NBER WORKING PAPER SERIES

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Working Paper 23760
http://www.nber.org/papers/w23760

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 2017

Johanna Catherine Maclean, Benjamin Le Cook, and Michael Pesko were supported by a Research Scholar Grant – Insurance, RSGI-16-019-01 – CPHPS, from the American Cancer Society. We thank Joachim Marti, Douglas Webber, and session participants at the 2017 International Health Economics Association World Congress for helpful comments. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 23760
August 2017
JEL No. I1,I13,I18

ABSTRACT

Mental illnesses are prevalent in the United States and globally, and cost is a critical barrier to treatment receipt for many afflicted individuals. Affordable insurance coverage can permit access to effective healthcare services and treatment of mental illnesses. We study the effects of recent and major eligibility expansions within Medicaid, a pubic insurance system in the U.S. that finances healthcare services for the poor, on psychotropic medications prescribed in outpatient settings. To this end, we estimate differences-in-differences models using administrative data on medications prescribed in outpatient settings for which Medicaid was a third-party payer between 2011 and 2016. Our findings suggest that these expansions increased psychotropic prescriptions by 22% with substantial heterogeneity across psychotropic class and state characteristics that proxy for patient need, expansion scope, and system capacity. We provide further evidence that Medicaid, and not patients, primarily financed these prescriptions. These findings suggest that public insurance expansions have the potential to improve access to evidence-based treatments among low-income populations suffering from mental illnesses.

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1. Introduction

Mental illnesses are prevalent in all countries of the world (World Health Organization, 2017). For example, in 2015 17.9% of adults in the United States met the diagnostic criteria for any mental illness and 4% met criteria for a serious mental illness (Center for Behavioral Health Statistics and Quality, 2016). Mental illnesses impose heavy burdens on afflicted individuals as these illnesses harm overall health, employment, and relationships (World Health Organization, 2017). In addition to imposing costs internalized by afflicted individuals, mental illnesses levy costs on broader society (Frank and McGuire, 2000). Each year mental illnesses cost the U.S. economy $504B in healthcare expenditures, disability payments, and a less productive work force (Insel, 2015).[1] Additionally, mental illness prevalence is not homogenous across the population. Less advantaged groups are more likely to suffer from such illnesses (World Health Organization, 2017). Within the U.S., mental illness prevalence is particularly high among lower income individuals (Center for Behavioral Health Statistics and Quality, 2016).

Although they impose substantial costs, mental illnesses can be effectively treated by primary care providers, who can prescribe psychotropic medications[2] and provide brief counseling, and specialty providers (e.g., psychiatrists, psychologists), who provide intensive psychopharmacological and psychosocial treatment, in outpatient or inpatient settings (Olfson, 2016). Despite established treatment effectiveness (American Psychiatric Association, 2006), there is a substantial amount of unmet need for mental illness treatment in the U.S. According to National Survey on Drug Use and Health (NSDUH) data, in 2015, more than half of U.S. adults who could benefit from mental illness treatment did not receive any treatment (Center for

[1] The authors inflated this number from the original estimate ($467B in 2012 dollars) to 2017 dollars using the Consumer Price Index.
[2] Psychotropic medications are used to treat mental illnesses such as anxiety, depression, and psychosis.

Behavioral Health Statistics and Quality, 2016). Unmet need for mental illness treatment is particularly high among the uninsured (Garfield et al., 2011). Among individuals who sought care but did not receive it, the most commonly reported reason for failure to receive care was inability to pay (Center for Behavioral Health Statistics and Quality, 2016). Thus, expanding insurance coverage to low income, uninsured individuals may remove cost-related barriers to unmet mental illness treatment needs.

In 2010, the U.S. federal government implemented the Affordable Care Act (ACA). This Act, arguably the most substantial U.S. healthcare legislation in a generation, was designed to address perceived inadequacies within the healthcare delivery system. A primary objective of the Act was to reduce uninsurance. In 2009, the year before the ACA was enacted, the U.S. uninsurance rate was 15.4% (Cohen et al., 2010). By 2016, the uninsurance rate had fallen to a historically low rate of 9% (Cohen et al., 2017); a 42% decline. The ACA increased insurance coverage through three principle policy levers: (i) premium subsidies to purchase private insurance, (ii) mandates that required employers to offer insurance and individuals to hold insurance, and (iii) expanded eligibility for Medicaid; an insurance system that finances healthcare services for the poor (Frean et al., 2017). Another objective of the ACA was to mitigate 'underinsurance': insurance that provides inadequate coverage of healthcare services. In particular, the ACA required that most insurance plans cover ten benefit classes, including mental illness treatment and prescription medications (Garfield et al., 2010).

We explore the effects of ACA-related Medicaid expansions that occurred between 2011 and 2016 on psychotropic medications prescribed in outpatient settings for which Medicaid was a third-party payer. While we do not directly capture medication use, prescriptions provide a reasonable proxy for such use (Lehmann et al., 2014). Analyses of pre-ACA data suggest that

individuals who gained eligibility through these expansions had elevated need for mental illness treatment (Garfield et al., 2011, Cook et al., 2016), which implies that newly insured populations may benefit from these expansions. This particular treatment modality is endorsed by providers – in professional practice treatment guidelines psychotropic medications are recommended as a component of treatment for most major mental illnesses (American Psychiatric Association, 2017) – and common – in 2015, 36.7% of U.S. adults with mental illness used psychotropic medications (Center for Behavioral Health Statistics and Quality, 2016). Because patients must receive a prescription from a provider to obtain them, studying psychotropic medications allows us to indirectly explore the ability of newly insured individuals suffering from mental illness to form relationships with providers and navigate the healthcare system.

Economic theory suggests that Medicaid expansions, by reducing out-of-pocket prices, will increase the quantity of prescriptions demanded by enrollees suffering from mental illnesses (Grossman, 1972). Moreover, increased awareness of mental illness treatment and its benefits may occur with Medicaid expansion, which may increase demand for psychotropic medications. There are numerous factors that may mute expansion effects, however: mental illness and treatment stigma, new patients' unfamiliarity with the healthcare delivery system, lack of participation in Medicaid by healthcare providers, and so forth (Decker, 2012, Center for Behavioral Health Statistics and Quality, 2016). Thus, the extent to which Medicaid expansions lead to changes in psychotropic medication prescriptions is an empirical question.

We couple administrative data on the universe of prescriptions obtained in outpatient settings and purchased through retail and online pharmacies for which Medicaid was a third-party payer with differences-in-differences models to study Medicaid effects. These models leverage within-state variation in Medicaid eligibility 2011-2016. Our findings suggest that,

post-expansion, psychotropic prescriptions increased 22% in expanding states relative to non-expanding states. There was heterogeneity by psychotropic class and state characteristics in effect sizes. Increased prescriptions were financed by Medicaid and not patients.

2. Medicaid and related literature

2.1 Medicaid and ACA-related expansions

Medicaid is the primary insurer for low-income families, low income elderly Medicare[3] beneficiaries, and disabled individuals in the U.S., covering 77 million individuals in 2017 (Sommers and Grabowski, 2017). Medicaid is a joint federal-state program, with the federal government setting minimum eligibility and coverage standards. States historically had ample latitude to determine specific eligibility criteria and benefit design within these standards. Prior to the ACA, most states limited Medicaid eligibility to the disabled and low-income parents; other low-income groups (e.g., childless, non-disabled adults) were simply not eligible for coverage. Medicaid is characterized by low patient cost-sharing and coverage of a relatively expansive list of healthcare services, including mental illness services (Kaiser Family Foundation, 2017). Indeed, comparison of plans suggests that Medicaid may provide more generous coverage for mental illness services than private insurance (Garfield et al., 2010).

Beginning in 2014, as part of the ACA, Medicaid was expanded in 31 states and D.C. (as of August 2017) to cover parents and other non-disabled adults with incomes up to 138% of the Federal Poverty Level [FPL] (Kaiser Commission on Medicaid and the Uninsured, 2016).[4] Categorical restrictions were removed. Individuals who gained eligibility through these

[3] Medicare is a public insurance system for the elderly and patients suffering from specific diseases (e.g., end stage renal disease) in the U.S.

[4] Originally, the ACA legislated that the Medicaid expansion was to occur nationally. Non-compliant states were to be denied all federal Medicaid funds. However, in 2012, the U.S. Supreme Court ruled that states would not lose federal funds if they choose not to expand Medicaid. Thus, the decision to expand, or not expand, Medicaid was left to states' discretion. We leverage these state decisions in our empirical models (outlined later in the manuscript).

Medicaid expansions are referred to as 'newly eligible'[5] and are insured by 'expansion' plans that cover both mental illness treatment and prescription medications (Garfield et al., 2010).

Medicaid expansions lead to large decreases in the uninsured rate among groups eligible for expansion coverage (Wherry and Miller, 2016). Moreover, Medicaid expansions increased access to care as measured by having a personal doctor and receiving an annual check-up (Sommers et al., 2016), and may have improved self-assessed health (Simon et al., 2017).[6]

2.2 Medicaid and mental illness

While there are numerous studies into the effects of Medicaid expansions on general health and healthcare use, there is less evidence on the effects of such expansions on mental illness. In particular, little is known on the effects of Medicaid expansions on psychotropic medications. This dearth represents a serious gap in our understanding of Medicaid health effects as use of psychotropic medications is an important indicator of access to prescribing physicians, is recommended as part of effective treatment for most major mental illnesses (American Psychiatric Association, 2017), and reflects a large share of mental illness treatment received in the U.S. (Center for Behavioral Health Statistics and Quality, 2016). Moreover, a

[5] Although we emphasize the newly eligible in our study, other groups experienced changes in insurance status and eligibility post-ACA. (i) Through 'welcome mat' effects, individuals who were previously eligible enrolled in Medicaid (Frean et al., 2017). (ii) In all states – both expansion and non-expansion – income eligibility was increased by 5 percentage points (this increase occurred with the migration to the 'Modified Adjusted Gross Income' [MAGI] criteria for determining program eligibility; https://www.healthcare.gov/glossary/modified-adjusted-gross-income-magi/ [accessed August 17th, 2017]). For expansion states the post-ACA income threshold is 138% of FPL (133% + 5 percentage points) and for non-expansion states the post-ACA income threshold is set 5 percentage points above the state's Medicaid income threshold in March 2010 (i.e., in advance of implementation of the major provisions of the ACA). These groups are not referred to as newly eligible and are not covered by expansion plans (Garfield et al., 2010). We leverage variation in Medicaid eligibility for the newly eligible group, but we note the possibility that welcome mat effects and the effect of increasing income eligibility by 5 percentage points may differ across expansion and non-expansion states. If such differences are present, our estimates will conflate these three distinct effects. Nonetheless, studying the overall effects of the ACA-related Medicaid expansion is an important first order question for understanding whether a large-scale public insurance expansion leads to changes in psychotropic medication prescriptions among low income populations with little historic access to insurance and elevated need for such treatment. We encourage further research, relying on other data sources, to explore the potentially differential effects across groups that gained Medicaid insurance through these expansions.

[6] We note that not all studies demonstrate health gains. See, for example, Courtemanche et al. (2017).

concern among policymakers is that mental healthcare demand is more elastic than general healthcare (Frank and McGuire, 2000) and insurance expansions may lead to particularly high costs for payers. Hence, providing evidence on the mental healthcare insurance-elasticity is critical for understanding how expansions will change service use, health, and costs.

Several studies examine the effects of Medicaid on overall mental illness service use and unmet treatment need, and mental illness using variation afforded by pre-ACA state expansions.[7] Golberstein and Gonzales (2015) find little effect of Medicaid on mental illness service use using the Medical Expenditure Panel Survey. On the other hand, Wen et al. (2015) utilize NSDUH data to show Medicaid expansions increased the probability of receiving mental illness treatment and reduced reports of unmet treatment need. Leveraging the National Health Interview Survey, McMorrow et al. (2016) find that Medicaid expansions reduced psychological distress among adults.[8] Finally, using experimental data from a large-scale randomized control trial in the state of Oregon, Baicker et al. (2013) document a substantial reduction in the rates of a positive screening result for depression among adults randomized to Medicaid.

