}\gamma_1 + \gamma_2 County_{it} + \gamma_3 Year_{it} + \gamma_4 Year \times County_{it} + \varepsilon_{it} \tag{5}$$

where Y is an adverse outcome for an ADHD patient i in year t; $\widehat{Treatment}$ represents medical treatment instrumented with provider's propensity to prescribe. X is a vector of controls that includes individual characteristics that do not vary with time: race, sex, and birth cohort; Z includes time-varying controls: age, county of residence,[19] monthly family income, $Year$ represents year controls, $Year \times County$ are county/year interactions, and ε is a stochastic error term. The parameter of interest α can be interpreted as the average annual effect of treatment on the individual experiencing an adverse outcome.

An advantage of utilizing a panel analysis is that in this set up we are able to control for an individual's age, year, county-year interactions, and other time varying covariates that could have an affect on an individual's health outcomes. The advantage of the panel analysis relative to our cross-sectional analysis is that we only utilize years when the individual is eligible and thus do not make any assumptions about the individual's outcomes when we are unable to observe them throughout ages 11-19. Because we are unable to identify if an individual is experiencing a new adverse event or the same adverse event from a year prior, once the individual experiences an adverse event we drop that individual. Note that our instrument and value of treatment is still defined as "ever treated" and is not changing annually. For the outcomes STD contraction, STD screening, substance abuse and teenage pregnancy, the coefficient on treatment can be interpreted as the average effect of ever

[19] For robustness, we use county unemployment rate, county income, and county population density instead of county controls and our findings hold.

receiving treatment on the first incidence of an adverse outcome. For the outcomes of the incidence of injuries and number of injuries, the coefficient on treatment can be interpreted as the average annual effect of ever receiving treatment.

5 IV Validity

5.1 Condition 1: First Stage Results

The first stage results for the entire sample (Table 3) and the outcome-specific results (Table 6 and Table 7) show that the relationship between the provider propensity to prescribe ADHD medication and the probability that the child ever fills a prescription is positive. It holds when we include a number of controls, such as family and individual characteristics, mother's age and education level, and county and birth cohort fixed effects. The estimated magnitude of the coefficient in the specification that includes all the controls and fixed effects (Column 3) suggests that a 10 percentage point increase in the provider propensity to prescribe is associated with a 3.53 percentage point increase in the probability of treatment receipt.

This relationship does not seem to be driven by the "extreme" values of provider propensity to prescribe. When we exclude all providers who either never prescribe ADHD medication or prescribe drugs to every child they diagnose, the first-stage result becomes stronger.

5.2 Condition 2: Exclusion Restriction

In order for our instrumental variable approach to be valid the exclusion restriction must hold. In our data, providers are not randomly assigned to patients but it is necessary that provider propensity to prescribe affects an individual's outcomes only through pharmacological treatment.

We devise a number of tests that could indicate whether the exclusion restriction is violated. There are three potential threats that we are able to address in the following subsections. First, provider prescribing preferences might be correlated with the provider quality and thus, would affect a patient's outcomes directly rather than through treatment receipt. Second, both our instrument and patient outcomes may be correlated with unobserved individual, family, and other characteristics. Finally, there might be a sample selection problem if the individual's length of enrollment in Medicaid is related to the provider propensity to prescribe. Although the tests of these hypotheticals do not ensure that the exclusion

Table 3: Results: First Stage

	(1)	(2)	(3)	(4)
Propensity to prescribe	**0.414**^{a}	**0.368**^{a}	**0.353**^{a}	**0.424**^{a}
	(0.006)	**(0.006)**	**(0.007)**	**(0.010)**
Male		0.044^a	0.047^a	0.049^a
		(0.003)	(0.004)	(0.004)
Race: Black		-0.057^a	-0.051^a	-0.053^a
		(0.004)	(0.004)	(0.005)
Hispanic		-0.131^a	-0.162^a	-0.169^a
		(0.010)	(0.014)	(0.015)
Other		-0.056^a	-0.068^a	-0.073^a
		(0.007)	(0.009)	(0.009)
Family net income		0.006	0.005	0.006
		(0.022)	(0.022)	(0.028)
Number of adults		-0.027	0.012	0.001
		(0.027)	(0.031)	(0.035)
Number of children		-0.002	-0.002	-0.001
		(0.002)	(0.002)	(0.002)
Cohort & County F.E.	N	Y	Y	Y
Mother characteristics	N	N	Y	Y
Propensity to prescribe $\in (0, 1)$	N	N	Y	N
R-squared	0.081	0.147	0.124	0.115
N obs.	58,685	58,685	42,693	34,507

Notes: The dependent variable in every specification is the binary prescription outcome of a patient. It equals one if the patient had an ADHD prescription while on Medicaid and zero otherwise. Controls that are not shown include individual's first county of residence, foster care, and disability status. Mother characteristics include mother's age when she gave birth and educational attainment. Family net income is measured in ten thousands of dollars; the coefficients on the number of adults are scaled up by 10 in order to show the magnitude of the effect. Coefficient estimates that are significant at 1%, 5%, and 10% level are denoted with a, b, and c respectively. Standard errors are in parentheses. They are clustered by individual's provider who diagnosed them with ADHD.

restriction is satisfied but they provide us with more confidence in that our instrument is valid.

5.2.1 Placebo test: first-in-sample provider propensity to prescribe

Physician quality, experience, and training have an impact on patient outcomes. If the propensity to prescribe medication reflects physician quality, it may confound our estimation results. For example, it could be the case that providers who prescribe medication to every single one of their patients do not properly evaluate their symptoms and/or determine a treatment strategy that would suit each particular case. In other words, if high propensity providers are those of lower quality, we would expect to find that treatment has unfavorable effects on health outcomes.

To address this concern we devise a placebo test. If provider quality is not related to his or her propensity to prescribe, we should see no relationship between the instrument and health outcomes of children who were never diagnosed with ADHD. By definition, this group has no diagnosing physician in the data. Instead, we find the earliest claim in our data and look up that physician's prescribing preferences in that year using the group of children who have ADHD.[20]

The results of this test are reported in Table 4, Panel A. The point estimates of the coefficients on the propensity to prescribe have large confidence intervals suggesting that there is no statistically significant relationship between provider quality and propensity to prescribe.

For comparison purposes, we also use first-in-sample provider propensity to prescribe to estimate our instrumental variable. Table 4, Panel B shows the results of the first and second stage regressions for children who were diagnosed with ADHD. We find that the first stage coefficients are positive and statistically significant, yet relatively weak in comparison to our preferred instrument of the diagnosing provider propensity to prescribe. The second stage results yield negative coefficient estimates that are not statistically significant likely due to the weak first stage and smaller number of observations.

