Managing Drug Use Through Administrative Burden: Evidence from Medicaid[†]

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Abstract

Means-tested programs that allocate benefits to low-income individuals typically rely on administrative hurdles, rather than prices, to ration access. We study the impact of prior authorization, one of the most widely used non-price mechanisms for rationing prescription drug use in Medicaid. We introduce a Regression-Discontinuity (RD) design leveraging age-based discontinuities in prior authorization restrictions to isolate its impact from other features of insurance design. Children below (or above) a certain age must obtain prior authorization for the same drugs that children on the other side of the age cutoff can fill without prior authorization. These age cutoffs vary across plans within a state, providing a unique source of identification. We find significant reductions in prescription drug use and spending for ADHD drugs. Using novel plan-level data on prior authorization approval criteria, which allows us to identify patients eligible for treatment, we show that these effects are primarily driven by the administrative hassles of the prior authorization process rather than by improved targeting of treatment.

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1 Introduction

Means-tested programs that allocate benefits to low-income individuals have limited ability to use price-based rationing, as doing so would greatly restrict access for beneficiaries. Instead, these programs primarily rely on non-price instruments—eligibility verification, recertification and waiting costs—that raise the shadow price of access rather than the monetary price. While a large literature examines how these administrative burdens, or "ordeals," impact program take-up (Nichols and Zeckhauser 1982; Currie 2006; Finkelstein and Notowidigdo 2019; Shepard and Wagner 2025), far less attention has been paid to the administrative burdens that beneficiaries face after enrollment.

In this paper, we study prior authorization—a post-enrollment administrative ordeal—in Medicaid, the largest health care safety-net program. In Medicaid, the use of price instruments is especially constrained due to the low-income population served. However, the program must still address moral hazard in order to operate within public budget constraints. Medicaid programs are required by federal law to cover all drugs, but they have limited ability to steer patients to low-cost drugs through traditional cost-sharing incentives. Cost-sharing must be minimal for low-income Medicaid beneficiaries, thus there is often little or no difference in copays between preferred and non-preferred drugs. As a result, Medicaid programs rely on non-price rationing for managing drug use, with prior authorization being one of the most widely used mechanisms for controlling spending.[1] Survey evidence from the Kaiser Family Foundation suggests that Medicaid beneficiaries are twice as likely to face prior authorization hurdles compared to Medicare, with one in four beneficiaries experiencing a delay or denial before receiving treatment (Pollitz et al. 2023). Prior authorization has the potential to target the use of prescription drugs to patients who need them the most by requiring healthcare providers to obtain insurer approval before prescribing certain medications. However, it can also distort utilization by creating an administrative hassle for providers, thus reducing access to beneficial treatments.

Despite its widespread use, there is limited causal evidence on the effects of prior authorization in Medicaid. The limited evidence is partly because of the complexity and lack of transparency of the prior authorization process. Prior authorization is largely invisible to the

[1] Other non-price mechanisms commonly used in Medicaid are prescription caps, quantity limits, and step therapy.

Medicaid beneficiary: they typically do not encounter the prior authorization requirement until a prescription is delayed or denied. Moreover, specific clinical criteria for approval are privately maintained by individual insurers and are not standardized across plans. Empirical investigation is further complicated because prior authorization is typically implemented alongside other insurance design features, such as cost-sharing and physician reimbursement, making it difficult to isolate its effects.

We address these challenges by introducing a new Regression-Discontinuity (RD) approach to estimating the effects of prior authorization which leverages age discontinuities in prior authorization restrictions. In Pennsylvania, some Medicaid Managed Care (MMC) plans implement age cutoffs such that children below (or above) a certain age must obtain prior authorization for certain medications, while children on the other side of the cutoff can obtain the same medication without prior authorization. These age cutoffs vary across MMC plans, and some MMC plans do not use any age restrictions, providing treated and control plans within the state. We leverage this variation in prior authorization requirements across ages and MMC plans in a Difference in Discontinuity (RD-DD) framework. Estimating discontinuities in prescription use and spending at these age thresholds, compared to plans that do not have the same age cutoff, allows us to estimate the causal effect of prior authorization while holding fixed other aspects of insurance design that do not change discontinuously by age. The RD-DD framework also allows us to control for other age-related factors that may influence drug utilization such as changes in Medicaid eligibility and school entry age that affect all plans uniformly within the state. The presence of multiple age cutoffs allows us to examine the utilization effects at various ages, improving the generalizability of our estimates.

We use Pennsylvania's Medicaid claims data linked with administrative information on the MMC plans' drug formularies and detailed plan-level prior authorization approval criteria which we collected from the state through Freedom of Information Act (FOIA) requests. We study how prior authorization impacts prescription use and Medicaid spending in the months around the age-discontinuities in these policies. We further leverage the detailed prior authorization approval criteria, which allows us to identify patients who are likely appropriate for treatment. We use this to estimate whether reductions in prescribing are due to the hassle costs of the prior authorization process or the improved targeting of treatment. We further explore whether prior authorization

restrictions generate spillover effects on patients not subject to these policies through changes in physician prescribing behavior.

Our analysis focuses on prior authorization for attention-deficit/hyperactivity disorder (ADHD) drugs. We focus on ADHD because of its importance within Medicaid and because it is one of the most heavily regulated therapeutic areas through prior authorization. In 2017, ADHD drugs accounted for 6% of Medicaid prescription drug spending, making it one of the top spending categories (Young 2019). ADHD drug spending has grown substantially in recent years and the majority of this increase has been concentrated in the Medicaid population (Chorniy et al. 2018; Xu et al. 2018). Additionally, concerns over the inappropriate use of ADHD medications have heightened scrutiny of prescribing practices, underscoring the potential role of prior authorization in curbing inappropriate use or misuse (McCabe et al. 2023).