To the best of our knowledge, only one study examines the effect of ACA-related Medicaid expansions on mental illness treatment. In an extension to their main analyses of the effect of ACA-related Medicaid expansions on overall prescriptions Ghosh et al. (2017), using

[7] These studies examine overall mental illness service use and do not distinguish psychotropic medications from other treatment modalities.

[8] While it is beyond the scope of our study to reconcile findings across these studies, we suspect that differences in the manner in which the authors modelled Medicaid expansion may play a role. Golberstein and Gonzales impute Medicaid eligibility following Cutler and Gruber (1996). Wen et al use indicator variables for a Section 1115 waivers expansion and specific features of the waivers (such waivers allow states to adjust Medicaid by expanding coverage to groups not historically eligible, for example: https://www.medicaid.gov/medicaid/section-1115-demo/index.html [accessed August 15th, 2017]). Finally, McMorrow et al enter Medicaid eligibility income thresholds directly into their regression models. See Hamersma and Kim (2013) for a recent discussion of various approaches to modelling pre-ACA Medicaid expansions.

claims data, find that psychotropic medications increased 19%, post-expansion, in expanding states relative to non-expanding states (overall prescriptions increased by the same percent).

Our analysis builds on the Ghosh et al. (2017) analysis in several important ways. (i) We assess heterogeneity across classes of psychotropic medications: antidepressants, anti-anxiety medications, anti-psychotics, mood stabilizers, and stimulants. Understanding the impact of Medicaid expansion on sub-classes of psychotropic medications provides critical evidence for policymakers assessing changes in the use of psychotropic medications shown to be beneficial for patients and those that present a higher risk to patients, and how insurance expansions may impact links to providers qualified to prescribe these medications. (ii) We directly estimate the overall costs of increases in psychotropic medication; costs are an essential input for assessing the value of major policy initiatives such as the Medicaid expansions we study. (iii) We test the extent to which state Medicaid programs vs. patients assumed the financial responsibility of increased psychotropic medication prescriptions, which allows us to shed additional light on the distributional effects of Medicaid expansion. (iv) We examine how Medicaid effects vary across state characteristics (e.g., uninsurance) that proxy for expansion scope, patient need, and system capacity. (v) We are able to study longer-term expansion effects as we have access to 36 months post-expansion (vs. 15 post-expansion months examined by Ghosh and colleagues).[9]

3. Data and methods

3.1 Prescriptions

We draw data on Medicaid-financed prescription medications from the State Drug Utilization Database (SDUD). The Centers for Medicaid and Medicare (CMS) compile the SDUD using state data supplied by Medicaid programs. The SDUD includes the universe of

[9] More specifically, these are post-expansion months for the states that expanded on January 1st 2014; this is the most common expansion date for ACA-related Medicaid expansions (see Table 2).

outpatient prescription medications covered under the Medicaid Drug Rebate Program for which Medicaid serves as a third-party payer (U.S. Department of Health and Human Services, 2012).

While the SDUD has included information from fee-for-service (FFS) since its inception, data on prescriptions financed by managed care (MC) plans were added to the SDUD in March 2010 following implementation of the Drug Rebate Equalization Act (2009). We use data from 2011 onward to examine both FFS and MC given the movement away from FFS and toward MC within Medicaid over time (Hurley and Somers, 2003).

We use SDUD data in all quarters between 2011 and 2016, yielding 24 periods of data for each state and D.C.: 12 periods pre-2014 and 12 periods post-2014. We exclude Arizona, Hawaii, Kansas, Ohio, Rhode Island, and Virginia due to odd data patterns.[10]

We study overall prescriptions for medications with indications for mental illnesses, and consider heterogeneity across major psychotropic groups: anti-depressants, anti-anxiety medications, anti-psychotics, mood stabilizers, and stimulants (Table 1). We first use medications provided by the National Institute of Mental Health to identify the medications in each psychotropic class. Next we refer to each medications' Medline webpage to broaden the list of included medications. Only medications with Food and Drug Administration indicators for treatment of adult mental illness are included in our analyses.[11] We identify medications in the SDUD with crosswalks between National Drug Codes (Roth, 2017).

3.2 Medicaid expansions

[10] Broadly, these states' data showed large spikes in prescriptions in at least one quarter of our study period. Results are robust to including these states in the analysis. Details available from the corresponding author.

[11] https://www.nimh.nih.gov/health/topics/mental-health-medications/index.shtml (accessed May 5th, 2017). We note that these lists do not provide a complete enumeration of all psychotropic medications used to treat mental illness. However, we argue that they reflect a substantial share of medications plausibly available to a Medicaid patient. Our medication selection was further informed by one of the authors who is a practicing psychiatrist.

Our classification of expansion states and expansion dates are listed in Table 2. The majority of states expanded Medicaid on January 1st, 2014 in conjunction with core ACA provisions. Two states expanded later in 2014 (Michigan, New Hampshire). Five states expanded in 2015 or 2016 (Alaska, Indiana, Louisiana, Montana, Pennsylvania). Prior to 2011, 4 states (Delaware, Massachusetts, New York, Vermont) and D.C. expanded eligibility to cover parents and childless adults with full Medicaid benefits up to 100% FPL or higher, and continued to enroll new beneficiaries. We code these states as treated throughout our study period.

We match Medicaid expansion dates to the SDUD by state, year, and quarter. Our expansion state classification algorithm closely follows prior examples; e.g., Wherry and Miller (2016), Maclean et al. (2017), and Simon et al. (2017).

3.3 Outcomes

We construct variables that reflect Medicaid-financed prescriptions for psychotropic medications. These include the number of prescriptions filled overall and within five psychotropic classes (anti-depressants, anti-anxiety, anti-psychotics, mood stabilizers, and stimulants). We convert all outcome variables to the rate per 100,000 18-64 year olds in the state using data from the American Community Survey (ACS) (Ruggles et al., 2015) and the University of Kentucky Center for Poverty Research Center (2016). This group was the primary target of the ACA-related Medicaid expansions (Frean et al., 2017).

3.4 Controls

We attempt to control for variables that plausibly predict our outcomes and a state's propensity to expand Medicaid in our regression models, and minimize omitted variable bias. To this end, we merge state-level variables into the SDUD.[12]

(i) We link the annual seasonally adjusted unemployment rate from the Bureau of Labor Statistics and the poverty rate (University of Kentucky Center for Poverty Research Center, 2016) to the SDUD. (ii) We merge in demographics from the ACS (age, sex, race, ethnicity, education). (iii) We link factors that possibly reflect sentiment toward social policies targeting the poor (University of Kentucky Center for Poverty Research Center, 2016): a Democrat governor, monthly maximum Temporary Assistance for Needy Family (TANF) for a family of four, the effective minimum wage, and the state-to-federal Earned Income Tax Credit (EITC) ratio. We translate monetary variables to 2016 dollars using a healthcare cost Gross Domestic Product (GDP) deflator (Dunn et al., 2016).

3.5 Model

Our differences-in-differences (DD) model is specified in Equation (1):

$$(1) \qquad M_{st} = \alpha_0 + \alpha_1 Ex_{st} + \alpha_2' X_{st} + S_s + \tau_t + \Omega_{st} + \varepsilon_{st}$$

M_{st} is a psychotropic prescription variable in state *s* in state/year/quarter ('period') *t*. Ex_{st} is an indicator for whether or not a state has expanded its Medicaid program in period *t*. X_{st} is a vector of time-varying state characteristics. S_s and τ_t are vectors of period fixed effects. Inclusion of state fixed effects allows for control of time-invariant state factors that are

[12] We note that many of the control variables we link to the SDUD are not yet available for 2016, the final year of our study period. We linearly extrapolate the 2016 values for these variables. We will incorporate the 2016 values into our analyses as they become available. However, we have re-estimated our models using the 2011-2015 period and results are robust. See Supplementary Table 1. Details are available from the corresponding author on request.

unobservable to the econometrician. Period fixed effects control for national trends in prescriptions. We also include state-specific linear time trends (Ω_{st}).[13] Including these trends allows each state to follow a separate linear trend in outcomes and allows us to control for time-varying state-level unobservable (to the econometrician) factors. ε_{st} is the error term.

We cluster standard errors around the state (Bertrand et al., 2004). The 45 clusters in our analysis dataset allow us to consistently estimate standard errors (Cameron and Miller, 2015). We estimate all regressions using unweighted OLS.

3.6 Validity

A necessary assumption for the DD model to recover causal estimates is that the treatment and comparison groups would have followed the same trend in the post-treatment period, had the treatment states not been treated. This assumption is untestable as expansion states did expand Medicaid and thus we cannot observe these states in the untreated state post-expansion. We attempt to provide suggestive evidence on this assumption in two ways.

(i) We examine unadjusted trends in the pre-expansion period in our outcome variables for the treatment group and 2011-2013 for the comparison group. If we find that the outcomes appear to have trended similarly in the pre-treatment period across these groups, such trends provide suggestive evidence that the SDUD data satisfy the parallel trends assumption. (ii) Using pre-Medicaid expansion data for each expanding state and 2011-2013 data for non-expanding states,[14] we estimate the regression model outlined in Equation (2):

$$(2) \qquad M_{st} = \gamma_0 + \gamma_1 Treat_s * Trend_t + \beta_2' X_{st} + S_s + \tau_t + \epsilon_{st}$$

[13] Specifically, we interact each state fixed effect with a linear time trend that takes on a value of one in 2011 Q1, 2 in 2011 Q2, and so forth.

[14] We use 2011-2013 data for states that expanded Medicaid after January 1st, 2014 in validity testing (see Table 2).

We replace the Ex_{st} variable in Equation (1) with an interaction between the treatment group indicator ($Treat_s$) and a linear time trend ($Trend_t$).[15] If we cannot reject the null hypothesis that γ_1 is zero, this finding provides support that our data satisfy the parallel trends assumption.[16]

4. Results

4.1 Summary statistics

Table 3 reports summary statistics for expansion and non-expansion states in the period 2011-2013.[17] In expanding states, the quarterly number of psychotropic prescriptions per 100,000 non-elderly adults was 9,641. The number of quarterly prescriptions for anti-depressants, anti-anxiety medications, anti-psychotics, mood stabilizers, and stimulants was 2,940; 2,598; 2,034; 1,239; and 830. Within non-expanding states the comparable quarterly prescriptions per 100,000 non-elderly adults was 9,169; 2,702; 2,327; 1,839; 1,496; and 806. Thus, medication use was higher in expanding states than non-expanding states, pre-expansion.

Turning to control variables, there were clear level differences between expanding and non-expanding states in the pre-expansion period; e.g., higher unemployment rates in expanding states. We control for all these variables in our regression model and DD models require common trends, not levels, for identification.

4.2 Validity

Figures 1-6 report graphical analysis of trends in outcomes aggregated to the year-treatment level.[18] The psychotropic prescription variables moved broadly in parallel pre-expansion, although stimulant trends were more ambiguous. Post-expansion, psychotropic

[15] We do not include state-specific linear time trends in Equation (2) because these would be perfectly collinear with our main interaction testing for pre-expansion parallel trends between expanding and non-expanding states.
[16] States with substantial expansions prior to 2011 are excluded from both validity tests (see Table 2).
[17] States with substantial pre-2011 Medicaid expansions are excluded (see Table 2).
[18] We aggregate the SDUD data to the year level to smooth out noise from seasonality.

prescriptions increased in expanding states relative to non-expanding states overall and for anti-depressants and anti-anxiety medications, while trends for other medications were less clear.

Table 4 reports regression-based parallel trends testing. In five of six regressions we cannot reject the null hypothesis that the treatment and comparison groups followed the same trend in psychotropic prescriptions pre-expansion: $\hat{\gamma}_1$ is not statistically different from zero and is small in magnitude. The exception is the mood stabilizer regression. $\hat{\gamma}_1$ is statistically different from zero and carries a negative sign, suggesting that expanding states were trending *downward*, relative to non-expanding states, in the pre-expansion period. Because we expect Medicaid expansion to have increased, or have left unchanged, prescription rates we suspect that these pre-expansion trends work against our ability to detect effects.