5.2.2 Confounding factor: provider selection

Another potential bias may arise if parents of children with relatively severe symptoms of ADHD seek and use prior information about the provider's propensity to prescribe. If they, on average, visit physicians with a relatively higher propensity to prescribe, this could

[20] Due to a high provider mobility in and out of Medicaid, we could not match all first-in-sample provider IDs to the diagnosing provider IDs.

Table 4: IV Validity: First-in-Sample Provider Propensity to Prescribe

	STD	STD +test	Subst. abuse
Panel A. Undiagnosed Children			
Propensity to Prescribe	0.019	0.027	-0.019
	(0.014)	(0.027)	(0.034)
Male	-0.111[a]	-0.227[a]	0.092[a]
	(0.011)	(0.013)	(0.013)
Race: Black	0.000	0.030[a]	-0.089[a]
	(0.009)	(0.009)	(0.012)
Hispanic	-0.045[b]	-0.082[a]	-0.079[a]
	(0.020)	(0.029)	(0.019)
Number of adults	0.001	-0.005	-0.017[a]
	(0.005)	(0.005)	(0.005)
Number of children	-0.005	-0.006[c]	-0.001
	(0.003)	(0.003)	(0.003)
Family net income	-0.002	-0.009	-0.020[a]
	(0.005)	(0.006)	(0.006)
N obs.	10,615		
Panel B. Children Diagnosed with ADHD			
First Stage	0.122[a]	0.122[a]	0.122[a]
	(0.018)	(0.018)	(0.018)
ADHD Treatment	**-0.042**	**-0.127**	**-0.046**
	(0.099)	**(0.111)**	**(0.150)**
Male	-0.119[a]	-0.202[a]	0.068[a]
	(0.010)	(0.012)	(0.012)
Race: Black	-0.014	0.004	-0.080[a]
	(0.016)	(0.018)	(0.021)
Hispanic	-0.057[c]	-0.042	-0.116[b]
	(0.033)	(0.042)	(0.046)
Number of adults	-0.008	-0.018[b]	-0.016[b]
	(0.006)	(0.007)	(0.008)
Number of children	0.011[a]	0.019[a]	0.013[a]
	(0.003)	(0.005)	(0.005)
Family net income	-0.001	-0.005	-0.018[a]
	(0.005)	(0.007)	(0.007)
N obs.	7,338		

Notes: Panel A and B show the results of an IV validity test. Propensity to prescribe ADHD medication refers to the first provider in the sample that patients visit. The coefficients in Panel A are estimated on the sample of children who do not have ADHD using OLS. The dependent variables take value of one if a child experienced each of the respective adverse events; it is zero otherwise. Panel B is estimated using 2SLS, where the instrument is the first-in-sample provider propensity to prescribe. All specifications are estimated on a subsample of relevant birth cohorts of SC Medicaid enrollees and include individuals born between 1987 and 1996. Coefficient estimates that are significant at 1%, 5%, and 10% level are denoted with *a*, *b*, and *c* respectively. Standard errors are in parentheses. They are clustered by individual's first-in-sample provider.

bias our findings of the effects of ADHD medication downward. Similarly, if the parents of children with relatively less severe ADHD symptoms seek pharmacological treatment, it could result in an upward bias in our findings.

We do not have a strong prior on the direction of the bias. First, the medical evidence on the effectiveness of ADHD medication is mixed and the evidence on long-term effects is very limited. Second, there is a large array of potential side effects associated with these drugs. They include sleep problems, suppressed appetite, nausea, headaches, stunted growth, aggression and irritability, and cardiac risks (Barkley (2006)). In sum, parents have to weigh the expected benefits and costs associated with medicating their child.

Table 5 reports the results on the relationship between physician propensity to prescribe and observed mother and family characteristics. They include mother's age and educational attainment at the time she gave birth, family net income, and the severity of ADHD. We find no evidence of consistent relationship between these observed characteristics and our instrumental variable except for a tightly-estimated zero for the family composition. In particular, unlike Dalsgaard et al. (2014) we find a very small and statistically insignificant correlation between family income and provider propensity to prescribe. It is likely due to the differences in the sample population. Medicaid enrollees are a relatively homogeneous group income-wise and is well-suited for our research design. Finally, we find no statistically significant relationship between provider propensity to prescribe and the severity of the underlying condition approximated by the history of injuries prior to the ADHD diagnosis.

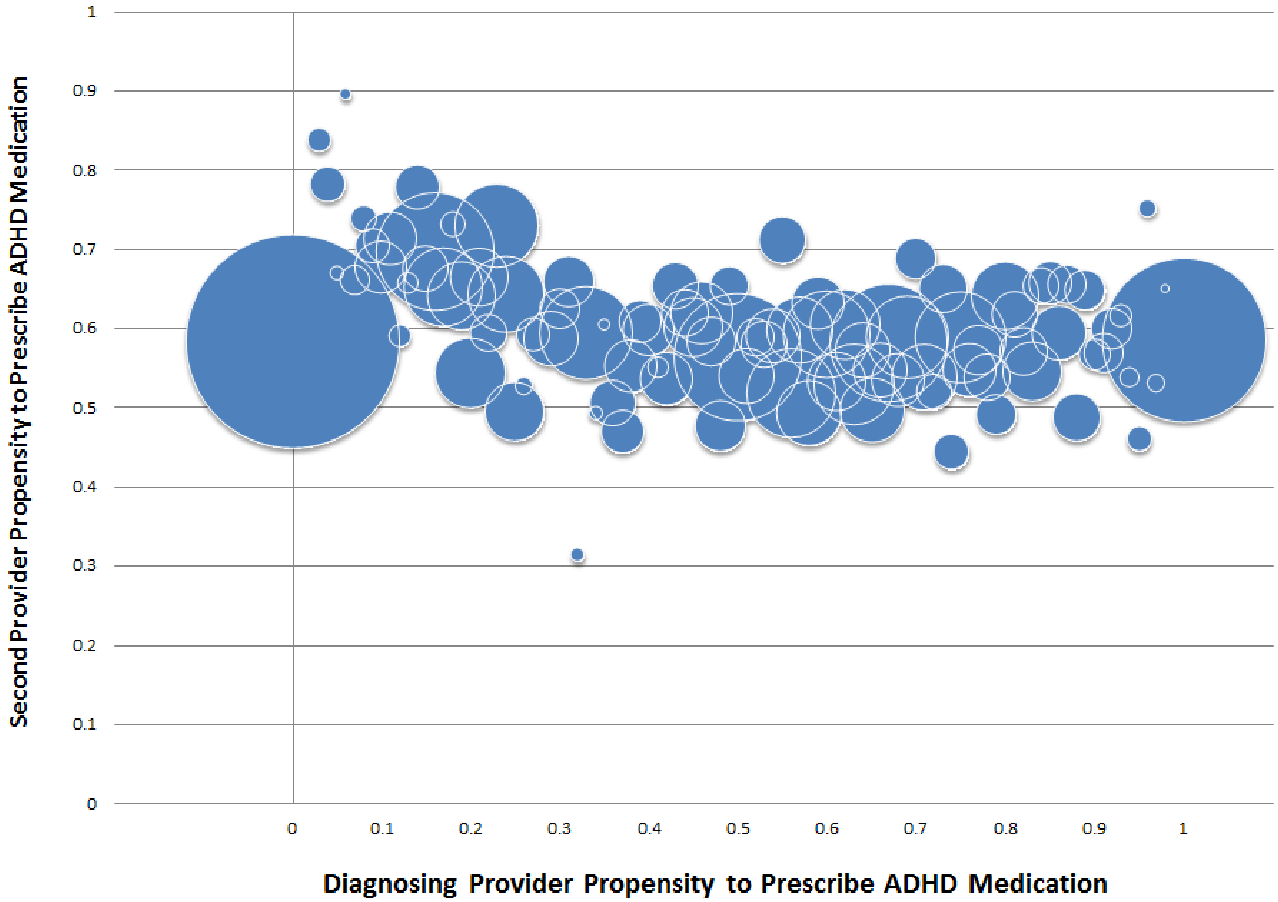
Although there are many unobserved characteristics that could have an impact on the choice of the ADHD provider, we argue that our test has a significant power. Covariates like family income and mother's characteristics have a long history of being used as predictors of health, parent quality, and other outcomes that we could be potentially concerned about.