The paper has three parts. First, we begin by examining the impact of prior authorization on patients' use and spending for ADHD drugs. We find that prior authorization reduces the likelihood of ADHD medication use by 14.7% on average, with effects varying across age groups. Among patients who ultimately receive their medications, prior authorization delays prescription fills by 2.4 days and decreases the probability of same-day prescription fulfillment by 29.5%. These restrictions result in a 13.7% reduction in overall ADHD medication expenditures.

Second, we disentangle the mechanisms behind the reduction in prescription use. Prior authorization could affect drug use through two channels. On the one hand, prior authorization could directly reduce prescription drug use through improved targeting of treatment because the approval criteria limit the set of patients eligible for treatment. By denying coverage for individuals deemed ineligible, insurers aim to improve the efficiency of healthcare spending. We refer to this as the "*screening effect.*" On the other hand, prior authorization imposes administrative burdens, requiring the submission of detailed and often complex requests for approval. These procedural challenges can deter physicians from prescribing medications subject to prior authorization, ultimately reducing patient access to necessary treatments. We refer to this as the "*hassle cost effect.*" As insurers completely rely on physicians to provide supporting documentation to identify patients who need the drug most, the presence of hassle costs may result in poor targeting of treatment, ultimately distorting the allocation of medical resources. Differentiating between these two mechanisms is essential for designing effective policies. If the hassle-cost effect is dominant,

policies should aim to reduce the administrative burden of obtaining prior authorization. Refining approval criteria alone, even when aligned with best practices, would fail to guarantee that medications reach the patients who need them most, as administrative barriers could continue to impede access irrespective of a patient's appropriateness for treatment.

To empirically disentangle the mechanisms driving the effects of prior authorization, we compare outcomes across patients based on their appropriateness for treatment. For patients who meet the approval criteria, any reduction in access is attributable solely to hassle costs, as their requests are expected to be approved once the required documentation is submitted. Conversely, for patients who do not meet the approval criteria, hassle costs still play a role, but the screening effect further reduces drug use because insurers deny the treatment. In other words, both hassle cost effect and screening effect are at play to explain the reduction in ADHD drug use. By comparing the impact of prior authorization across these two groups—patients who would or would not meet approval criteria—we can disentangle and quantify the relative contributions of each mechanism. Our empirical results show that while both effects are significant, hassle costs account for a larger share of the reduction in drug use.

Finally, we further examine whether there are spillovers to patients not subject to prior authorization restrictions. Although prior authorization is designed to target patients in a specific plan, its influence may extend to patients in other plans by altering physician's prescribing habits. Physicians handling prior authorization requests operate under resource constraints and limited attention, which can shape their prescribing practices by influencing how they allocate time and effort across patients. Physicians treating many patients enrolled in MMCs that require prior authorization may reduce prescriptions even for those in plans not directly subject to these requirements. Our results, however, rule out this type of spillover effect. We do not find evidence of spillovers on patients of plans without prior authorization. Instead, we find that physicians treating more patients with prior authorization reduce their prescribing for those patients to a greater extent, suggesting a possible cumulative effect of administrative burden.

Our robustness checks show that the observed effects are not driven by compositional changes at Medicaid eligibility thresholds, copay changes, plan switching in response to prior authorization restrictions, or other age-related factors influencing drug use such as school-entry

age and FDA-approval based on age. Estimates are stable across alternative functional forms and a range of alternative bandwidths. Placebo tests at pseudo cutoffs yield no effects.

Overall, our results demonstrate that prior authorization substantially reduces prescription use and spending. The reduction in prescription use is primarily driven by the hassle costs associated with filing prior authorization requests, leading to a potentially significant misalignment in the targeting of treatment and limiting access to needed care. Moreover, the growing administrative workload imposed by prior authorization likely strains physicians' capacity in managing prior authorization requests and maintaining optimal prescribing practices.

Our analysis contributes to the literature on how Medicaid programs ration access to healthcare. Prior research has focused on expansions in Medicaid eligibility (Miller et al. 2021), coverage (Finkelstein et al. 2012), reimbursement to providers (Alexander and Schnell 2024; Cabral et al. 2025) and enrollment obstacles (Aizer 2007; Arbogast et al. 2024). For prescription drug access specifically, existing studies have focused on prescription caps (Layton et al. 2022) rather than cost-sharing mechanisms, as Medicaid programs impose minimal copayments on beneficiaries. Given Medicaid's limited ability to use financial incentives for managing drug utilization, non-price mechanisms— often in the form of administrative hurdles— have emerged as critical policy tools. However, empirical evidence on the impacts of these administrative burdens within Medicaid remains limited.