4.3 Differences-in-differences

Table 5 reports DD results. Post-expansion, overall psychotropic prescriptions increased by 2,076 per quarter per 100,000 non-elderly adults in expanding states relative to non-expanding states, or an 22% increase relative to the baseline mean in expanding states in the pre-expansion period (9,641). Henceforth, all coefficient estimates are compared to this time period/group to convert estimates from absolute to relative terms.

Turning to heterogeneity by psychotropic class, Medicaid expansion increased prescriptions for anti-depressants, anti-anxiety medications, and stimulants. Post-expansion, anti-depressants and anti-anxiety medications prescriptions increased by 34% and 25% in expanding states relative to non-expanding states, with no statistically significant change in anti-psychotic, mood stabilizer, or stimulant prescriptions. Although coefficient estimates are positive, providing suggestive evidence that prescriptions for these medications increased.

We next construct total, Medicaid, and non-Medicaid (e.g., patient cost-sharing)[19] payments for the psychotropic medications so that we can study the costs of increased psychotropic medications post-expansion. We consider both Medicaid and non-Medicaid payments so that we can explore financing. In particular, we can investigate the following question: did state Medicaid programs or patients bear the financial responsibility of increased prescriptions? We convert payments to 2016 terms using the previously noted GDP-deflator.[20]

Table 6 reports DD estimates of the effect of Medicaid expansion on total, Medicaid, and non-Medicaid psychotropic medication payments. Medicaid financed the majority of the psychotropic medications in the pre-expansion period. For instance, for all psychotropic medications considered here, Medicaid payments captured roughly 97% of total payments.[21]

We find no statistically significant changes in any payments post-expansion. Post-expansion, total and Medicaid payments increased for depression (10% and 11%) and anti-anxiety (17% and 17%) medications, in expanding states relative to non-expanding states. We find no change in total and Medicaid payments for other psychotropic classes and no change in non-Medicaid payments for any psychotropic class. The magnitude of the estimates for total and Medicaid payments are comparable and non-Medicaid payments were unchanged post-expansion, suggesting that Medicaid programs – not patients – provided the majority of the financing for the increased medication use.[22]

[19] We note that the non-Medicaid payment variable likely includes payments from other payers, for example, Medicare in the case of 'dual eligibles' (i.e., individuals who qualify for both Medicaid and Medicare insurance programs). Nonetheless, examining total and Medicaid payments can shed light on the financial burden shouldered by Medicaid vs. other payers, which include patients.

[20] We do not convert payments to rates as we are interested in overall payments. We control for the state population age 18 to 64 years in all payment regressions, however.

[21] We note that the sum of Medicaid and non-Medicaid payments do not sum to total payments. SDUD documentation notes that differences are due to rounding and reporting errors. More details available on request.

[22] Indeed, the estimated coefficients in the Medicaid payments regressions are often larger than the estimated coefficients in the total payments regressions. However, 95% confidence intervals overlap and thus we cannot reject the hypothesis that total payments increased more than Medicaid payments. Details available on request.

That we observe no statistically significant evidence that overall payments increased post-expansion in expanding states is somewhat surprising. There are several possible mechanisms for this finding. (i) Coefficient estimates are positive and standard errors are large, thus we cannot rule out the possibility that payments increased. (ii) By expanding, Medicaid programs may have gained a stronger negotiating position vis-à-vis pharmaceutical manufacturers, which allowed Medicaid to bargain lower prices, at least for some medications.[23] (iii) The newly eligible may have been directed towards less expensive medications through, for example, the use of generics vs. branded drugs or less costly medications within the same psychotropic class. (iv) The overall psychotropic group includes medications that increased and did not increase post-expansion; combining groups may attenuate effects.

5. Extensions and robustness checks

5.1 Heterogeneity

The effects of Medicaid expansion on psychotropic prescriptions may vary across state features, such as need for mental illness treatment, access to primary care, mental illness co-morbidities, and uninsurance. These characteristics plausibly reflect differences in the potential benefits to states from expansion and capacity of states' healthcare delivery systems to support a large-scale insurance expansion. Documenting the impact of such heterogeneity is important for policymakers in the 19 states that have not expanded Medicaid in determining whether expanding could benefit their constituents, and in the 31 states and D.C. that have expanded Medicaid for understanding how to amplify expansion benefits and/or the costs of curtailing Medicaid, and for considering the distributional effects of a large policy shift across states.

[23] However, we note that Medicaid primarily, but not solely, price negotiates over rebates from manufacturers and, as we discuss later in the manuscript, we do not have access to rebates in our data. Nonetheless, we argue that it is plausible that the expansions allowed at least some state Medicaid programs to better negotiate on non-rebate prices.

We explore such heterogeneity by estimating separate regressions for states at/above and below the national median for (i) prevalence of serious mental illness among adults from the NSDUH, (ii) ratio of primary care doctors to Medicaid beneficiaries using data from the Area Resource File (ARF) and CMS, (iii) adult smoking rate from the Behavioral Risk Factor Surveillance Survey,[24] (iv) adult substance use disorder (SUD) prevalence rate from the NSDUH, and (v) uninsurance rate among adults 18-64 from the ACS.[25] We use 2010 data (in advance of the expansions we study) to construct these variables to avoid concerns that we are stratifying our sample on an endogenous variable.

Results are reported in Appendix Tables 1 (treatment need), 2 (primary care access), 3 (smoking), 4 (SUD), and 5 (uninsurance). Expansion effects were generally larger in states with high treatment need, low primary care access, high smoking rates, low SUD rates, and high uninsurance rates. These findings are in line with our expectations, with the exception of SUD rates: we hypothesized larger effects within states with higher SUD rates.[26]

5.2 Policy endogeneity

State policies are determined by the political economy within the state. An important empirical concern is therefore reverse causality. For example, state legislatures, concerned with

[24] We stratify by adult smoking rate because smoking is highly correlated with mental illness. In the U.S. adults with mental illness consume 30% of all cigarettes (Substance Abuse and Mental Health Services Administration, 2013). We stratify on SUD prevalence given the established co-morbidities between mental illness and SUDs (Center for Behavioral Health Statistics and Quality, 2016).

[25] We rely on NSDUH data from 2009/2010 for this analysis as we use the public state-level NSDUH which is only available at two-year intervals. Our proxy for need for mental illness treatment is defined as follows: 'Serious mental illness (SMI) is defined as having a diagnosable mental, behavioral, or emotional disorder, other than a developmental or substance use disorder, that met the criteria found in the 4th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) and resulted in serious functional impairment.' Our SUD variable is based on the DSM-IV definition. Details available on request.

[26] While it is beyond the scope of our study to explore the somewhat unexpected finding for our SUD stratification, we suspect that it is plausible that newly eligible enrollees suffering from SUDs may receive treatment for their SUDs and manage co-morbidities (Maclean and Saloner, 2017).

rising mental illness or other factors, may implement policies, such as the decision to expand Medicaid, in an attempt to reverse these trends.

We estimate an event study to examine reverse causality following Autor (2003). We include a series of variables for each time period before and after expansion (policy leads and lags) in Equation (1). These lead and lag variables are constructed by interacting each period indicator with an indicator for expansion states.[27] We set Q4 2013 as the index period. State-specific linear time trends are excluded from the event study following Wolfers (2006).[28] We drop states with substantial expansions before 2011. Results are presented graphically in Figures 7-12. We report the coefficient estimates and associated 95% confidence intervals that account for within-state clustering for each lead/lag.[29]

The event studies do not reveal evidence of reverse causality: the coefficient estimates on the leads are small and imprecise,[30] and alternate in sign. Post-expansion for all medications, anti-depressants, anti-anxiety medications, and stimulants, the estimated coefficients are positive and generally precise. The event study results suggest that increases in prescriptions were not immediate and instead emerged over time. This pattern of results is not surprising as the newly eligible must take up Medicaid and make an appointment with a provider prior to filling and obtaining a prescription. We find no evidence that anti-psychotic or mood stabilizer medication prescriptions changed post-expansion.[31]

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[27] Coded one if the state expanded Medicaid during our study period and zero otherwise.
[28] Wolfers argues that models with dynamics (such as the leads and lags in an event study) should not include state-specific trends as such trends can muddle interpretation of the estimates of dynamic effects.
[29] Coefficient and standard error estimates for each lead/lag variable are available on request.
[30] We note that some coefficients do raise to statistical significance, but these estimates carry a negative a sign and thus work against our DD findings that the expansions increased utilization.
31 We observe that the confidence intervals surrounding the 2016 lags are somewhat large. We suspect that this reduction in precision is due to noise in the CMS data as the 2016 was just released and may contain some errors due to reporting difficulties by state Medicaid programs. We will update the 2016 data with any new data provided by CMS. In unreported analyses, we have dropped the 2016 data from our analyses and the results are robust and, in particular, the confidence intervals do not fan out in the post-expansion period.

5.3 Weighting

The economics field has not yet reached consensus regarding the use of weights in analyses seeking to estimate causal effects. Given the lack of consensus, we re-estimate Equation (1) using the state population ages 18-64 years as weights. Weighted results (Appendix Table 6) are not appreciably different.

5.4 Unobservables

We next probe the sensitivity of our results to alternative approaches to controlling for between state heterogeneity. Specifically, we rely on (i) state- and period-fixed effects, and (ii) state-specific quadratic time trends. We also include additional time-varying observable state characteristics from the ARF: doctors providing primary care, registered nurses, managed care penetration, and community mental healthcare centers. We note that some of these additional state variables may be bad controls and urge readers to interpret findings generated in this specification with some caution (Angrist and Pischke, 2009). Results are reported in Appendix Table 7 and are not appreciably different from our main findings. Estimates are generally larger (smaller) in specifications that provide less (more) control for between state heterogeneity.

5.5 Additional robustness checks

We convert our medication variables to the rate per 100,000 individuals ages 18-64. Due to other changes embedded in the ACA,[32] it is plausible that older adults may be affected by Medicaid expansions. We re-estimate Equation (1) using the state population ages 18+ as the denominator. Results (Appendix Table 8) are not appreciably different. We explore the robustness of our results to alternative functional forms: the non-transformed measure of prescriptions (i.e., we do not convert this variable to a rate), a Poisson model, and taking the

[32] E.g., individuals eligible for Medicaid and Medicare ('dual eligibles').

logarithm of our prescription variables. Results are broadly robust, although estimates generated in the model that uses the non-transformed prescription variables and Poisson model are more precisely estimated (Appendix Table 9). Finally, we test alternative approaches to coding Medicaid expansion. We drop states with substantial pre-2011 expansions following Wherry and Miller (2016) and use a coding scheme outlined in Maclean and Saloner (2017). Results are broadly robust (Appendix Table 10).

6. Discussion

Lower income populations are at elevated risk for mental illness and are less likely to have insurance. Public insurance expansions can allow such populations to obtain insurance coverage and, in turn, receive effective treatment for mental illness. We examined the effect of a large-scale and recent public insurance expansion that covered mental illness services and prescription medications in the U.S. Specifically, we leveraged within-state variation in Medicaid eligibility generated by provisions in the ACA 2011-2016 to study changes in Medicaid-financed prescriptions for psychotropic medications obtained in outpatient settings.

We find that post-expansion the number of Medicaid-financed psychotropic prescriptions increased by 22% in expanding states relative to non-expanding states. This finding is similar to the findings of Ghosh et al (2017) who document a 19% increase using claims data. Given that we study a longer post-expansion period (by 21 months), our findings suggest that expansion effects are persisting, and perhaps increasing, over time. We identify heterogeneity in effects across psychotropic class: post-expansion prescriptions for anti-depressants and anti-anxiety medications increased by 34% and 25% in expanding states relative to non-expanding states while anti-psychotic, mood stabilizer, and stimulant prescriptions were unchanged.