5.2.3 Treatment shopping: second provider selection

About 10% of our sample (5,734 patients) switch to a different health care provider after being diagnosed with ADHD. If a reason for a switch is to alter their treatment, it could undermine our research design and create a bias. Of the individuals that switch providers, 57.6% go to a subsequent provider with a higher propensity to prescribe than the diagnosing provider, 39.4% go to a subsequent provider with a lower propensity to prescribe, and 3.0% go to a subsequent provider with a propensity to prescribe equal to the first diagnosing provider.

Figure 2 plots this relationship. It shows that there is no clear pattern in the switchers' behavior, suggesting that individuals who switch to a subsequent provider do so randomly or for reasons independent of the provider propensity to prescribe. If diagnosing provider

Figure 2: Provider Shopping: Diagnosing and Subsequent Provider Propensity to Prescribe



Notes: In the data, 5,734 patients switch health care providers. This figure shows the relationship between the individual's diagnosing provider propensity to prescribe and their subsequent provider propensity to prescribe. Prescribing propensities vary from zero to one.The bubble size indicates the number of patients for each pair of propensity scores.

PP is equal to zero, the mean of the second provider PP is 0.58. If diagnosing provider PP is equal to one, the mean of the second provider PP is 0.57. Moreover, the share of treated patients is similar for both groups: switchers and non-switchers. Approximately 83% of switchers receive pharmaceutical treatment and 79% of those who do not switch receive pharmaceutical treatment.

5.2.4 Provider propensity to prescribe and individual's length of eligibility

The final test we perform is concerned with the length an individual is eligible (and enrolled) for Medicaid. The only time we observe individual's treatment and adverse outcomes is when he/she is enrolled in the program. This feature of the data would undermine our research strategy if the instrument is correlated with the length of enrollment.

For example, if a patient was diagnosed by a provider with a relatively high propensity to prescribe and received medication, it is plausible to suggest that they may remain enrolled for a longer period of time. As described in the Data section, individuals could be eligible but not enrolled if they do not fill out their annual paperwork on time or do not have any health care encounters. Since the longer an individual is eligible in our data set, the more probable it is that we will observe an adverse outcome for that individual: STD contraction, STD screening, substance abuse disorder, or teenage pregnancy. If an individual's Medicaid eligibility length is positively correlated with provider propensity to prescribe, it could bias our results towards finding that pharmaceutical treatment receipt, instrumented with provider propensity to prescribe, is correlated with worse outcomes.

Table 5 reports the results. We find that an individual's length of eligibility is not correlated with the individual's diagnosing provider propensity to prescribe. In other words, individuals are not selecting into the sample based on their diagnosing provider's propensity to prescribe.

Table 5: IV Validity: Additional Evidence

Dependent Variable:	**Propensity to Prescribe**		**Eligibility Length**	
Regressors	**Coeff.**	**SE**	**Coeff.**	**SE**
Individual Characteristics				
Male	0.011^{a}	0.003	-0.081^{a}	0.016
Race: Black	-0.020^{a}	0.003	0.292^{a}	0.017
Hispanic	-0.049^{a}	0.009	0.171^{a}	0.057
Other	-0.035^{a}	0.005	0.187^{a}	0.036
Mother & Family Characteristics				
Educ: Less than HS	0.002	0.006	0.103^{b}	0.039
Some HS	-0.002	0.003	0.077^{a}	0.018
Some college	-0.004	0.004	-0.269^{a}	0.024
College degree or higher	0.003	0.006	-0.406^{a}	0.036
Family net income	-0.002	0.002	-0.083^{a}	0.010
Number of adults	0.004^{b}	0.002	0.051^{a}	0.013
Number of children	0.003^{b}	0.001	0.059^{a}	0.007
Severity of ADHD	-0.001	0.003		
Provider Propensity to Prescribe			0.006	0.028
R-squared	0.257		0.238	
N obs.	39,753		42,140	

Notes: This table shows two additional tests in support of our instrumental variable. Both regressions are estimated using OLS and include birth cohort and county fixed effects. Family income is measured in thousands of dollars; ADHD severity is approximated by the incidence of injuries prior to ADHD diagnosis. Coefficient estimates that are significant at 1%, 5%, and 10% level are denoted with *a*, *b*, and *c* respectively.

6 Results

We find evidence that ADHD medication treatment reduces the probability and severity of a wide range of adverse events and that these reductions are observable in the patient's short-term and lifetime outcomes. It is effective in reducing the probability of a teenager contracting an STD, becoming pregnant, suffering from a substance use and abuse disorder, and having an injury.

Tables 6–9 summarize these results. For every adverse outcome, we show estimated coefficients using IV and OLS for comparison purposes. In most cases, OLS estimates agree in the direction of the effect with the IV-estimated coefficients, but it understates the magnitude of the beneficial effects associated with treatment. Notably, OLS estimates for the substance abuse and injury outcomes seem to have a larger bias relative to our other outcome measures. The OLS estimates suggest that medical treatment increases the probability of suffering from a substance abuse disorder and getting injured while the IV estimates suggest that medical treatment decreases the probability of these adverse outcomes.