Among administrative barriers, prior authorization is one of the most widely used mechanisms influencing prescription drug use. The prior literature finds that prior authorization of prescription drugs reduces drug utilization among low-income beneficiaries in Medicare Part D (Brot-Goldberg et al. 2023), within Texas's workers' compensation program (Dillender 2018) and generates cost savings in Medicaid programs such as those in Louisiana (Agafiev Macambira et al. 2022) and Massachusetts's Medicaid FFS program (Burn and Ristovska 2025). Additionally, a small medical literature shows that prior authorization requirements are associated with decreased use of nonsteroidal anti-inflammatory drugs, antipsychotics, antidepressants, COX-2 inhibitors, and buprenorphine (Fischer et al. 2004; Siracuse and Vuchetich 2008; Stein et al. 2014; Mark et al. 2020). Our study makes two primary contributions to this literature. First, we provide the first causal identification of prior authorization's impact on prescription drug access exploiting age-based discontinuities in prior authorization restrictions, which is widely implemented in practice.

This strategy uniquely enables us to disentangle the effects of prior authorization from other insurance design features that are often implemented simultaneously. Second, we are the first to decompose the underlying mechanisms for prior authorization's impacts by analyzing detailed approval criteria from the prior authorization process, which is typically proprietary information maintained by insurance plans that has not been used in previous research. Our findings highlight an important tradeoff in the implementation of prior authorization. We find that while prior authorization generates savings for insurers, it also significantly distorts the targeting of treatment, due to the hassle costs imposed on physicians.

More broadly, our analysis adds to the existing literature on the effects of administrative burdens in health care. Previous studies have documented how various administrative burdens reduce spending and limit both inappropriate and appropriate use of health services. Examples include billing denials (Dunn et al. 2024), prescription drug monitoring programs (Alpert et al. 2024), Medicare claim audits (Shi 2024), and spending caps on physical therapy (Gandhi and Shi 2025). There is also a long literature documenting how administrative burdens can screen individuals and influence the take-up of public programs (Nichols and Zeckhauser 1982; Shepard and Wagner 2025; Ericson et al. 2025). However, this literature does not consider the impacts of administrative burdens that occur after program enrollment.

We also contribute to the growing literature on physician prescribing behavior. The literature has found substantial variation in physicians' treatment decisions and prescribing patterns, shaped by multiple factors. These determinants include medical training (Schnell and Currie 2018), geographic location (Finkelstein et al. 2022; Ding 2023), pharmaceutical marketing (Carey et al. 2021; Agha and Zeltzer 2022; Alpert et al. 2022), and clinical guidelines (Ody and Schmitt 2019; Abaluck et al. 2020). Our analysis builds on this literature by examining how administrative burdens imposed by insurance design influence overall prescribing practices, which may spill over across patients. Because most providers treat patients covered by multiple payers, insurance design in Medicaid could potentially have far-reaching consequences, influencing prescribing patterns in Medicare and commercial insurance as well.

The remainder of the paper is organized as follows: Section 2 provides background on the prior authorization process for drugs in Medicaid. Section 3 describes the data sources and sample construction. Section 4 outlines the empirical strategy. Section 5 presents the main results,

including the overall impact of prior authorization on drug use and spending and the underlying mechanisms. Section 6 presents the robustness tests. Finally, Section 7 concludes the paper.

2 Background

2.1 Prior Authorization Policies

Prior authorization is a utilization management tool widely implemented by health insurers. It requires healthcare providers to obtain advance approval before specific medications can be covered by insurance. It is extensively employed across Medicaid, Medicare, and commercial insurers to control costs and reduce potentially unnecessary or inappropriate care.

The prior authorization process typically involves several sequential steps. When prescribing a medication requiring prior authorization, providers must submit detailed documentation justifying medical necessity, which often includes the patient's diagnosis, previous treatment history, and clinical rationale for the specific medication choice. This documentation is reviewed against predetermined criteria set by the insurer. If denied, providers can appeal through a formal review process, which often requires additional clinical documentation and involves case-by-case review. Once approved, patients can obtain the medication at the covered out-of-pocket price.

2.2 Prior Authorization in Pennsylvania's Medicaid Program for ADHD Drugs

A. Medicaid Coverage of Prescription Drugs

Pennsylvania's Medicaid program is the fifth largest in the U.S. covering 2.4 million beneficiaries at a cost of $44 billion in 2022, of which $3.7 billion was spent on outpatient prescription drugs (PA Department of the Auditor General 2018). We focus our analysis on children and young adults ages 4-23, who qualify for Medicaid based on income, disability (Supplemental Security Income), or pregnancy criteria.[2]

[2] Eligibility for Medicaid is determined under two main categories. The first category is based on the Modified Adjusted Gross Income (MAGI), which includes children aged 18 and under (infant based on income up to 215% FPL, age 1 to age 5 based on income up to 157% FPL, age 6 to age 18 based on income up to 133% FPL), pregnant women until one year postpartum (based on income up to 215% FPL), parent caretakers of children under 21 and adults ages 19-64 with income at or below 133% FPL. The non-MAGI group includes individuals who are blind and/or disabled, Medicaid Assistance for Workers and Disabilities, and individuals receiving long-term care or home and community-based services. More details on eligibility criteria can be found on the PA Medicaid website

Pennsylvania contracted with seven Medicaid Managed Care (MMC) plans, covering around 90% of all Medicaid beneficiaries[3], during our study period from 2017-2018.[4] Federal regulations require Medicaid to cover all drugs but allow states to have considerable flexibility in the implementation of formulary design (e.g. preferred drug lists), prior authorization, and other utilization management strategies. When pharmacy benefits are provided by MMC plans, each plan independently manages their prescription drug benefits and retains discretion in designing their own drug formularies and establishing prior authorization criteria.[5] This decentralized approach can lead to variation in prior authorization requirements across plans within the same state, potentially creating administrative complexity for providers who must navigate different criteria and submission processes for patients in different plans. The prior authorization processes are subject to approval from Pennsylvania's Medicaid agency to ensure compliance with state minimum coverage requirements. Additionally, MMC plans have some discretion in setting cost-sharing amounts, but copays must not exceed federal and state limits.[6] In Pennsylvania, copays are capped at $3 for brand drugs and $1 for generics for all plans. Beneficiaries under age 18 are exempt from copays.[7]

(https://www.pa.gov/agencies/dhs/resources/medicaid/medicaid-general-eligibility.html) and Medicaid Assistance Eligibility Handbook (http://services.dpw.state.pa.us/oimpolicymanuals/ma/index.htm#t=Title_Page.htm).