While the SDUD will not allow us to explore the factors that lie behind the differential response by psychotropic class, we hypothesize that differences in patients, providers, and/or treatment access through charity care or other programs potentially drive these differences (Garfield et al., 2010). For example, patients receiving antipsychotics and mood stabilizers are likely to have more severe psychiatric disorders (e.g., schizophrenia, bipolar disorder), and face greater barriers to treatment access and medication adherence (e.g., cognitive, functional, logistical, social) (Wilder et al., 2010). Individuals with depressive and anxiety disorders may be more able or more highly motivated to seek treatment. Because psychotropic medications require a prescription from a healthcare provider, our findings imply that newly eligible beneficiaries were able to meet with a healthcare provider within the complex outpatient mental healthcare system. This level of self-management would likely be more challenging for individuals with severe psychiatric disorders. Alternatively, a proportion of individuals with severe psychiatric disorders may have had insurance pre-expansion through other programs (e.g. disability benefits, charity care), thus moving pre-expansion medication access higher.

We identify heterogeneity in effects by state pre-ACA characteristics that proxy for patient need and system capacity. Effects generally were larger in states with high need for mental illness treatment, low access to primary care, high smoking rates, low SUD prevalence, and high uninsurance. Our analysis suggests that increases in medication prescriptions were primarily financed by Medicaid and not patients, likely due to low cost-sharing within Medicaid.

Our findings contribute to the growing literature investigating the effects of the ACA-related Medicaid expansions. In line with previous research we show that these expansions increased use of healthcare services (Ghosh et al., 2017, Sommers et al., 2016, Miller and Wherry, 2017, Wherry and Miller, 2016, Maclean et al., 2017, Wen et al., 2017). In particular,

we document that individuals suffering from mental illnesses are also experiencing these increases in healthcare service use.

Our study has limitations. (i) We lack data on patients and providers, and cannot explore issues such as the appropriateness of care (i.e. evidence-based clinical indication for psychotropic medications), and the characteristics of patients obtaining prescriptions and the providers delivering such care. (ii) The SDUD does not include manufacturer rebates to states and thus we have error in our payment variables. (iii) We have information on a single payer.

Our analysis suggests that public insurance expansions allow low-income individuals with mental illnesses to access valuable healthcare services. Reforms that curtail such access could worsen health outcomes for such individuals and, given the established negative externalities associated with mental illness (Insel, 2008), have implications for broader society.

Table 1. Psychotropic medications

Class:	Medications
Antidepressant	Aplenzin, Budeprion, Bupropion, Celexa, Citalopram, Cymbalta, Duloxetine, Effexor, Escitalopram, Fluoxetine, Forfivo, Lexapro, Paroxetine, Paxil, Pexeva, Prozac, Rapiflux, Sarafem, Selfemra, Sertraline, Venlafaxine, Wellbutrin, and Zoloft.
Anti-anxiety	Alprazolam, Ativan, Buspar, Buspirone, Clonazepam, Klonopin, Lorazepam, Niravam, and Xanax.
Anti-psychotic	Abilify, Aripiprazole, Chlorpromazine, Clozapine, Clozaril, Etrafon, Fazaclo, Fluphenazine, Geodon, Haldol, Haloperidol, Invega, Latuda, Lurasidone, Olanzapine, Paliperidone, Perphenazine, Permitil, Prolixin, Quetiapine, Risperdal, Risperidone, Seroquel, Symbyax, Thorazine, Trilafon, Triavil, Ziprasidone, and Zyprexa.
Mood stabilizer	Depakene, Depakote, Divalproex sodium, Eskalith, Lamictal, Lamotrigine, Lithane, Lithium, Lithobid, Stavzor, Valproate sodium, and Valproic acid.
Stimulant	Adderall, Amphetamine, Aptensio, Concerta, Dexedrine, Dextroamphetamine, Dextrostat, Lisdexamfetamine, Metadate, Methylin, Methylphenidate, Procentra, Quillichew, Quillivant, Ritalin, and Vyvanse.

Notes: Data source is National Institute of Mental Health: https://www.nimh.nih.gov/health/topics/mental-health-medications/index.shtml and Medline websites (https://www.medline.com/) for specific medications (e.g., Aplenzin) embedded in the website (both websites accessed June 10th, 2017). Overall psychotropic medications include the union of the classes listed in this table. More details available on request from the corresponding author.

Table 2. State Medicaid eligibility expansions

State:	Medicaid expansion date
States with substantial expansions before 2011	
Delaware	Before 2011
District of Columbia	Before 2011
Massachusetts	Before 2011
New York	Before 2011
Vermont	Before 2011
States with substantial expansions in 2011-2014	
Arizona [a,b]	1/1/2014
Arkansas	1/1/2014
California [c]	1/1/2014
Colorado	1/1/2014
Connecticut [d]	1/1/2014
Hawaii [b]	1/1/2014
Illinois	1/1/2014
Iowa	1/1/2014
Kentucky	1/1/2014
Maryland	1/1/2014
Michigan	4/1/2014
Minnesota [d]	1/1/2014
Nevada	1/1/2014
New Hampshire	8/15/2014
New Jersey [d]	1/1/2014
New Mexico	1/1/2014
North Dakota	1/1/2014
Ohio [b]	1/1/2014
Oregon	1/1/2014
Rhode Island [b]	1/1/2014
Washington [e]	1/1/2014
West Virginia	1/1/2014
Late expansion states (post-2014)	
Alaska	9/1/2015
Indiana	2/1/2015
Montana [f]	1/1/2016
Louisiana [f]	7/1/2016
Pennsylvania	1/1/2015

Notes: Medicaid expansion dates derived from Simon et al. (2017). 'Substantial' expansions covered both parents and childless adults up to at least 100% FPL, were open to new enrollees, and had full Medicaid benefits.

[a] Expanded eligibility prior to 2011 but closed to new enrollees in 2011.

[b] Excluded, with Virginia, from the analysis due to data quality issues.

[c] From 2011 through 2013, some but not all California counties expanded eligibility, and income eligibility thresholds varied by county.

[d] Expanded eligibility prior to 2014 but with low eligibility thresholds.

[e] Expanded eligibility prior to 2014 but only to people who had previously enrolled in a state program.

[f] Non-expansion during the entire study period, 2011-2015.

Table 3. Summary statistics for expansion and non-expansion states: SDUD 2011-2013

Sample:	Expansion states	Non-expansion states	Difference (*p*-value)*
Mental illness prescriptions per 100,000			
All medications	9,641	9,169	0.1863
Depression medications	2,940	2,702	0.0621
Anxiety medications	2,598	2,327	0.0305
Ant-psychotic medications	2,034	1,839	0.0011
Mood stabilizer medications	1,239	1,496	0.0005
Stimulant medications	830	806	0.3852
State-year level characteristics			
Unemployment rate	7.643	7.204	0.0103
Poverty rate	13.80	14.82	0.0013
Family income ($)	80,104	70,357	0.0000
Age	38.07	37.50	0.0001
Female	0.505	0.507	0.0010
Male	0.495	0.493	0.0010
White	0.714	0.719	0.7317
African American	0.085	0.130	0.0000
Other race	0.082	0.055	0.0000
Hispanic	0.118	0.096	0.0205
Less than high school	0.311	0.327	0.0000
High school	0.295	0.296	0.6089
Some college	0.193	0.197	0.0192
College degree	0.201	0.180	0.0000
Democrat governor	0.565	0.098	0.0000
Max monthly TANF benefit for a family of 4 ($)	556.8	395.0	0.0000
Minimum wage (S)	8.080	7.723	0.0000
EITC (state-to-federal ratio)	0.066	0.017	0.0000
Observations	276	204	--

Notes: Unit of observation is the state-year-quarter. States with substantial expansions before 2011 excluded from the analysis (see Table 2).
*Two-tailed *t*-tests applied.

Table 4. Parallel trends test for psychotropic medication prescriptions: SDUD 2011-2013

Outcome:	**Prescriptions**
Mean value in expansion states, pre-expansion	9,641
All medications	-49
	(48)
Mean value in expansion states, pre-expansion	2,940
Depression medications	-1
	(17)
Mean value in expansion states, pre-expansion	2,598
Anti-anxiety medications	-14
	(28)
Mean value in expansion states, pre-expansion	2,034
Anti-psychotic medications	-5
	(6)
Mean value in expansion states, pre-expansion	1,239
Mood stabilizer medications	-31**
	(12)
Mean value in expansion states, pre-expansion	
Stimulant medications	1
	(3)
Observations	480

Notes: Unit of observation is the state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. All models control for demographics, social policies, and state and period fixed effects. Standard errors are clustered at the state level and are reported in parentheses. States with substantial expansions before 2011 excluded from the analysis (see Table 2).

***,**,* = statistically different from zero at the 1%,5%,10% level.

Table 5. Effect of Medicaid expansion on psychotropic medication prescriptions using differences-in-differences models: SDUD 2011-2016

Outcome:	**Prescriptions**
Mean value in expansion states, pre-expansion	9,641
All medications	2,076**
	(913)
Mean value in expansion states, pre-expansion	2,940
Depression medications	1,004***
	(370)
Mean value in expansion states, pre-expansion	2,598
Anti-anxiety medications	647***
	(235)
Mean value in expansion states, pre-expansion	2,034
Anti-psychotic medications	212
	(198)
Mean value in expansion states, pre-expansion	1,239
Mood stabilizer medications	83
	(96)
Mean value in expansion states, pre-expansion	830
Stimulant medications	130
	(86)
Observations	1,080

Notes: Unit of observation is the state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. All models control for demographics, social policies, state and period fixed effects, and state-specific linear time trends. Standard errors are clustered at the state level and are reported in parentheses.
***,**;* = statistically different from zero at the 1%,5%, 10% level.

Table 6. Effect of Medicaid expansion on psychotropic medication prescription payments using differences-in-differences models: SDUD 2011-2016

Outcome:	Total payments	Medicaid payments	Non-Medicaid payments
Mean value in expansion states, pre-expansion	$41,584,276	$40,286,436	$1,297,840
All medications	3,808,271	4,136,150	-327,880
	(3,020,319)	(2,945,167)	(240,579)
Mean value in expansion states, pre-expansion	$4,991,200	$4,884,278	$106,922
Depression medications	521,055*	543,814*	-22,760
	(288,031)	(288,643)	(18,519)
Mean value in expansion states, pre-expansion	$873,554	$844,733	$28,821
Anti-anxiety medications	149,690***	143,240***	6,450
	(45,542)	(45,617)	(21,764)
Mean value in expansion states, pre-expansion	$27,361,517	$26,595,418	$766,099
Anti-psychotic medications	2,581,007	2,814,623	-233,617
	(2,420,894)	(2,360,065)	(143,044)
Mean value in expansion states, pre-expansion	$6,524,606	$6,239,572	$285,034
Mood stabilizer medications	423,470	468,847	-45,377
	(713,954)	(674,657)	(76,855)
Mean value in expansion states, pre-expansion	$1,833,399	$1,722,436	$110,964
Stimulant medications	133,048	165,625	-32,577
	(207,823)	(205,416)	(20,551)
Observations	1,080	1,080	1,080

Notes: Unit of observation is the state-year-quarter. All models control for demographics, social policies, the state population ages 18 to 64 years, state and period fixed effects, and state-specific linear time trends. Standard errors are clustered at the state level and are reported in parentheses.