6.1 Lifetime Effects of ADHD Treatment

We find that medication is effective in reducing the probability of the outcomes produced by risky behaviors. ADHD children who received pharmacological treatment are 3.6 percentage points less likely to be treated for an STD condition, 7.7 percentage points less likely to be screened for an STD, and 12.5 percentage points less likely to receive medical attention related to a substance abuse disorder. The point estimate on the probability of teenage pregnancy is also negative (-3.7 percentage points) but not statistically significant.

Table 6 summarizes the results. Compared to the OLS estimates, the coefficients obtained using an IV are of the same sign for outcomes of STD contraction, STD screening and teen pregnancy, but are larger in absolute value and statistically significant for STD contraction and STD testing. In other words, OLS understates the effects of treatment but indicates that treatment has favorable effects on outcomes. The OLS estimates for the outcome of substance abuse suggest that treatment slightly increases the probability of abusing substances. When we instrument for treatment, we find that the coefficient on treatment flips signs and increases in magnitude suggesting that treatment decreases the probability that an individual abuses substances.

The results also show that males are less likely to be treated (12.8 percentage points) or screened (20.7 percentage points) for an STD but 5.2 percentage points more likely to have medical history of substance abuse. This finding is consistent with the reports on STDs[21].

[21] CDC, "Trends in Reportable Sexually Transmitted Diseases in the United States, 2005",

For example, the chlamydia case rate per 100,000 females in 2005 was more than three times higher than for males. Most of this difference is attributed to the fact that women are more likely to be screened than men. Whites are the most likely to suffer from one of the adverse events that we focus on, which is also likely to be an outcome of higher probability of being screened.

Family characteristics that we control for include family composition (number of adults and children in the individual's household) as well as family net income at the time of the child's diagnosis. The coefficients on these controls are consistent with our prior. Going from a one to two-adult family decreases the probability of adverse events by 1-2 percentage points depending on the type of the event. This result is statistically significant for the STD condition and screening combined, substance abuse, and teen pregnancy.

On the other hand, individuals in families with a higher number of children are more likely to experience one of the adverse events. The magnitude of the effect varies from 1 to 3 percentage points, being the highest for teenage pregnancy. It is likely due to the fact that there is relatively less parental oversight in larger families. Finally, family income is negatively correlated with the incidence of risky behavioral outcomes. As we would expect, the better off the family is in terms of income, the less likely their child will experience an adverse events, however the magnitude of the effect is very low. A $100 increase in the net monthly income would produce a 0.02, 0.08, 0.28, and 0.23 percentage point decrease in the probability of STD, STD screening, substance abuse, and teen pregnancy respectively. Note that most families on Medicaid are relatively poor and there is not enough income variation in this population group to evaluate the effect of income on the incidence of adverse events.

These results generally hold in a smaller sample of ADHD patients for whom we have birth certificate data available and are able to control for mother's age and education (Table 7).

6.2 Yearly Effects of ADHD Treatment

Perhaps an even more policy-relevant question is what is the per year difference in outcomes for children who are treated with ADHD medication versus children who are not. The average cost for prescription medication is $347 per patient per year and the average cost for ADHD-related physician visits is $562 per patient per year (measured in 2013 dollars) during the sample period. It is valuable to compare these treatment expenditures to what Medicaid pays for adverse events.[22]

http://www.cdc.gov/std/stats05/trends2005.htm. Accessed on July 14, 2015.

[22]It is one of the goals of our future work to differentiate these effects by the year of diagnosis, adherence status, and length of treatment.

Table 6: Lifetime Effects of ADHD Treatment on Adverse Health and Behavioral Outcomes

	STD		**STD+test**		**Subst. abuse**		**Pregnancy**	
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**
First stage		0.472[a]		0.472[a]		0.472[a]		0.501[a]
		(0.013)		(0.013)		(0.013)		(0.021)
ADHD Treatment	-0.009	**-0.036**[c]	-0.009	**-0.077**[a]	0.006	**-0.125**[a]	-0.032[a]	**-0.037**
	(0.006)	**(0.022)**	(0.007)	**(0.026)**	(0.008)	**(0.045)**	(0.012)	**(0.041)**
Male	-0.129[a]	-0.128[a]	-0.210[a]	-0.207[a]	0.047[a]	0.052[a]	-	-
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)		
Race: Black	-0.011[c]	-0.015[b]	0.015[c]	0.006	-0.072[a]	-0.087[a]	-0.026[b]	-0.027[c]
	(0.007)	(0.007)	(0.008)	(0.009)	(0.010)	(0.011)	(0.013)	(0.014)
Hispanic	-0.037	-0.039[c]	-0.017	-0.024	-0.117[a]	-0.131[a]	-0.066[c]	-0.066[c]
	(0.022)	(0.023)	(0.027)	(0.027)	(0.026)	(0.027)	(0.037)	(0.037)
Other	-0.023[c]	-0.025[b]	-0.039[a]	-0.044[a]	-0.087[a]	-0.097[a]	-0.077[a]	-0.077[a]
	(0.012)	(0.012)	(0.014)	(0.015)	(0.016)	(0.017)	(0.024)	(0.023)
Number of adults	-0.007[c]	-0.006[c]	-0.020[a]	-0.019[a]	-0.020[a]	-0.018[a]	-0.016[c]	-0.016[c]
	(0.004)	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)	(0.008)	(0.008)
Number of children	0.006[b]	0.006[b]	0.013[a]	0.012[a]	0.010[a]	0.009[a]	0.034[a]	0.033[a]
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)
Family net income	-0.003	-0.002	-0.008	-0.008	-0.029[a]	-0.028[a]	-0.023[a]	-0.023[a]
	(0.004)	(0.004)	(0.005)	(0.003)	(0.005)	(0.005)	(0.007)	(0.007)
Mean outcome	0.129		0.229		0.261		0.271	
N obs.	14,736		14,736		14,736		5,570	

Notes: The main coefficient estimates (in bold) in this table can be interpreted as the effect of treatment on the probability of an adverse event during an individual's adolescence. All specifications include individual county of residence and birth year fixed effects. We also control for the individual's age of the first ADHD diagnosis, Medicaid eligibility timing and length, disability and foster care status. First stage coefficients show the relationship between treatment receipt and physician propensity to prescribe medication. All specifications are estimated on a subsample of relevant birth cohorts of SC Medicaid enrollees and include individuals born between 1987 and 1996. Coefficient estimates that are significant at 1%, 5%, and 10% level are denoted with a, b, and c respectively. Standard errors are in parentheses. They are clustered by individual's provider who diagnosed them with ADHD.