[3] Fee-for-service (FFS) covers the remaining 10% of Medicaid enrollees in Pennsylvania, including individuals who are dually eligible for Medicare and Medicaid, as well as those residing in skilled nursing facilities or state-run institutions. This study focuses on managed care plans, which account for the majority of Medicaid enrollment for non-institutionalized kids and young adults.

[4] The Pennsylvania Medicaid program is divided into five service regions, each offering multiple managed care plan options to beneficiaries.

[5] In Pennsylvania, the prior authorization process needs to be initiated by phone or fax. After providers submit a prior authorization form along with supporting documents to the MMC, pharmacists in MMCs review each request and decide whether to approve or deny treatment. MMCs are required by the state Medicaid program to provide a response within 24 hours. However, if additional supporting documents are requested, the process may extend beyond this timeframe.

[6] Pennsylvania does not impose a statewide prescription cap on the total number of prescriptions or refills (Lieberman et al. 2016) in our study period. However, individual drugs may be subject to quantity limits, which are managed separately by each Medicaid managed care plan (MMC) and typically do not vary by patient age.

[7] While the minimum age at which prescription drug copayments can be charged is 18 (see https://www.pa.gov/agencies/dhs/resources/medicaid/copay-help.html#accordion-ea5833630f-item-9b20b25be1), Medicaid managed care plans (MMCs) may choose to begin imposing copays at a later age. Since we leverage age variation in prior authorization restrictions, we can control for copay differences across plans which do not change discontinuously at the age cutoffs. For age 18 and 21 prior authorization changes, specifically, we will test for the effect of copay changes by restricting our analysis to plans that have the same copay schedule around the age cutoff. We find that these copay changes do not influence our estimates. Prior authorization changes under age 18 are unaffected by copay effects because copays are zero for all plans.

B. Prior Authorization of ADHD Drugs

We study prior authorization for prescription drugs to treat attention-deficit/hyperactivity disorder (ADHD). In the U.S., approximately 1 in 9 U.S. children have ever received an ADHD diagnosis (Danielson et al. 2024). ADHD medications—stimulants and non-stimulants— together with behavioral therapies are recommended to be the first-line therapy for children aged six years and older (American Academy of Pediatrics 2011).[8] Timely access to ADHD medications is crucial to mitigating the adverse effects of the condition, such as long-term academic and behavioral challenges (Harstad et al. 2014; Arnold et al. 2020). However, stimulants, the primary drug class used in ADHD treatment, carry their own risks including the potential for misuse, substance use and other adverse effects (Cooper et al. 2011). To balance these benefits and risks, prior authorization is heavily implemented for ADHD medications.

In Pennsylvania, MMC plans implement age cutoffs for prior authorization such that children below (or above) a certain age must obtain prior authorization for ADHD medications, while children on the other side of the cutoff can obtain the same medication without prior authorization. These age-based prior authorization requirements reflect differences in clinical appropriateness and potential benefits across the age spectrum. Age-based prior authorization restrictions are commonly implemented in Medicaid programs for ADHD and there is considerable variation in age cutoffs across states and MMC plans (Hulkower et al. 2017; MACPAC 2024). In Pennsylvania, three MMC plans require prior authorization based on age while the other four plans do not impose any age cutoffs. This makes Pennsylvania an advantageous setting for our analysis because we can estimate changes in prescription use at age cutoffs in treated plans compared to control plans that do not have the same age cutoff. As shown in Figure 1, UnitedHealth requires prior authorization only for children under age 6. UPMC and AmeriHealth/Keystone First require prior authorization only above ages 18 and 21, respectively .[9] These plans are treated in our study and we leverage a Regression Discontinuity (RD) design at each of the three age cutoffs. The

[8] The FDA approves ADHD medications for specific age groups based on clinical trial evidence and safety profiles. Stimulants are the primary category of ADHD medications and are generally approved as first-line treatments for children aged six years and older, while behavioral therapy is often recommended as the primary intervention for children under six years of age.

[9] AmeriHealth and Keystone First are listed as two separate plans for consumers, but Keystone First is part of the AmeriHealth Umbrella. These two plans share the same formulary and prior authorization guidelines for ADHD drugs, so we combine these two plans together in the analysis.

remaining four plans (Gateway, Health Partner, Aetna, and Geisinger) will be used in the control group because they either require prior authorization for ADHD drugs across all ages or do not impose prior authorization requirements at any age. The requirement of prior authorization by some plans for the youngest and oldest patients reflects the observed age distribution of ADHD treatment in the population. We show in Figure 2 that the probability of receiving an ADHD drug increases with age—peaking at age 12 when about 10% of Medicaid beneficiaries receive an ADHD drug—and then declines in later adolescence.[10] Thus, plans typically require prior authorization only for patients at the extremes of the age distribution (i.e., under age 6 and over age 18 or 21), who are more marginal for ADHD treatment.