***,**,* = statistically different from zero at the 1%,5%, 10% level.

Appendix Table 1. Heterogeneity in Medicaid expansion effects on psychotropic medication prescriptions by need for mental illness healthcare using differences-in-differences models: SDUD 2011-2016

Outcome:	**Prescriptions**
Sample: High mental illness care need states	
Mean value in expansion states, pre-expansion	10,090
All medications	2,349***
	(694)
Mean value in expansion states, pre-expansion	3,105
Depression medications	1,265***
	(301)
Mean value in expansion states, pre-expansion	2,775
Anti-anxiety medications	725***
	(205)
Mean value in expansion states, pre-expansion	1,969
Anti-psychotic medications	169
	(110)
Mean value in expansion states, pre-expansion	1,405
Mood stabilizer medications	54
	(95)
Mean value in expansion states, pre-expansion	837
Stimulant medications	136**
	(57)
Observations	552
Sample: Low mental illness care need states	
Mean value in expansion states, pre-expansion	9,056
All medications	1,901
	(1,333)
Mean value in expansion states, pre-expansion	2,725
Depression medications	703
	(553)
Mean value in expansion states, pre-expansion	2,369
Anti-anxiety medications	481
	(315)
Mean value in expansion states, pre-expansion	2,118
Anti-psychotic medications	290
	(251)
Mean value in expansion states, pre-expansion	1,024
Mood stabilizer medications	287*
	(160)
Mean value in expansion states, pre-expansion	820
Stimulant medications	140
	(124)
Observations	528

Notes: Unit of observation is the state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. All models control for demographics, social policies, state and period fixed effects, and state-specific linear time trends. Standard errors are clustered at the state level and are reported in parentheses. Need for mental illness treatment calculated using National Survey of Drug Use and Health 2009/2010 state-level data.
***,**,* = statistically different from zero at the 1%,5%, 10% level.

Appendix Table 2. Heterogeneity in Medicaid expansion effects on psychotropic medication prescriptions by access to primary care using differences-in-differences models: SDUD 2011-2016

Outcome:	**Prescriptions**
Sample: High primary care access states	
Mean value in expansion states, pre-expansion	8,755
All medications	1,105
	(808)
Mean value in expansion states, pre-expansion	2,812
Depression medications	600**
	(283)
Mean value in expansion states, pre-expansion	2,230
Anti-anxiety medications	366**
	(170)
Mean value in expansion states, pre-expansion	1,911
Anti-psychotic medications	27
	(173)
Mean value in expansion states, pre-expansion	1,028
Mood stabilizer medications	77
	(135)
Mean value in expansion states, pre-expansion	773
Stimulant medications	36
	(77)
Observations	528
Sample: Low primary care access states	
Mean value in expansion states, pre-expansion	11,018
All medications	1,851
	(1,157)
Mean value in expansion states, pre-expansion	3,138
Depression medications	998*
	(507)
Mean value in expansion states, pre-expansion	3,171
Anti-anxiety medications	697**
	(320)
Mean value in expansion states, pre-expansion	2,225
Anti-psychotic medications	204
	(224)
Mean value in expansion states, pre-expansion	1,567
Mood stabilizer medications	-165
	(128)
Mean value in expansion states, pre-expansion	917
Stimulant medications	117
	(99)
Observations	552

Notes: Unit of observation is the state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. All models control for demographics, social policies, state and period fixed effects, and state-specific linear time trends. Standard errors are clustered at the state level and are reported in parentheses. Access to primary care calculated using CMS and Area Resource File 2010 data.

***,**,* = statistically different from zero at the 1%,5%, 10% level.

Appendix Table 3. Heterogeneity in Medicaid expansion effects on psychotropic medication prescriptions by smoking status using differences-in-differences models: SDUD 2011-2016

Outcome:	**Prescriptions**
Sample: High smoking rate states	
Mean value in expansion states, pre-expansion	10,445
All medications	2,594**
	(1,000)
Mean value in expansion states, pre-expansion	3,007
Depression medications	1,261***
	(405)
Mean value in expansion states, pre-expansion	2,897
Anti-anxiety medications	864***
	(288)
Mean value in expansion states, pre-expansion	2,179
Anti-psychotic medications	240
	(163)
Mean value in expansion states, pre-expansion	1,471
Mood stabilizer medications	83
	(121)
Mean value in expansion states, pre-expansion	892
Stimulant medications	146*
	(77)
Observations	576
Sample: Low smoking rate states	
Mean value in expansion states, pre-expansion	8,763
All medications	2,198*
	(1,191)
Mean value in expansion states, pre-expansion	2,866
Depression medications	1,007*
	(526)
Mean value in expansion states, pre-expansion	2,273
Anti-anxiety medications	452
	(308)
Mean value in expansion states, pre-expansion	1,876
Anti-psychotic medications	404*
	(213)
Mean value in expansion states, pre-expansion	986
Mood stabilizer medications	130
	(148)
Mean value in expansion states, pre-expansion	762
Stimulant medications	204*
	(104)
Observations	504

Notes: Unit of observation is the state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. All models control for demographics, social policies, state and period fixed effects, and state-specific linear time trends. Standard errors are clustered at the state level and are reported in parentheses. Smoking rates calculated using Behavioral Risk Factor Surveillance Survey 2010 data.
***,**,* = statistically different from zero at the 1%,5%,10% level.

Appendix Table 4. Heterogeneity in Medicaid expansion effects on psychotropic medication prescriptions by SUD prevalence using differences-in-differences models: SDUD 2011-2016

Outcome:	**Prescriptions**
Sample: High SUD prevalence states	
Mean value in expansion states, pre-expansion	8,384
All medications	-317
	(886)
Mean value in expansion states, pre-expansion	2,611
Depression medications	190
	(362)
Mean value in expansion states, pre-expansion	2,193
Anti-anxiety medications	8
	(189)
Mean value in expansion states, pre-expansion	1,859
Anti-psychotic medications	-293
	(233)
Mean value in expansion states, pre-expansion	986
Mood stabilizer medications	-132
	(129)
Mean value in expansion states, pre-expansion	735
Stimulant medications	-90
	(92)
Observations	528
Sample: Low SUD prevalence states	
Mean value in expansion states, pre-expansion	11,012
All medications	3,637***
	(1,023)
Mean value in expansion states, pre-expansion	3,298
Depression medications	1,597***
	(453)
Mean value in expansion states, pre-expansion	3,041
Anti-anxiety medications	1,034***
	(307)
Mean value in expansion states, pre-expansion	2,224
Anti-psychotic medications	463***
	(154)
Mean value in expansion states, pre-expansion	1,516
Mood stabilizer medications	278*
	(136)
Mean value in expansion states, pre-expansion	933
Stimulant medications	264***
	(76)
Observations	552

Notes: Unit of observation is the state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. All models control for demographics, social policies, state and period fixed effects, and state-specific linear time trends. Standard errors are clustered at the state level and are reported in parentheses. SUD prevalence rates calculated using National Survey of Drug Use and Health 2009/2010 state-level data.
***,**,* = statistically different from zero at the 1%,5%,10% level.

Appendix Table 5. Heterogeneity in Medicaid expansion effects on psychotropic medication prescriptions by uninsurance rate using differences-in-differences models: SDUD 2011-2016

Outcome:	**Prescriptions**
Sample: High uninsurance rate states	
Mean value in expansion states, pre-expansion	9,355
All medications	2,742**
	(1,088)
Mean value in expansion states, pre-expansion	2,784
Depression medications	1,302***
	(447)
Mean value in expansion states, pre-expansion	2,572
Anti-anxiety medications	840***
	(274)
Mean value in expansion states, pre-expansion	1,972
Anti-psychotic medications	288
	(237)
Mean value in expansion states, pre-expansion	1,202
Mood stabilizer medications	147
	(97)
Mean value in expansion states, pre-expansion	825
Stimulant medications	165
	(106)
Observations	600
Sample: Low uninsurance rate states	
Mean value in expansion states, pre-expansion	10,012
All medications	1,918**
	(690)
Mean value in expansion states, pre-expansion	3,142
Depression medications	842***
	(222)
Mean value in expansion states, pre-expansion	2,633
Anti-anxiety medications	461**
	(181)
Mean value in expansion states, pre-expansion	2,115
Anti-psychotic medications	269*
	(137)
Mean value in expansion states, pre-expansion	1,287
Mood stabilizer medications	189
	(160)
Mean value in expansion states, pre-expansion	835
Stimulant medications	158**
	(64)
Observations	480

Notes: Unit of observation is the state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. All models control for demographics, social policies, state and period fixed effects, and state-specific linear time trends. Standard errors are clustered at the state level and are reported in parentheses. Uninsurance rates calculated using the American Community Survey 2010 data.

***,**,* = statistically different from zero at the 1%,5%,10% level.

Appendix Table 6. Effect of Medicaid expansion on psychotropic medication prescriptions using differences-in-differences models using population weights: SDUD 2011-2016

Outcome:	**Prescriptions**
Mean value in expansion states, pre-expansion	8,928
All medications	2,538***
	(819)
Mean value in expansion states, pre-expansion	2,720
Depression medications	1,111***
	(344)
Mean value in expansion states, pre-expansion	2,440
Anti-anxiety medications	685***
	(196)
Mean value in expansion states, pre-expansion	2,032
Anti-psychotic medications	369**
	(166)
Mean value in expansion states, pre-expansion	956
Mood stabilizer medications	182*
	(91)
Mean value in expansion states, pre-expansion	780
Stimulant medications	191**
	(77)
Observations	1,080

Notes: State populations ages 18 to 64 years serve as the weights. Unit of observation is the state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. All models control for demographics, social policies, state and period fixed effects, and state-specific linear time trends. Standard errors are clustered at the state level and are reported in parentheses.

***,**,* = statistically different from zero at the 1%,5%,10% level.

Appendix Table 7. Effect of Medicaid expansion on psychotropic medication prescriptions using differences-in-differences models with different controls for between-state differences: SDUD 2011-2016

Model:	**(1)**	**(2)**	**(3)**	**(4)**
Mean value in expansion states, pre-expansion	9,641	9,641	9,641	9,641
All medications	2,076**	2,070**	1,517*	1,618**
	(913)	(948)	(872)	(642)
Mean value in expansion states, pre-expansion	2,940	2,940	2,940	2,940
Depression medications	1,004***	1,240***	798**	840***
	(370)	(387)	(358)	(292)
Mean value in expansion states, pre-expansion	2,598	2,598	2,598	2,598
Anti-anxiety medications	647***	702***	519**	570***
	(235)	(222)	(211)	(198)
Mean value in expansion states, pre-expansion	2,034	2,034	2,034	2,034
Anti-psychotic medications	212	141	119	125
	(198)	(193)	(176)	(116)
Mean value in expansion states, pre-expansion	1,239	1,239	1,239	1,239
Mood stabilizer medications	83	-150	-7	-5
	(96)	(139)	(105)	(77)
Mean value in expansion states, pre-expansion	830	830	830	830
Stimulant medications	130	137	88	88
	(86)	(89)	(78)	(54)
Observations	1,080	1,080	1,080	1,080

Notes: The outcome variable in each regression is the number of prescription fills and refills. Unit of observation is the state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. Standard errors are clustered at the state level and are reported in parentheses. Model (1) controls for demographics, social policies, state and period fixed effects, and state-specific linear time trends (baseline mode, see Equation [1] in the manuscript text for more details). Model (2) controls for demographics, social policies, and state and period fixed effects. Model (3) controls for demographics, social policies, state and period fixed effects, and state-specific quadratic time trends. Model (4) controls for demographics, social policies, state and period fixed effects, state-specific linear time trends, and extended set of state-level controls.

***,**,* = statistically different from zero at the 1%,5%,10% level.

Appendix Table 8. Effect of Medicaid expansion on psychotropic medication prescriptions using differences-in-differences models using the population 18 years+ as the denominator: SDUD 2011-2016

Outcome:	**Prescriptions**
Mean value in expansion states, pre-expansion	7,870
All medications	1,659**
	(719)
Mean value in expansion states, pre-expansion	2,400
Depression medications	803***
	(292)
Mean value in expansion states, pre-expansion	2,119
Anti-anxiety medications	514***
	(184)
Mean value in expansion states, pre-expansion	1,664
Anti-psychotic medications	170
	(157)
Mean value in expansion states, pre-expansion	1,009
Mood stabilizer medications	68
	(76)
Mean value in expansion states, pre-expansion	678
Stimulant medications	104
	(68)
Observations	1,080

Notes: Unit of observation is the state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 years and older. All models control for demographics, social policies, state and period fixed effects, and state-specific linear time trends. Standard errors are clustered at the state level and are reported in parentheses. ***,**,* = statistically different from zero at the 1%,5%,10% level.