Table 7: Lifetime Effects of ADHD Treatment on Adverse Health and Behavioral Outcomes; with Mother Characteristics

	STD		STD+test		Subst. abuse		Pregnancy	
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**
First stage		0.482^{a}		0.482^{a}		0.482^{a}		0.541^{a}
		(0.020)		(0.020)		(0.020)		(0.031)
ADHD Treatment	-0.012	**-0.032**	-0.008	**-0.061**^{c}	0.013	**-0.071**	-0.030	**-0.007**
	(0.009)	**(0.029)**	(0.011)	**(0.034)**	(0.012)	**(0.049)**	(0.018)	**(0.052)**
Male	-0.125^{a}	-0.124^{a}	-0.203^{a}	-0.200^{a}	0.056^{a}	0.061^{a}	-	-
	(0.009)	(0.010)	(0.011)	(0.011)	(0.010)	(0.011)		
Race: Black	-0.022^{b}	-0.025^{b}	0.024^{b}	0.017	-0.080^{a}	-0.090^{a}	-0.030^{c}	-0.027
	(0.009)	(0.010)	(0.012)	(0.013)	(0.012)	(0.013)	(0.017)	(0.019)
Hispanic	-0.047	-0.050	-0.059	-0.068	-0.176^{a}	-0.190^{a}	-0.127	-0.118
	(0.035)	(0.033)	(0.046)	(0.046)	(0.054)	(0.054)	(0.097)	(0.097)
Other	-0.029	-0.031^{c}	-0.025	-0.029	-0.096^{a}	-0.103^{a}	-0.112^{a}	-0.110^{a}
	(0.018)	(0.018)	(0.023)	(0.023)	(0.025)	(0.025)	(0.040)	(0.039)
Number of adults	-0.007	-0.007	-0.016^{b}	-0.015^{c}	0.003	0.005	-0.007	-0.007
	(0.006)	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.013)	(0.013)
Number of children	0.001	0.001	0.013^{a}	0.013^{a}	0.011^{b}	0.010^{c}	0.039^{a}	0.040^{a}
	(0.003)	(0.003)	(0.005)	(0.004)	(0.005)	(0.005)	(0.008)	(0.008)
Family net income	-0.001	-0.001	-0.005	-0.005	-0.021^{a}	-0.021^{a}	-0.025^{b}	-0.025^{b}
	(0.005)	(0.005)	(0.007)	(0.007)	(0.006)	(0.007)	(0.011)	(0.011)
Mean outcome	0.124		0.231		0.251		0.224	
N obs.	6,952		6,952		6,952		2,586	

Notes: The main coefficient estimates (in bold) in this table can be interpreted as the effect of treatment on the probability of an adverse event during an individual's adolescence. All specifications include individual's county of residence and birth year fixed effects. We also control for the individual's age of the first ADHD diagnosis, Medicaid eligibility timing and length, disability and foster care status, mother's educational attainment, and age when she gave birth. First stage coefficients show the relationship between treatment receipt and physician propensity to prescribe medication. All specifications are estimated on a subsample of relevant birth cohorts of SC Medicaid enrollees and include individuals born between 1987 and 1996. Coefficient estimates that are significant at 1%, 5%, and 10% level are denoted with a, b, and c respectively. Standard errors are in parentheses. They are clustered by individual's provider who diagnosed them with ADHD.

The results suggest that pharmaceutical treatment is associated with a 1.1 percentage point decrease each year in the probability of first contracting an STD, a 2.0 percentage point decrease each year in the probability of first being screened for an STD, a 1.8 percentage point decrease each year in the probability of first abusing substances, and a 3.1 percentage point decrease each year in the probability of being injured, or a reduction of 0.109 injuries each year.

The panel analysis results reported in Table 8 are consistent with our cross-section analysis: we find that treatment is associated with a reduction in the probability of contracting an STD, being screened for an STD test, and abusing substances. The magnitudes of the coefficients in the yearly effects regressions are complementary rather than directly comparable to the lifetime effects of ADHD treatment. In the former we specifically focus on the periods of the child's continuous eligibility for Medicaid, controlling for the patient's age and other time-varying parameters.

The coefficients on covariates of interest also support the findings on the lifetime effects. For the outcome injury, the signs are as expected. Boys are more likely to get injured and the severity of the injuries are greater (they have 2.8 percentage points more injury-related medical procedures performed). Whites are consistently more likely to suffer from any adverse event, including injuries, than blacks and Hispanics. We posit that this is related to the likelihood of using medical services in general.

Family composition has effects across all potential adverse events that we identified. If it is a two- rather than one-parent household, the probability of an adverse event is generally lower by 0.1–1.8 percentage points. Although the effect for the injury incidence is negligible, for number of injuries there is a reduction of 0.016 injuries if a the family has two adults instead of one adult. Finally, the family income coefficient estimates consistently point at the fact that a relatively well-off family could provide better care for a child and reduce the probability and severity of an adverse event. The effect is small but precise. For injuries, the probability of injury in a given year is reduced by 0.9 percentage point and the number of injuries goes down by 0.018 for every additional $1,000 of net family income.

6.3 Effects of ADHD Treatment on Medicaid Spending

All the results described above were based on the adverse events and the event of an ADHD diagnosis that were identified using ICD-9 diagnosis codes and CPT procedure codes. Only occasionally do the codes of this system tell us the severity of the condition or event. It is entirely possible that ADHD medication has an effect not only on the incidence of the adverse events but also on their severity. A way to address this question is to look at the