If a patient meets the age criteria for submitting a prior authorization request, their provider must submit documentation demonstrating that they meet the approval criteria for medical necessity. The approval criteria typically include proof of ADHD diagnosis, failure of alternative therapies and medications (i.e., step therapy), or require a comprehensive evaluation from a specialist such as a pediatric neurologist, though specific requirements vary by managed care plan (see example criteria in Appendix Figure A1).

3 Data and Sample Construction

3.1 Prior Authorization Guidelines and Drug Formulary

We obtained each MMC plan's drug formulary and prior authorization guidelines in Pennsylvania's Medicaid program through a Freedom of Information Act (FOIA) request. The drug formulary indicates whether each drug is preferred or non-preferred and whether there is prior authorization, step therapy requirement, and quantity limits for that drug. The prior authorization guidelines show the specific criteria used by each MMC plan to determine whether to approve or deny treatments for ADHD drugs. These criteria consider some or all of the following factors: the patient's diagnosis, prescribing doctor's specialty, and patient's drug usage history (e.g., whether certain drugs were previously used and failed). Importantly for our study, the guidelines also specify the age groups for which prior authorization is required. We show that, empirically, age matters.

[10] We find a similar distribution of ADHD drug use by age using the MEPS for Medicaid and privately insured patients.

3.2 Medicaid Claims

We use the Transformed Medicaid Statistical Information System (T-MSIS) administrative data for the Pennsylvania Medicaid program for 2017-2018, obtained from the Centers for Medicare & Medicaid Services (CMS). These data provide comprehensive information on beneficiary demographics, monthly enrollment status, managed care plan, prescription drug utilization, and outpatient service use within the Medicaid program. Through unique beneficiary identifiers, we constructed a dataset that tracks individual enrollment status and prescription drug utilization at each age measured in months. We identify all ADHD medications in the Medicaid prescription claims by NDC and link these data with the formulary and prior authorization criteria based on the enrollee's managed care plan. Reports from CMS and Mathematica confirm the high quality and reliability of the prescription-related variables in the T-MSIS data (CMS 2024).

3.3 Medicaid State Drug Utilization Data (SDUD)

To study how prior authorization affects drug spending, which is not fully captured in the claims, we use Medicaid State Drug Utilization Data (SDUD) in 2017 to 2018 to obtain ADHD drug prices for Pennsylvania's Medicaid program. SDUD records the total number of prescriptions and total amount of reimbursement for each NDC that is used in the Medicaid program for each state separately for Fee-For-Service and MMC plans. SDUD derives more accurate spending information from the Medicaid Drug Rebate Program.[11] We construct the ADHD drug prices at the NDC level by dividing the total amount of Medicaid reimbursement by the total number of prescriptions among MMCs in Pennsylvania. We further compute ADHD drug spending for beneficiaries by multiplying the price of each drug (constructed using the SDUD) by the number of prescriptions in the Medicaid claims.

3.4 Sample Construction and Summary Statistics

We restricted our analysis to Medicaid beneficiaries aged 4 to 23 as this age range encompasses the primary age group for ADHD medication utilization. In our RD analysis, we further restrict to one-year bands around each prior authorization age cutoff. We defined monthly enrollment status based on a minimum threshold of 15 enrolled days per month and included only beneficiaries with at least one month of Medicaid enrollment between January 2017 and December

[11] We follow Dranove et al. (2021) and Starc and Wollmann (2022) to construct drug spending and price.

2018.[12] The final analytical sample comprises 1,445,123 beneficiaries in 2017 and 1,466,168 beneficiaries in 2018. We construct the dataset at the beneficiary-age level, with age measured in months. For each beneficiary, we include only the ages during which they maintained Medicaid enrollment. We measure both prescription drug utilization and outpatient service use during these corresponding ages.

Table 1 presents summary statistics for our sample around the three prior authorization age cutoffs. The comparable demographic characteristics between treated and control plans across these cutoffs suggest minimal selection bias in plan enrollment patterns. We will test for the causal effects of prior authorization in the next section.

4 Empirical Strategy

To understand the causal effect of prior authorization on ADHD drug prescribing, we leverage age-based discontinuities in prior authorization requirements using a regression discontinuity (RD) approach. First, we compare outcomes for patients who are just above versus just below the age cutoff for prior authorization requirements. For each age cutoff, we estimate the following specification:

$$Y_{ipa} = \alpha_0 + \alpha_1 D_{pa} + \alpha_2 f(Age_i) + \alpha_3 f(Age_i) \cdot D_{pa} + \Sigma_k X_{it}^k \gamma^k + \epsilon_{ipa} \quad (1)$$

where Y_{ipa} is the outcome of interest for beneficiary i enrolled in managed care plan p with age in months a. D_{pa} is a binary indicator for whether the beneficiary needs prior authorization to obtain ADHD drugs at age a in plan p. D_{pa} equals 1 when prior authorization turns on for: 1) beneficiaries in UnitedHealth whose age is less than 6, 2) beneficiaries in UPMC whose age is greater than 18, and 3) beneficiaries in AmeriHealth/Keystone whose age is greater than 21.[13] D_{pa} equals 0 when prior authorization turns off based on age for these same plans. $f(Age_i)$ denotes a

[12] We also exclude beneficiaries simultaneously enrolled in CHIP program (determined by the presence of duplicate demographic information in the data).