Appendix Table 9. Effect of Medicaid expansion on psychotropic medication prescriptions using differences-in-differences models using alternative Medicaid expansion coding schemes: SDUD 2011-2016

Medicaid expansion coding scheme:	**Maclean & Saloner**	**Wherry & Miller**
Mean value in expansion states, pre-expansion	10,774	9,641
All medications	1,606	2,262***
	(1,012)	(813)
Mean value in expansion states, pre-expansion	3,319	2,940
Depression medications	787*	1,078***
	(411)	(329)
Mean value in expansion states, pre-expansion	2,932	2,598
Anti-anxiety medications	517*	702***
	(259)	(217)
Mean value in expansion states, pre-expansion	2,164	2,034
Anti-psychotic medications	118	204
	(216)	(176)
Mean value in expansion states, pre-expansion	1,452	1,239
Mood stabilizer medications	102	146*
	(97)	(86)
Mean value in expansion states, pre-expansion	907	830
Stimulant medications	82	131*
	(94)	(77)
Observations	1,080	960

Notes: Unit of observation is the state-year-quarter. See text for a discussion of the alternative Medicaid expansion coding schemes. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. All models control for demographics, social policies, state and period fixed effects, and state-specific linear time trends. Standard errors are clustered at the state level and are reported in parentheses.

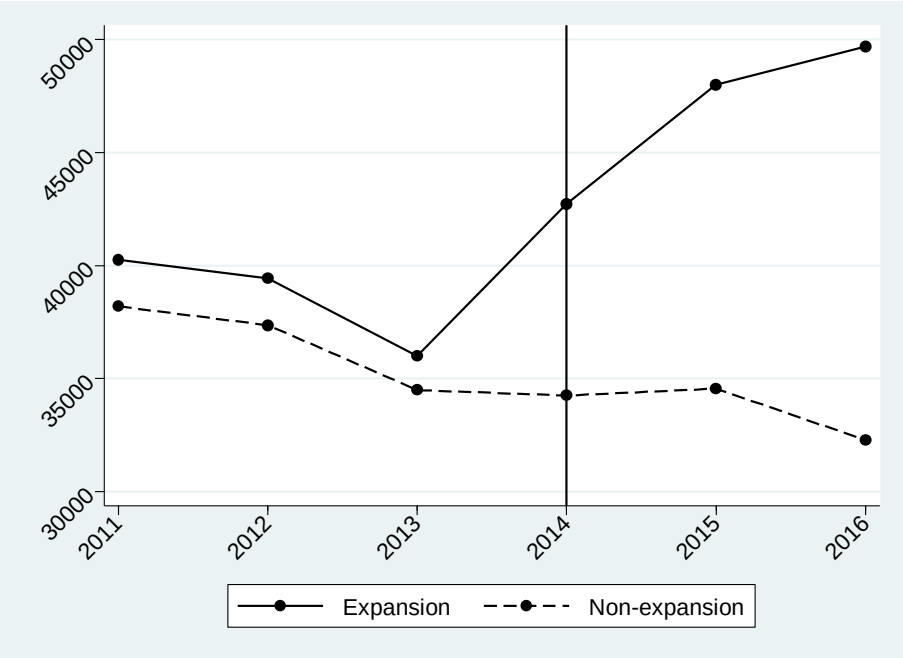
***,**;* = statistically different from zero at the 1%,5%, 10% level.

Appendix Table 10. Effect of Medicaid expansion on psychotropic medication prescriptions using differences-in-differences models using alternative functional forms: SDUD 2011-2016

Functional form:	Non-transformed LS	Logged model	Poisson model
Mean value in expansion states, pre-expansion	356,035	9,641	356,035
All medications	61,719***	0.095	73,179***
	(19,370)	(0.080)	(25,422)
Mean value in expansion states, pre-expansion	108,453	2,940	108,453
Depression medications	29,439***	0.195**	31,268***
	(8,140)	(0.082)	(9,643)
Mean value in expansion states, pre-expansion	97,321	2,598	97,321
Anti-anxiety medications	19,141***	0.170**	23,804***
	(6,492)	(0.082)	(6,716)
Mean value in expansion states, pre-expansion	81,017	2,034	81,017
Anti-psychotic medications	6,962**	-0.008	10,031**
	(2,594)	(0.088)	(4,628)
Mean value in expansion states, pre-expansion	38,127	1,239	38,127
Mood stabilizer medications	2,250	-0.016	3,666
	(2,806)	(0.082)	(3,269)
Mean value in expansion states, pre-expansion	31,118	830	31,118
Stimulant medications	3,927***	0.045	5,023**
	(1,138)	(0.082)	(2,253)
Observations	1,080	1,080	1,080

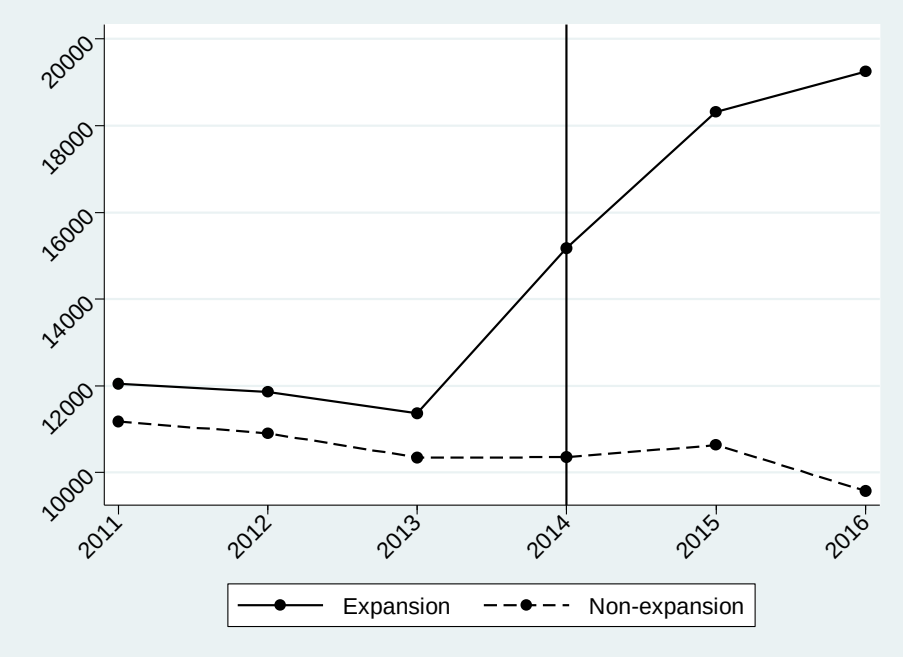
Notes: Unit of observation is the state-year-quarter. Non-transformed LS regression controls for the state population ages 18 to 64 years. Logged model outcomes are converted to a rate per 100,000 persons 18 to 64 years and the natural logarithm transformation is applied to this rate. Average marginal effects are reported in Poisson models rather than beta coefficients, and the state population ages 18 to 64 years is the exposure variable. All models control for demographics, social policies, state and period fixed effects, and state-specific linear time trends. Standard errors are clustered at the state level and are reported in parentheses.
***,**;* = statistically different from zero at the 1%,5%, 10% level.

Figure 1. Trends in all psychotropic medication prescriptions in expansion and non-expansion states: SDUD 2011-2016



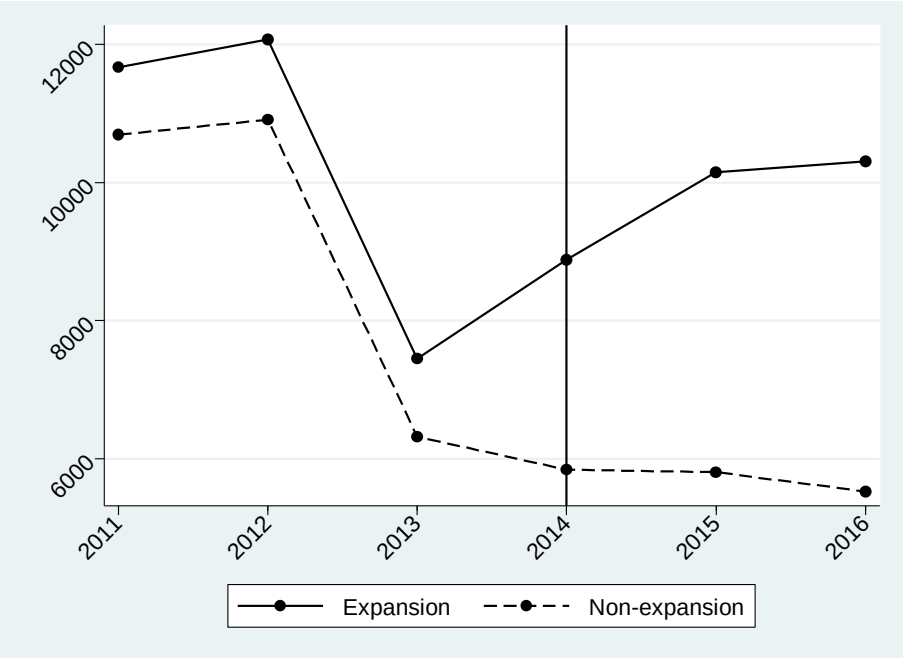
Notes: Data is aggregated to the treatment-year level.

Figure 2. Trends in depression medication prescriptions in expansion and non-expansion states: SDUD 2011-2016



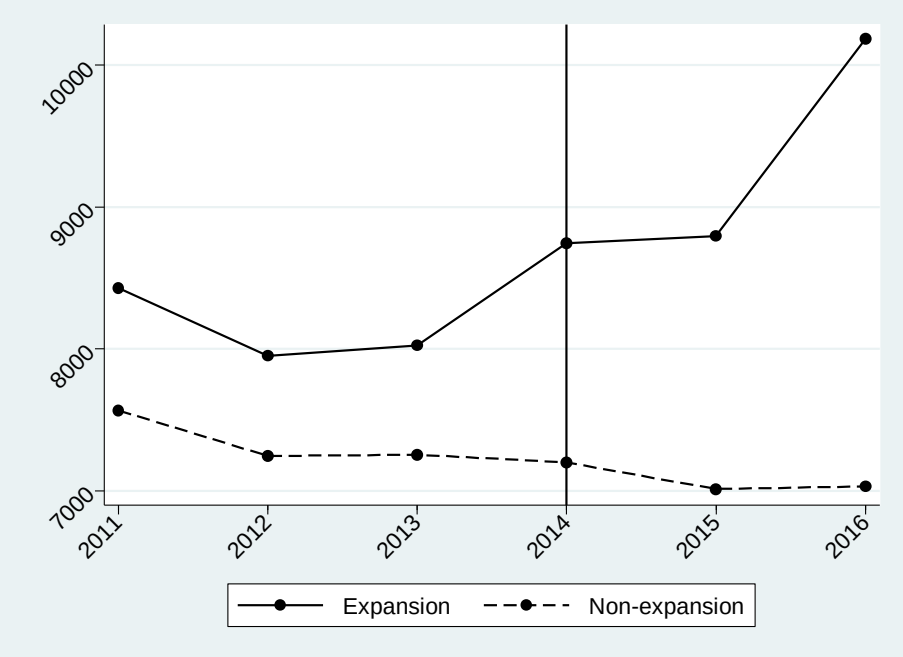
Notes: Data is aggregated to the treatment-year level.