Table 8: Yearly Effects of ADHD Treatment on Health and Behavioral Outcomes

	STD		**STD+test**		**Subst. abuse**		**Pregnancy**		**Injury (0/1)**		**N Injuries**	
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**
First stage		0.469[a]		0.468[a]		0.473[a]		0.516[a]		0.327[a]		0.327[a]
		(0.006)		(0.006)		(0.006)		(0.010)		(0.003)		(0.003)
ADHD	-0.003[a]	**-0.012**[b]	-0.003[c]	**-0.021**[a]	0.002	**-0.020**[c]	-0.009[a]	**-0.004**	0.005[c]	**-0.031**[c]	-0.003	**-0.109**[a]
Treatment	(0.001)	**(0.005)**	(0.002)	**(0.007)**	(0.002)	**(0.010)**	(0.003)	**(0.011)**	(0.003)	**(0.017)**	(0.007)	**(0.041)**
Male	-0.028[a]	-0.028[a]	-0.053[a]	-0.052[a]	0.009[a]	0.011[a]	-	-	0.026[a]	0.028[a]	0.067[a]	0.073[a]
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)			(0.002)	(0.002)	(0.006)	(0.006)
Race: Black	-0.001	-0.002	0.005[a]	0.003	-0.018[a]	-0.020[a]	-0.007[b]	-0.007[c]	-0.046[a]	-0.049[a]	-0.128[a]	-0.136[a]
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	(0.003)	(0.007)	(0.007)
Hispanic	-0.010[c]	-0.011[c]	-0.007	-0.009	-0.027[a]	-0.030[a]	-0.023[b]	-0.022[c]	-0.068[a]	-0.073[a]	-0.140[a]	-0.156[a]
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.012)	(0.012)	(0.009)	(0.009)	(0.021)	(0.022)
N adults	-0.002	-0.002	-0.031[a]	-0.032[a]	-0.007[a]	-0.007[a]	-0.012[a]	-0.012[a]	0.009[a]	0.009[a]	0.017[a]	0.016[a]
	(0.009)	(0.009)	(0.012)	(0.012)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)
N children	0.001	-0.001	-0.002	-0.004	-0.001	-0.001	0.010[a]	0.010[a]	0.002	0.001	-0.001	-0.002
	(0.006)	(0.006)	(0.007)	(0.007)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Family income	-0.002[b]	-0.002[b]	-0.003[a]	-0.003[a]	-0.006[a]	-0.006[a]	-0.011[a]	-0.011[a]	-0.008[a]	-0.009[a]	-0.018[a]	-0.018[a]
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.003)	(0.003)
Mean outcome	0.024		0.046		0.050		0.055		0.266		0.464	
N obs.	68,378		64,622		64,328		25,666		266,181		266,181	

Notes: The main coefficient estimates (in bold) in this table can be interpreted as the average annual effect of treatment on the probability of a post-diagnosis adverse event. All specifications include individual's county of residence fixed effects, year fixed effects, and their interactions. We also control for the individual's disability and foster care status. The coefficients on the number of children and adults are scaled up by 10 in the STD and STD screening regressions in order to report their magnitudes. First stage coefficient shows the relationship between treatment receipt and physician propensity to prescribe medication. All specifications except for injuries are estimated on a subsample of relevant birth cohorts of SC Medicaid enrollees and include individuals born between 1987 and 1996. Coefficient estimates that are significant at 1%, 5%, and 10% level are denoted with a, b, and c respectively. Standard errors are in parentheses. They are clustered by individual's provider who diagnosed them with ADHD.

direct cost to Medicaid of all outcomes that we observe in the data. We posit that the more visits are needed and the more costly they are, the more severe is the patient's condition.

We focus on the periods of continuous eligibility (as described in detail earlier). The cost to Medicaid is zero if a patient experienced no adverse events; all costs are in 2013 dollars. Panel A of Table 9 shows the results for the average annual cost to Medicaid over the patients' lifetime eligibility period for STD, STD testing, substance abuse, and injuries. If the patient is treated for ADHD, every patient per year of eligibility would cost Medicaid $1.23 ($8.11) less in STD-related expenses (if we include STD tests); $123.71 less in substance abuse-related costs' and $178.72 in injury spending. In per year terms (Panel B), when we control for patient age and other time-varying characteristics, the results tell the same story and are very similar in magnitude.

OLS estimates that we present for comparison purposes, have the same sign as the IV estimates and are mostly noisy.

7 Robustness

We perform several robustness checks. First, we test the sensitivity of the results to alternative definitions of pharmacological treatment. Our baseline findings have the same signs on the coefficients of interest and differ from the alternative specifications' results in an expected way. Second, we introduce two alternative instrumental variables: the first-in-data provider propensity to prescribe and propensity to prescribe of all providers in a county. The alternative IVs would be expected to have weaker explanatory power but are arguably more exogenous. Both IVs tell the story compatible with our preferred instrument. The summary of the results is shown in Table 10. Each row represents the three different treatment definitions and reports both the first stage coefficient and the coefficient on treatment instrumented with an alternative instrumental variable and our preferred instrument for comparison purposes.

7.1 Alternative definition of treatment

Pharmacological treatment can be defined in a number of ways. Our baseline definition considers an individual as treated if they have a record of taking any medication approved for ADHD after being diagnosed with ADHD. The estimates are reported in the top section of Table 10.

Alternatively, we could assign the treated status to individuals who take a prescription within a year from their initial diagnosis. This definition captures the differences between

Table 9: Effects of ADHD Treatment on the Costs of ADHD-associated Adverse Events to Medicaid

	STD		**STD+test**		**Subst. abuse**		**Injury**	
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**
Panel A: Effects of ADHD Treatment on Medicaid Costs on Adverse Outcomes per Year of Eligibility								
First stage		0.504^a		0.504^a		0.504^a		0.368^a
		(0.016)		(0.016)		(0.016)		(0.006)
Treatment	-5.22	**9.37**	-7.57	**2.09**	-24.98	**-174.04**^{b}	-31.26^b	**-178.72**^{b}
	(6.67)	**(17.15)**	(6.70)	**(18.23)**	(22.62)	**(85.16)**	(15.52)	**(76.44)**
Mean outcome	20.18		34.83		224.13		202.10	
	(251.72)		(261.26)		(1,028.60)		(2097.94)	
N obs.	9,575		9,575		9,575		58,408	
Panel B: Yearly Effects of ADHD Treatment on Medicaid Costs on Adverse Outcomes (Panel)								
First stage		0.475^a		0.475^a		0.475^a		0.328^a
		(0.006)		(0.006)		(0.006)		(0.003)
Treatment	-9.63^c	**-11.74**	-10.96^b	**-23.45**^{c}	-11.02	**-106.45**	-9.63	**-338.20**^{b}
	(5.33)	**(12.49)**	(5.06)	**(13.33)**	(14.27)	**(58.06)**	(18.72)	**(145.56)**
Mean outcome	17.85		31.37		158.84		218.45	
	(328.97)		(345.42)		(1,524.39		(6,279.69)	
N obs.	74,016		74,016		74,016		239,907	

Notes: The main coefficient estimates (in bold) in Panel A can be interpreted as the effect of treatment on the average cost of ADHD-related post-diagnosis adverse events to Medicaid per year of uninterrupted individual's enrollment. In Panel B, we control for time-varying characteristics and the coefficients can be interpreted as the effect of ADHD treatment on the average annual cost of adverse events to Medicaid. All specifications in Panel B include individual county of residence fixed effects, year fixed effects, and their interactions. Medicaid spending is adjusted to 2013 dollars. First stage coefficients show the relationship between treatment receipt and physician propensity to prescribe medication. All specifications except for injuries are estimated on a subsample of relevant birth cohorts of SC Medicaid enrollees and include individuals born between 1987 and 1996 who were eligible for Medicaid at age of 11 years old or later. Coefficient estimates that are significant at 1%, 5%, and 10% level are denoted with a, b, and c respectively. Standard errors are in parentheses. They are clustered by individual's provider who diagnosed them with ADHD.

treated and non-treated in the first years after the diagnosis better and thus, is expected to perform well in a setting where we are looking at the incidence of adverse events immediately after the initial ADHD diagnosis. The relationship between the provider propensity to prescribe medication and treatment under this definition is stronger as expected. By construction, a given provider prescribes medication within a year of the diagnosis. We impose this restriction in response to the data limitation as described in Section 4 in detail. The estimation yields relatively smaller point estimates for treatment in absolute value compared to our preferred specification. This result is not surprising as many individuals may receive treatment after 365 days of being diagnosed and have beneficial outcomes but are being coded as never treated in this specification.