[13] Although not all ADHD drugs in UnitedHealth and AmeriHealth/Keystone are subject to prior authorization after the age cutoff, we consider all ADHD drugs to be treated in our main specification. We do this for two reasons. First, when the treated plans turn on prior authorization, most high-volume drugs are typically subject to this requirement which covers the vast majority of prescriptions. Second, there could be spillovers across drugs, such as substitution between drugs with and without prior authorization. Thus, we consider the entire drug class to be treated if there is prior authorization for some drugs. Our results remain robust when we restrict the analysis to specific drugs that are directly subject to prior authorization (Appendix Table A2 and Figure A3)

smooth function of beneficiaries' age in months, the running variable, and we allow separate trends on either side of the age cutoff via the interaction between $f(Age_i)$ and D_{pa}. α_1 is the coefficient of interest and represents the treatment effect of prior authorization. Guided by the visual inspection of raw data, we use a global second-order polynomial as the main functional form for the smooth function of the running variable, with a 1-year bandwidth. We test different functional forms and different bandwidths, including the optimal bandwidth proposed in Calonico et al. (2020), in the robustness checks. X_{it}^{k} is a set of controls including female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects. We run separate RD regressions for each age cutoff among treated plans that experience a change in prior authorization requirements at the age cutoff.

Second, to get an aggregate effect of prior authorization across the different cutoffs, we use a normalizing and pooling approach estimated in Eq.(2):

$$Y_{ipa'} = \alpha_0 + \alpha_1 D_{a'} + \alpha_2 f(Age_i) + \alpha_3 f(Age_i) \cdot D_{a'} + \sum_k X_{it}^k \gamma^k + \epsilon_{ipa'} \quad (2)$$

where a' is the standardized age around each age cutoff, running from -12 to 12 months, and $f(Age_i)$ is the smooth function of the standardized age in months. This allows us to simultaneously analyze the effect of prior authorization across all three age cutoffs. This pooled RD estimate—the so called "double average" (Cattaneo et al. 2016)— captures the combined treatment effect across all cutoffs weighted by the density around each cutoff and the likelihood of each individual being near a cutoff. The pooled RD estimate thus provides richer information than a single-cutoff RD design by integrating estimation across multiple cutoffs.

Finally, we also estimate an alternative specification using a regression discontinuity difference-in-differences (RD-DID) design that compares treated and control MMC plans within Pennsylvania.[14] This approach enables us to directly control for unobserved shocks at the age cutoffs, such as state and national level policies that vary by age but not across plans (e.g.,

[14] Around age 6, United Health is the treated plan and all other plans (AmeriHealth/Keystone First, UPMC, Aetna, Geisinger, Health Partner, Gateway) are control plans. At age 18, UPMC is the treated plan and all other plans (United Health, AmeriHealth/Keystone First, Aetna, Geisinger, Health Partner, Gateway) are control plans. At age 21, AmeriHealth/Keystone First is the treated plan and all other plans (United Health, UPMC, Aetna, Geisinger, Health Partner, Gateway) are control plans.

Medicaid eligibility thresholds, FDA approval criteria and clinical guidelines for ADHD drugs, school entry age, etc.)We estimate the following equation:

$$\mathrm{Y_{iap}} = \delta_0 + \delta_1 f(\mathrm{Age_i}) + \mathrm{D_{ia}}(\gamma_0 + \gamma_1 f(\mathrm{Age_i})) +$$

$$\mathrm{T_{ip}}[\alpha_0 + \alpha_1 f(\mathrm{Age_i}) + \mathrm{D_i}(\beta_0 + \beta_1 f(\mathrm{Age_i}))] + v_{iap} \qquad (3)$$

Where T_{ip} equals to 1 when patient i is enrolled in a treated plan. β_0 is the coefficient of interest, representing the difference in the discontinuity of outcomes at the age cutoffs between treated and control plans.

The identifying assumption of our RD design is that ADHD drug use would trend smoothly across the age distribution near the age discontinuities absent changes in prior authorization requirements. To test this assumption, we examine the balance of covariates around the age cutoffs. The results in Table 2 indicate that the beneficiary's gender, race, eligibility category and ZIP code-level median income are either statistically insignificant or have small point estimates in treated plans, suggesting no meaningful differences in pre-determined demographic characteristics around the age thresholds. The covariates are also balanced using the RD-DID specification, demonstrating that the demographic characteristics are not trending differently in treated and control plans near the age cutoffs.

5 Results

5.1 Impact on ADHD drug use and spending

A. Drug Utilization

We begin by examining the impact of prior authorization on ADHD drug use and spending. We measure drug use as the probability of having any ADHD prescription (extensive margin) and the average number of ADHD prescription claims (intensive margin). Figure 3 presents the proportion of beneficiaries using any ADHD drug in treated and control plans around the age cutoffs of 6, 18, and 21. In all three panels, ADHD drug use exhibits a clear discontinuity in treated plans at each age threshold where prior authorization begins but trends smoothly among control plans.

Column (1) in Table 3 quantifies the magnitudes of these effects on drug use for treated plans. Column (1) shows that prior authorization decreases the probability of filling any ADHD

prescription by 10.6% at age 18 and 29.4% at age 21. At age 6, the point estimate indicates a 7.7% reduction, although this effect is not statistically significant. Overall, across the three age cutoffs, using Eq (2), prior authorization reduces ADHD drug use by 14.7% on average. The magnitudes are similar for the intensive margin.[15] In column (2), we show placebo tests on control plans where there are no age-based discontinuities in prior authorization requirements. We find no evidence of discontinuities in prescription use in the absence of prior authorization changes as the coefficients are all close to zero and not statistically significant.