Figure 3. Trends in anti-anxiety medication prescriptions in expansion and non-expansion states: SDUD 2011-2016



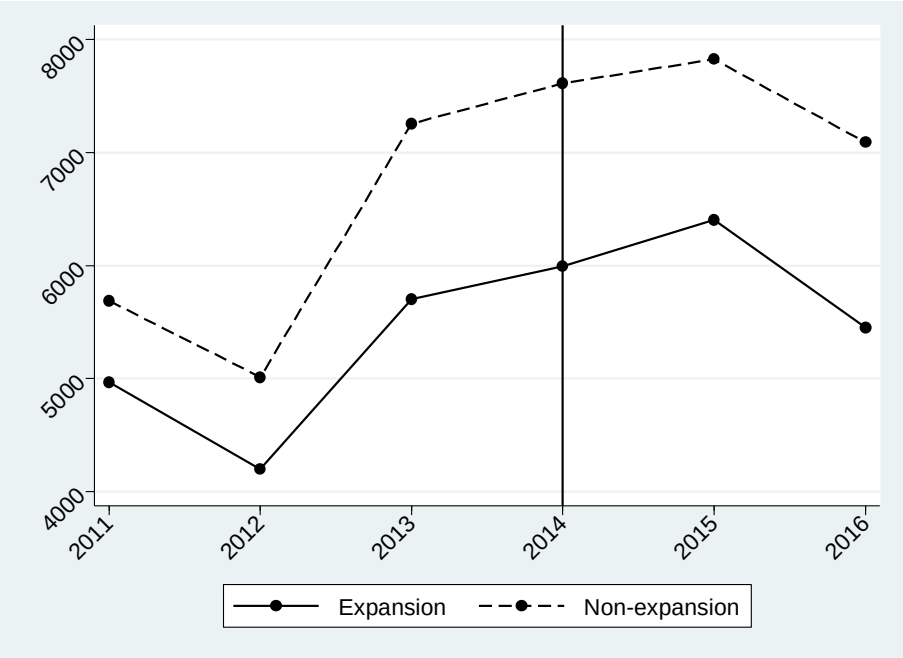
Notes: Data is aggregated to the treatment-year level.

Figure 4. Trends in anti-psychotic medication prescriptions in expansion and non-expansion states: SDUD 2011-2016



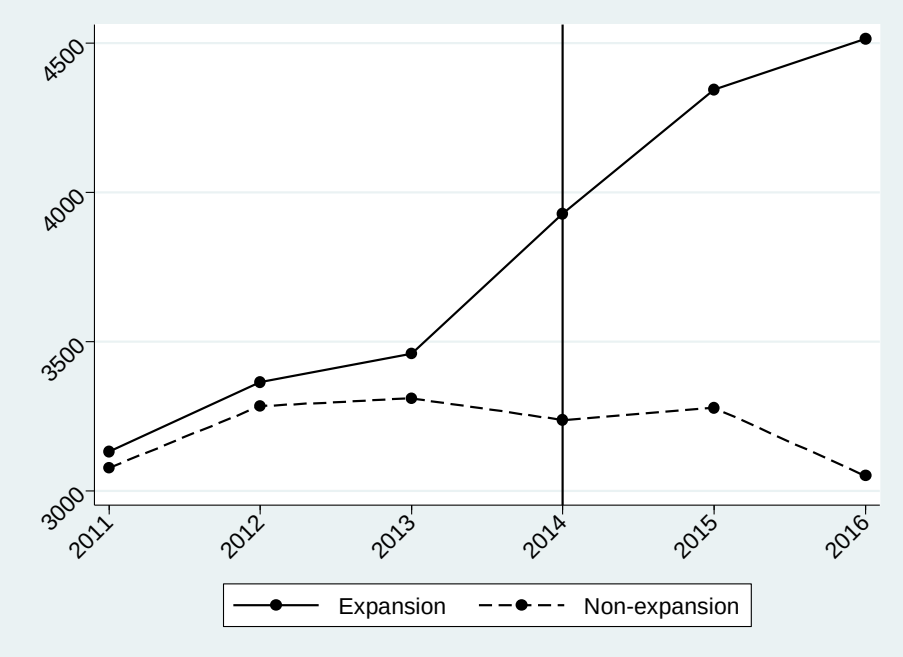
Notes: Data is aggregated to the treatment-year level.

Figure 5. Trends in mood stabilizer medication prescriptions in expansion and non-expansion states: SDUD 2011-2016



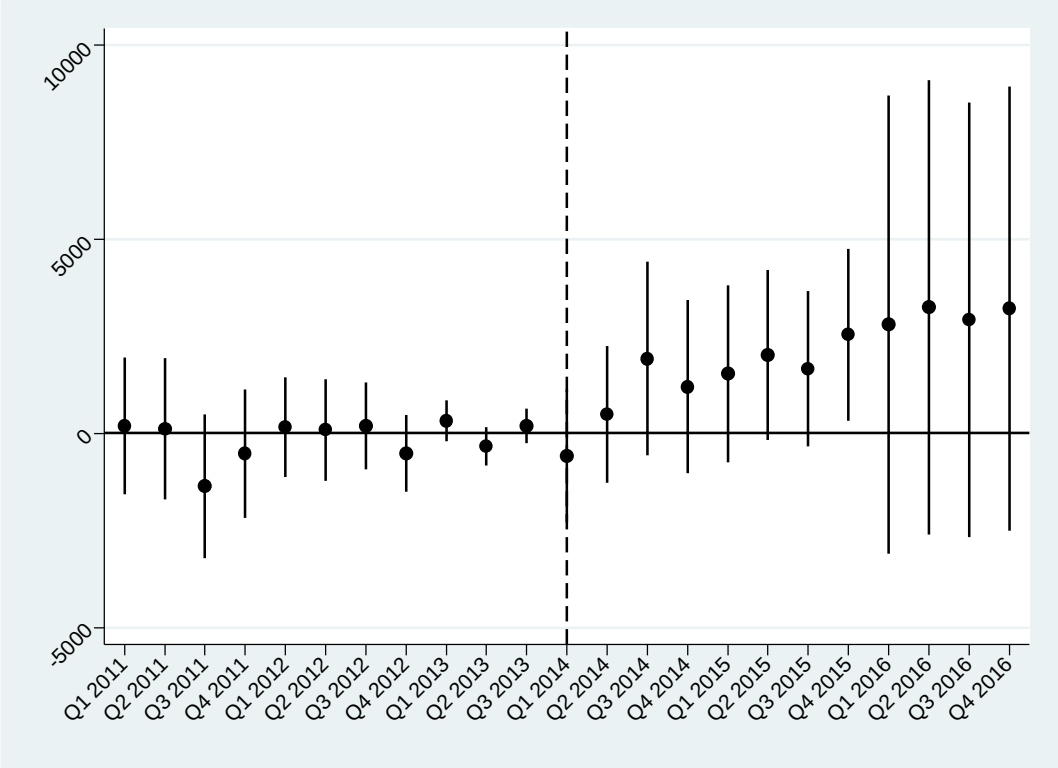
Notes: Data is aggregated to the treatment-year level.

Figure 6. Trends in stimulant medication prescriptions in expansion and non-expansion states: SDUD 2011-2016



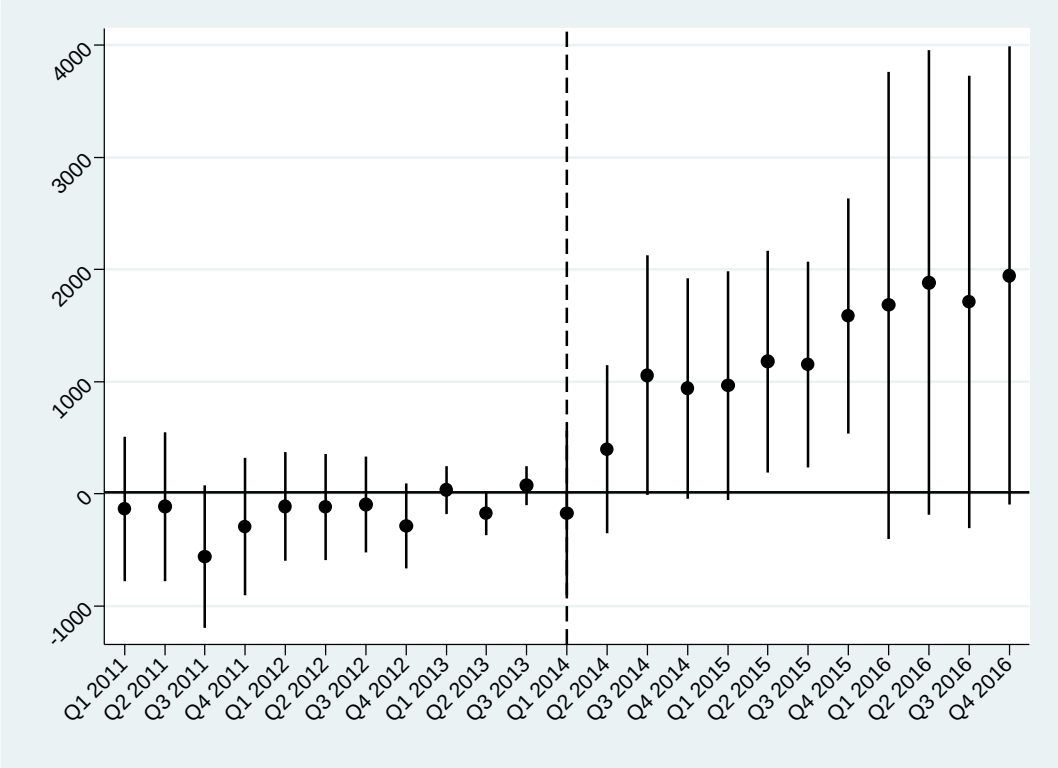
Notes: Data is aggregated to the treatment-year level.

Figure 7. Effect of Medicaid expansions on psychotropic medication prescriptions per 100,000 using an event study model: SDUD 2011-2016



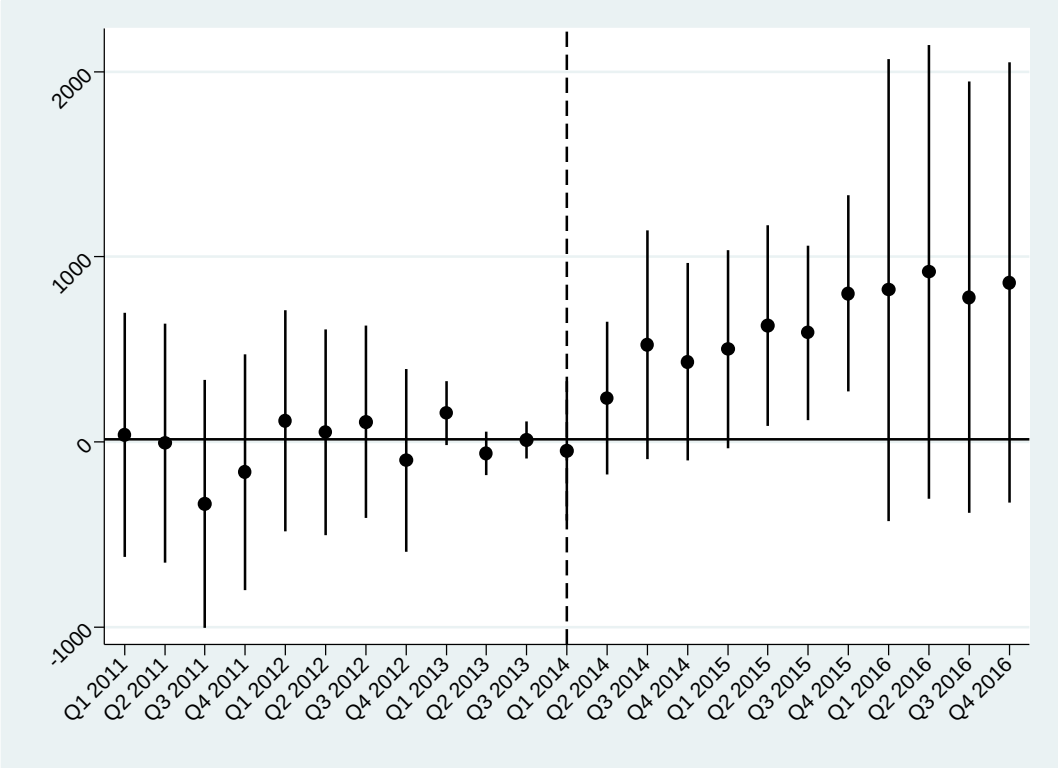
Notes: Unit of observation is a state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. Event study dummy variables include each year-quarter cell between Q1 2011 and Q4 2016, the omitted category is Q4 2013. All models control for demographics, social policies, and state and period fixed effects. 95% confidence intervals account for state-level clustering and are reported in vertical bars. States with substantial expansions before 2011 excluded from the analysis (see Table 2). N=960.