For the second test, we define treatment as a sequence of six or more medications following earlier literature (see Dalsgaard et al. (2014)). This definition captures the idea of treatment adherence. Perhaps one prescription would not cure or even alleviate the condition, but half a year of treatment is likelier to have an impact on the child's health and behavioral outcomes. Again, by construction, the instrument based on patient adherence predicts a take up of any treatment weaker than the baseline. Perhaps not surprising, when we define the treated population as only those who adhere to treatment for six months, we find treatment to be more effective.

We present this result for comparison purposes and we argue that our baseline IV is more exogenous. The provider might influence adherence to treatment and health outcomes through channels other than prescribing medication. Moreover, the data show that it is common for a child to temporarily suspend treatment over school holidays and restart treatment later in the year. The IV based on six months of continuous treatment may not include these individuals. In other words, our IV can be interpreted as a lower bound estimate of the effects of treatment on adverse outcomes.

7.2 Alternative instrumental variables

We construct two alternative instrumental variables and test them on all treatment definitions described above. First, instead of the diagnosing provider propensity to prescribe we look at the first-in-data provider prescribing preferences regarding the ADHD medications. The purpose behind this IV is to address potential concerns about the provider selection based on the probability they would prescribe medication. We argue that children visit their pediatrician or family provider for most health issues, including ADHD, rather than selecting a specific provider to go to with ADHD-related concerns. We look at all child's medical records and select the individual's first-in-data provider. We calculate a measure of prescribing preferences for this provider based on all ADHD patients he had in that year. Note that not all providers have ADHD patients every year and there is also a significant provider mobility in and out of Medicaid. For this reason, we do not have a first-in-data provider propensity to prescribe for everyone who was diagnosed with ADHD in our sample.

In line with our main specification findings, the results utilizing this alternative instrument suggest that treatment reduces the probability of STD contraction, STD screening and substance abuse disorders (see Table 10). The reduction in sample size likely explains the increase in the noise of our coefficient estimates. These results provide additional support to the evidence we presented earlier (Section 5) on the absence of provider selection. We show that although we cannot rule out that unobservable characteristics are correlated with our preferred instrument, observable characteristics are not.

Next, we define a county level propensity to prescribe as an alternative instrument. For this instrument, we use a subsample of patients who visit a provider outside of their county of residence in order to control for residential county fixed effects. The results point in the same direction as our baseline specification, however the estimates are noisier. Although provider propensity to prescribe medication on a county level is more exogenous, there is less variation across counties than across individual providers in addition to the smaller sample size (results available upon request).

8 Conclusion

This paper investigates the effectiveness of ADHD medication in reducing the probability of short-term and long-term adverse outcomes associated with the disorder. Over the past decade, SC Medicaid spending on prescription drugs increased nearly three-fold to $69 million in 2013. It is important to understand whether the increased expenditures on treatment produced any benefit in terms of improved health (fewer and less severe injuries), reduction in risky behaviors that potentially lead to teen pregnancies, STDs, and substance abuse. The focus population of our study are children from relatively disadvantaged families who are enrolled in SC Medicaid and who are diagnosed with ADHD. This population is particularly vulnerable: up to a quarter of Medicaid enrollees are diagnosed with ADHD in their birth cohort.

We use a panel data set of South Carolina Medicaid claims paid between 2003 and 2013. To overcome potential endogeneity of treatment takeup, we use variation in physician prescribing preferences for ADHD conditions. Our findings suggest that ADHD medication is effective in reducing the probability of every adverse health and behavioral outcome that we are able to identify in administrative data. Based on our preferred specification, over the

Table 10: Robustness: Alternative Instrumental Variable and Treatment Definition

Treatment definition	**STD**		**STD+test**		**Subst. abuse**	
	Baseline	1st provider	Baseline	1st provider	Baseline	1st provider
Baseline: Ever treated						
First Stage	0.472^{a}	0.122^{a}	0.472^{a}	0.122^{a}	0.472^{a}	0.122^{a}
	(0.013)	(0.018)	(0.013)	(0.018)	(0.013)	(0.018)
ADHD Treatment	-0.036^{c}	-0.042	-0.077^{a}	-0.127	-0.125^{a}	-0.046
	(0.022)	(0.099)	(0.026)	(0.111)	(0.045)	(0.150)
1+ Rx within the 1st year						
First Stage	0.512^{a}	0.123^{a}	0.512^{a}	0.123^{a}	0.512^{a}	0.126^{a}
	(0.014)	(0.018)	(0.014)	(0.018)	(0.014)	(0.018)
ADHD Treatment	-0.025	-0.041	-0.052^{b}	-0.126	-0.076^{c}	-0.046
	(0.020)	(0.099)	(0.023)	(0.110)	(0.040)	(0.149)
6+ Rx ever (Dalsgaard et al. (2014))						
First Stage	0.209^{a}	0.071^{a}	0.209^{a}	0.071^{a}	0.209^{a}	0.071^{a}
	(0.013)	(0.017)	(0.013)	(0.017)	(0.013)	(0.017)
ADHD Treatment	-0.061	-0.072	-0.127^{b}	-0.218	-0.187^{c}	-0.079
	(0.050)	(0.172)	(0.057)	(0.202)	(0.099)	(0.256)
N obs.	14,736	7,338	14,736	7,338	14,736	7,338

Notes: "Baseline" column contains estimates for our preferred instrument – diagnosing provider propensity to prescribe. First provider IV uses prescribing preferences of the first-in-data provider. Coefficient estimates that are significant at 1%, 5%, and 10% level are denoted with *a*, *b*, and *c* respectively. Standard errors are in parentheses. Standard errors are clustered by diagnosing provider for specification using diagnosing provider propensity to prescribe; standard errors are clustered by first provider for specification using first-in-data provider propensity to prescribe.

course of teenage years the probability of contracting an STD decreases by 3.6 percentage points; and individual is 7.7 percentage points less likely to be screened for an STD, and 12.5 percentage points less likely to receive medical attention related to a substance abuse disorder. The point estimate on the probability of teenage pregnancy is also negative (-3.7 percentage points) but not statistically significant.