B. Drug Spending

We also examine the effects of prior authorization on drug spending, as reducing costs is a key rationale for state Medicaid programs to implement prior authorization. Figure 4 illustrates average ADHD drug spending among all beneficiaries in treated and control plans around the three age cutoffs. As expected, ADHD drug spending decreases sharply at all three age thresholds among treated plans, while spending trends remain smooth for control plans. In Column (4) of Table 3, the estimated magnitude of the discontinuities is 16.2% around age 6, 10% around age 18, and 29.8% around age 21, which are all statistically significant at the 1% level. Across all three age cutoffs, prior authorization reduces ADHD drug spending by13.7% relative to a baseline mean of $7.4 per beneficiary per month.

The RD-DID estimates closely mirror those from our main specification. Prior authorization reduces the probability of using ADHD drugs by 15.1% (compared to 14.7% in the main RD specification) and decreases ADHD drug spending by 13% (compared to 13.7% in the main RD specification). This similarity is expected given that the RD estimates for the control plans are close to zero.

C. Drug Prices

Given the spending reductions, we explore whether this is due to reductions in utilization or shifts in prescribing toward cheaper drugs. Appendix Figure A2 reveals a discontinuous reduction in drug prices around age 6 for treated plans, but no significant visual discontinuity is observed around ages 18 and 21. As shown in Appendix Table A2, there is a 22.81% drop in the

[15] We also examine the discontinuity in ADHD diagnosis. Table A1 shows no discontinuity in enrollees' ADHD diagnoses, indicating that the effects we observe are not driven by shifts in the diagnostic composition of the patient population.

price of filled ADHD medications around age 6 in the treated plan, while no statistically significant effect is observed in the control plans.

One reason that the pricing effect is only observed around age 6 is that the treated plan placed Vyvanse—one of the most frequently prescribed branded medications—under prior authorization before age 6, effectively encouraging substitution toward cheaper alternatives. We can see this directly, by comparing utilization for the specific drugs that required prior authorization (treated drugs) and those that did not (control drugs) in the treated plans.[16] Appendix Table A4 and Figure A4 present our results. Around age 6, we observe a substitution pattern: when prior authorization is in effect, the use of drugs that require prior authorization declines while the use of drugs that do not require prior authorization increases by a similar magnitude. This substitution pattern explains why the overall RD estimates at age 6 are not statistically significant in the main specification because utilization for the two groups of drugs almost perfectly offset each other. In contrast, treated plans imposed prior authorization on most or all ADHD medications after ages 18 and 21. Consequently, there is almost no incentive for substitution toward lower-cost drugs at these later ages due to prior authorization.[17]

As a falsification exercise, in columns (3) and (4) of Appendix Table A4, we also examine trends in the use of treated and control drugs among control plans. We did not observe discontinuities in utilization in control plans across age cutoffs, which rules out the possibility that our estimates are driven by unobserved shocks targeting specific treated drugs. These findings indicate that the strategic design of prior authorization policies can be effectively

[16] As discussed previously, our main specification considers all ADHD drugs as treated when prior authorization turns on in a plan. In Appendix Figure A3 and Table A2, we separately consider the drugs that require prior authorization (treated drugs) versus those that do not (control drugs). Most ADHD drugs require prior authorization, so there is minimal opportunity for substitution to avoid the prior authorization requirement. At baseline, 0.6% of beneficiaries who are age 6 use any control drugs that do not require prior authorization (compared to 2.4% who use treated drugs). There are no control drugs at age 18 and almost no beneficiaries use control drugs at age 21.

[17] An alternative explanation for observing the price effect at the age 6 cutoff relates to treatment initiation timing. Age 6 often coincides with the initiation of ADHD treatment, where the choice of medication is particularly significant. It is common for patients to try different medications for mental health conditions when starting treatment to identify the most effective option. Prior authorization policies could significantly influence which medications are available to try, while having a more minimal impact on overall initiation rates. In contrast, older patients are more likely to have established medication regimens and may choose to forgo treatment if they cannot access their preferred drug. These differential responses could motivate insurers to strategically steer patients toward preferred medications at younger ages when treatment patterns remain malleable, rather than at older ages. Our results highlight the importance of jointly considering patient-side clinical factors and insurer-specific prior authorization policy designs when evaluating the overall effectiveness of prior authorization as a policy tool.

leveraged to steer prescribing behavior towards cost-saving alternatives for insurers. Such substitution effects can't be recovered without observing the detailed plan information and the heterogeneity across plans in their specific targeting of certain drugs.

D. Heterogeneity in Prior Authorization Effects on Drug Use and Spending

The impact of prior authorization differs significantly across age thresholds, with effects nearly twice as large at age 21 compared to age 18. This variation may stem from three potential sources: age-specific effects (heterogeneous treatment effects at each age threshold), plan-specific implementation (insurers managing prior authorization requirements differently), and patient composition differences (varying patient populations due to Medicaid eligibility rules). Our analysis explores two of the potential mechanisms: variation in plan-specific prior authorization requirements and differences in patient population composition. We cannot rule out heterogeneous treatment effects by age. Regarding plan implementation, we analyzed the detailed prior authorization requirements we collected from all plans. All insurers require providers to provide documentation of an ADHD diagnosis, but AmeriHealth imposes additional constraints at age 21, including documented trials and failures of preferred medications or contraindications for preferred medications based on the patient's diagnosis, medical conditions, and ongoing therapies. In contrast, UPMC has less stringent requirements at age 18, allowing continuation of stimulant medication for patients who began treatment before age 18.