Figure 8. Effect of Medicaid expansions on depression medication prescriptions per 100,000 using an event study model: SDUD 2011-2016



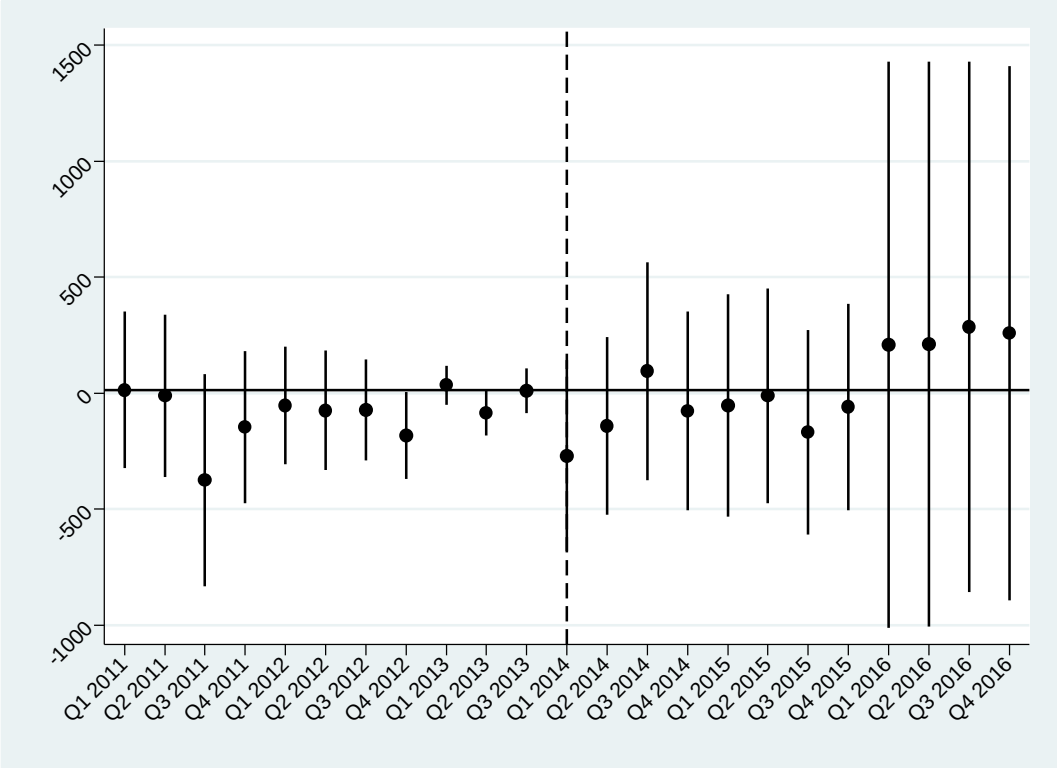
Notes: Unit of observation is a state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. Event study dummy variables include each year-quarter cell between Q1 2011 and Q4 2016, the omitted category is Q4 2013. All models control for demographics, social policies, and state and period fixed effects. 95% confidence intervals account for state-level clustering and are reported in vertical bars. States with substantial expansions before 2011 excluded from the analysis (see Table 2). N=960.

Figure 9. Effect of Medicaid expansions on anti-anxiety medication prescriptions per 100,000 using an event study model: SDUD 2011-2016



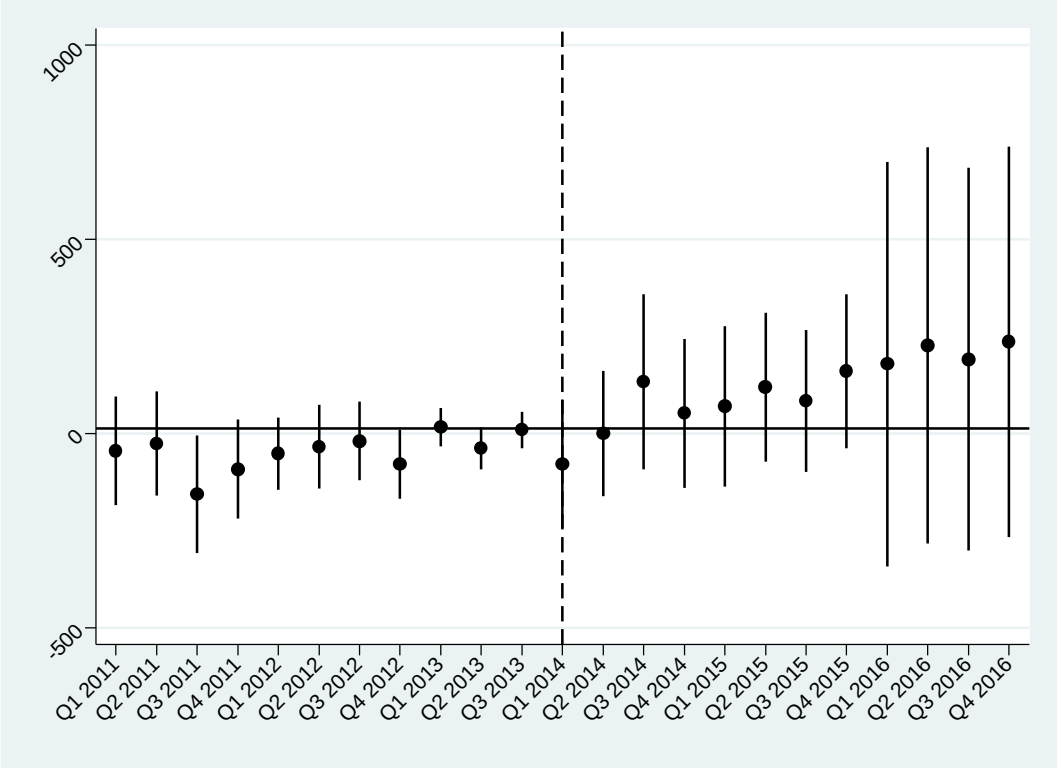
Notes: Unit of observation is a state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. Event study dummy variables include each year-quarter cell between Q1 2011 and Q4 2016, the omitted category is Q4 2013. All models control for demographics, social policies, and state and period fixed effects. 95% confidence intervals account for state-level clustering and are reported in vertical bars. States with substantial expansions before 2011 excluded from the analysis (see Table 2). N=960.

Figure 10. Effect of Medicaid expansions on anti-psychotic medication prescriptions per 100,000 using an event study model: SDUD 2011-2016



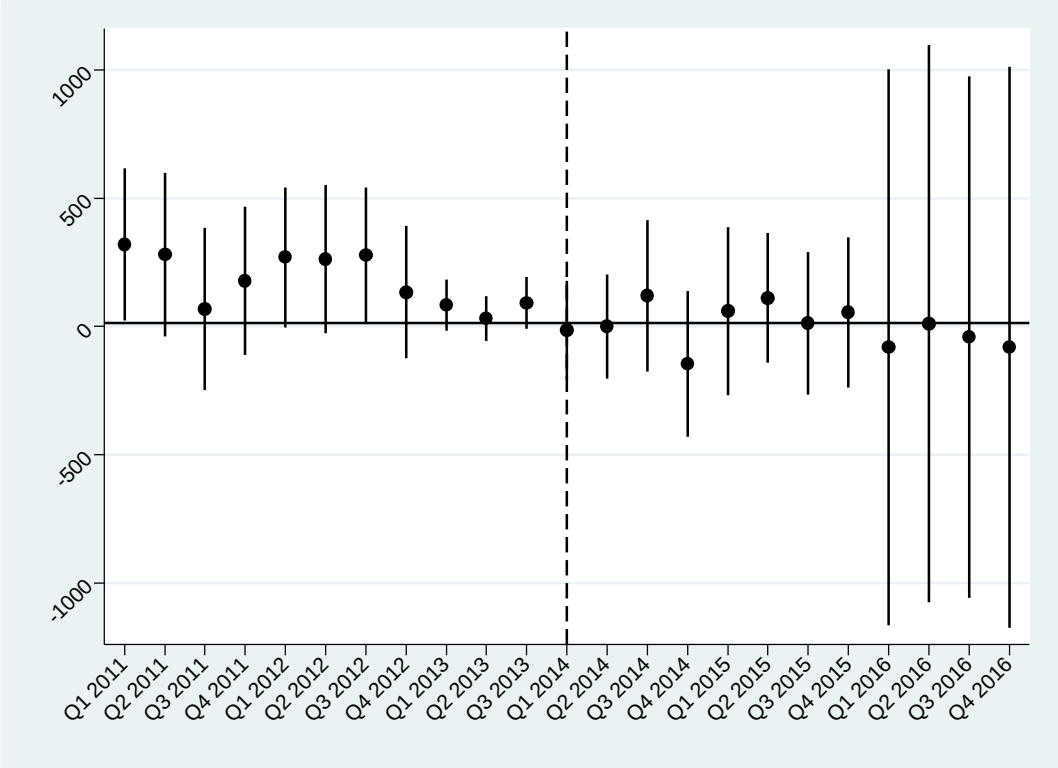
Notes: Unit of observation is a state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. Event study dummy variables include each year-quarter cell between Q1 2011 and Q4 2016, the omitted category is Q4 2013. All models control for demographics, social policies, and state and period fixed effects. 95% confidence intervals account for state-level clustering and are reported in vertical bars. States with substantial expansions before 2011 excluded from the analysis (see Table 2). N=960.

Figure 11. Effect of Medicaid expansions on mood stabilizer medication prescriptions per 100,000 using an event study model: SDUD 2011-2016



Notes: Unit of observation is a state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. Event study dummy variables include each year-quarter cell between Q1 2011 and Q4 2016, the omitted category is Q4 2013. All models control for demographics, social policies, and state and period fixed effects. 95% confidence intervals account for state-level clustering and are reported in vertical bars. States with substantial expansions before 2011 excluded from the analysis (see Table 2). N=960.

Figure 12. Effect of Medicaid expansions on stimulant medication prescriptions per 100,000 using an event study model: SDUD 2011-2016



Notes: Unit of observation is a state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. Event study dummy variables include each year-quarter cell between Q1 2011 and Q4 2016, the omitted category is Q4 2013. All models control for demographics, social policies, and state and period fixed effects. 95% confidence intervals account for state-level clustering and are reported in vertical bars. States with substantial expansions before 2011 excluded from the analysis (see Table 2). N=960.

Supplementary Table 1. Effect of Medicaid expansion on mental illness medication prescriptions using differences-in-differences models: SDUD 2011-2015

Outcome:	**Prescriptions**
Mean value in expansion states, pre-expansion	9,641
All medications	1,946***
	(542)
Mean value in expansion states, pre-expansion	2,940
Depression medications	966***
	(240)
Mean value in expansion states, pre-expansion	2,598
Anti-anxiety medications	552***
	(159)
Mean value in expansion states, pre-expansion	2,034
Anti-psychotic medications	196**
	(81)
Mean value in expansion states, pre-expansion	1239
Mood stabilizer medications	106
	(75)
Mean value in expansion states, pre-expansion	830
Stimulant medications	126***
	(39)
Observations	900

Notes: Unit of observation is the state-year-quarter. All outcomes are converted to a rate per 100,000 persons 18 to 64 years. All models control for demographics, social policies, state and period fixed effects, and state-specific linear time trends. Standard errors are clustered at the state level and are reported in parentheses.
***,**;* = statistically different from zero at the 1%,5%, 10% level.

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