In per year terms and controlling for time-varying characteristics, these findings translate into a 1.1 percentage point decrease in the probability of contracting an STD each year, a 2.0 percentage point decrease in the probability of being screened for an STD each year, a 1.8 percentage point decrease each year in the probability of abusing substances, and a 3.1 percentage point decrease each year in the probability of being injured, or 0.201 reduction each year in the number of injury-related medical procedures.

These results generally agree with the findings of Dalsgaard et al. (2014) that find medication is effective in reducing the incidence of injuries and criminal activity. However, both papers produce evidence that is contrary to the results in Currie et al. (2014). In their paper, they find that an increase in medication use is associated with negative effects on children's educational outcomes, deterioration in relationships with parents, and increase in the probability of depression. These differences are likely due to the differences in the population. Medicaid enrollees are worse off in terms of income and health relative to the general population, while children on the margin who were drawn into the treatment group in Currie et al. (2014) study are likely to be relatively healthy and have less severe ADHD. Finally, in this paper we concentrate on noncognitive outcomes that are qualitatively different from the cognitive abilities that constitute most of the outcomes in the paper by Currie et al. (2014).

It is plausible to suggest that ADHD medication has an effect not only on the incidence of adverse events but also on their severity. We go beyond the existing literature and address this question by looking at the direct cost to Medicaid of all outcomes that we observe in the data. We posit that the more visits are needed and the more costly they are, the more severe is the patient's condition. For every patient treated for ADHD, each year of eligibility would cost Medicaid an estimated $1.23 ($8.11) less in STD-related expenses (if we include STD tests); $123.71 less in substance abuse-related costs and $178.72 in injury spending. In per year terms, when we control for patient age and other time-varying characteristics, the results tell the same story and are very similar in magnitude.

The limitations of this study that we hope to address in future research include the scope of the effects of interest and external validity. First, our results reflect the effect of treatment of a marginal patient and do not attempt to measure the benefit of pharmaceutical treatment for ADHD children that will inevitably be treated. Second, although our sample of Medicaid children makes up a large proportion of the population diagnosed with ADHD, the results are not necessarily generalizable to the non-Medicaid population. At the same time, the population in our study is the most affected by the adverse events that children with ADHD are prone to, which makes our findings even more policy-relevant.

On average, SC Medicaid spent $347 for prescription medication and $562 on ADHD-related physician visits, including behavioral therapy, while the total savings across all adverse events summed up to $379 on average per teenage per year. However, these "savings" do not include the costs associated with a teenage pregnancy, any indirect benefits that stem from preventing adverse health and behavioral outcomes, or any indirect benefits of the ADHD individual's peers. We are also not able to estimate costs in terms side effects of the medication. With the increasing rates of ADHD diagnosis and respective government spending on programs like Medicaid as well as Medicaid expansion, comparison of treatment costs and benefits deserve special investigation in future work.

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Table 11: Summary Statistics: Individual and Family Characteristics; Undiagnosed Children

	N obs.	**Mean**	**Median**	**SD**	**Min**	**Max**
Individual characteristics						
Age 1st in sample	134,075	7.83	8.00	5.02	1	19
Male	134,075	0.45			0	1
Race: White	134,075	0.35			0	1
Black	134,075	0.55			0	1
Hispanic	134,075	0.05			0	1
Family & home environment						
Monthly family net income	134,075	717.06	573.5	660.72	0	6,356
Number of adults	134,075	1.25	1.14	0.58	0	3
Number of children	134,075	2.07	2.00	1.06	0	6
Ever in foster care	134,075	0.04			0	1
Ever had disability	134,075	0.05			0	1
Mother's characteristics						
Age when gave birth	73,923	23.60	22.00	5.62	11	48
Educ: Less than HS	73,923	0.06			0	1
Some HS	73,923	0.33			0	1
HS diploma	73,923	0.42			0	1
Some college	73,923	0.14			0	1
College degree or higher	73,923	0.05			0	1

Notes: The sample includes a random group of SC Medicaid enrollees, who were eligible for Medicaid for at least one year at any age between 3 and 18 years old in 2003-2013 and who did not have an ADHD-related medical history during this time period. Family characteristics are reported on average per patient/eligibility year. Foster care and disability rates are calculated based on the Medicaid enrollment categories. Mother characteristics are reported based on in-state birth certificate information matched to Medicaid records. They are available only for a subsample of the 73,923 patients. Mother's age and educational attainment are recorded at the time of the child's birth. "HS" stands for high school education level.

Table 12: Summary Statistics: Adverse Outcomes; Undiagnosed Children

	N obs.	Mean	Median	SD	Min	Max
Years in sample	134,075	6.72	6.00	3.08	1	11
Outcome: Risky sexual behavior						
1. Teen Pregnancy						
Age at 1st pregnancy	19,750	17.47	18.00	1.42	11	19
Race: White	19,750	0.42			0	1
Black	19,750	0.53			0	1
2. STD						
Age at 1st STD	14,687	16.02	17.00	2.46	11	19
Age at 1st STD (incl. screening)	26,334	16.33	17.00	2.21	11	19
Male	14,687	0.23			0	1
Race: White	14,687	0.38			0	1
Black	14,687	0.56			0	1
Annual cost of STD	14,687	397.61	143.49	1283.26	1	90,461
Annual cost of STD+test	26,334	341.62	169.70	932.95	1	90,461
Outcome: Substance Abuse						
Age at 1st substance abuse	15,073	16.53	17.00	1.92	11	19
Male	15,073	0.47			0	1
Race: White	15,073	0.50			0	1
Black	15,073	0.45			0	1
Annual cost of substance abuse	15,073	1501.46	439.32	3736.11	1	109,293
Outcome: Injuries						
Ever injured	134,075	0.86			0	1
Age at injury	115,526	10.92	11.00	4.41	3	19
Male	115,526	0.48			0	1
Race: White	115,526	0.39			0	1
Black	115,526	0.51			0	1
N of injury claims	134,075	0.36	0.25	0.42	0	11
Annual cost of injuries	115,526	702.09	213.11	3463.53	2	394,516

Notes: The sample includes a random group of SC Medicaid enrollees, who were eligible for Medicaid for at least one year at any age between 3 and 18 years old in 2003-2013 and who did not have an ADHD-related medical history during this time period. Annual costs of adverse events are given in 2013 dollars per patient/year conditional on the occurrence of an adverse event. They are based on the Medicaid reimbursement. The out-of-pocket patient costs are nearly zero for our population of interest.