Regarding eligibility differences, most enrollees around age 18 qualify for Medicaid based on age criteria (under 19 years), while those around age 21 primarily qualify due to poverty-related factors[18]. This demographic distinction results in a generally healthier patient population at age 18, who may navigate the prior authorization process more effectively than the older cohort. Together with the stricter plan rules imposed at age 21, these compositional differences plausibly explain the larger estimated prior-authorization effect at age 21 relative to age 18. Understanding this type of heterogeneity in prior authorization effects is important and has not been a focus of prior research that has primarily studied aggregated effects across plans and enrollees.

[18] Individuals around the age 21 cutoff (i.e. age 20-21) qualify for Medicaid for the following Poverty related eligibility codes in our data: 46 (Poverty Level Aged or Disabled), 72 (Adult Group-Individuals at or below 133% FPL, 19-64, newly eligible for all states), and 02 (Transitional Medicaid Assistance)

We further explore heterogeneous treatment effects across demographic and provider characteristics. Table A1 Panel A examines differences by gender, while Panel B analyzes variation by self-reported race and ethnicity. Despite higher baseline ADHD medication use among boys and white Medicaid beneficiaries, prior authorization reduces utilization by similar magnitudes across gender and racial/ethnic groups. Table A1 Panel C shows heterogeneity by provider type, comparing patients whose modal prescriber is a physician versus a non-physician provider such as a nurse practitioner.[19] The results suggest that prior authorization effects are concentrated among patients treated by physicians, with smaller impact on those treated by non-physician providers.

Overall, prior authorization reduces ADHD drug spending. For young adult patients, this reduction is primarily driven by a decrease in the quantity of prescriptions. For young children, the reduction in spending is largely attributed to a shift towards prescribing cheaper drugs, but there is no change in the likelihood of receiving a prescription. For the remainder of our analysis, we focus on the pooled effect across the three age cutoffs to study other effects of prior authorization and mechanisms.

5.2 Delays in filling ADHD prescriptions

This section investigates whether prior authorization delays access to ADHD medications. Even when a prescription is ultimately filled, the prior authorization process which involves manual reviews of medical documents can introduce delays. We measure these delays using three metrics: (1) the number of days between the drug prescription date and fill date, (2) the probability of filling the prescription on the same day as it was written, and (3) the probability of filling the prescription within seven days of the prescription date.

Table 4 summarizes the estimated effects of prior authorization on these outcomes. Column (1) shows that prior authorization significantly increases the average time to fill a prescription by 2.4 days, representing a 17.3% increase relative to the pre-policy mean of 14 days.[20] Additionally, prior authorization reduces the likelihood of same day fills by 10 percentage points, corresponding to a 29.5% decline from the baseline mean. Prior authorization also reduces the probability of filling the prescription within seven days by 8.1 percentage points, reflecting a 13.0% drop. These

[19] Defined as the provider from whom the patient receives the majority of their prescriptions during the study period.
[20] Because many ADHD medications involve frequent refills, the interval between the prescription date and the fill date can appear notably extended.

findings highlight the substantial delays introduced by the prior authorization process, which may hinder timely access to ADHD medications. While these delays could result from both submission and review procedures inherent to prior authorization and patients' delayed actions in filling prescriptions, the findings particularly underscore the significant hassle costs associated with obtaining prior authorization approval—a process that can be time-consuming and require multiple interactions or responses from providers over an extended period.

5.3 Hassle vs. Screening Effects of Prior Authorization

Prior authorization operates through two primary mechanisms. First, it imposes approval criteria that restrict eligibility for the drug, a mechanism we refer to as the "screening effect." This effect aims to ensure that only patients who are medically appropriate for treatment receive the medication, thereby improving the targeting of prescribing. Second, prior authorization introduces administrative burdens for providers, requiring the submission of supporting documentation during the approval process. We refer to this as the "hassle cost effect." These administrative burdens may discourage physicians from prescribing the medication, even for patients who meet the criteria, potentially reducing access for those appropriate for treatment. As insurers completely rely on physicians to provide supporting documentation to identify patients who need the drug most, the presence of hassle costs may result in poor targeting of treatment, ultimately undermining the intended purpose of prior authorization restrictions.

In Appendix B, we present a model of the two mechanisms through which prior authorization reduces drug use: a hassle cost and a screening rule based on an approval threshold. If we interpret the insurer's approval threshold as the socially optimal marginal cost of covering the drug, the utilization of ADHD medication in the absence of prior authorization exceeds the socially efficient level. Introducing prior authorization results in declines in use that are due both to hassle and screening effects for patients who do not meet the approval criteria (inappropriate patients in our setting; area A in Appendix Figure A7), which is welfare-improving. However, the decline in use is welfare-reducing for patients who meet the criteria yet fail to obtain the drug due to hassle costs (appropriate patients in our setting; area B in Appendix Figure A7). The remainder of this section empirically quantifies the contributions of hassle costs and screening to these reductions in utilization.

Distinguishing between these two mechanisms empirically is critical for the design of effective government regulations. If the hassle cost effect dominates, regulatory efforts should prioritize reducing administrative burdens for physicians, such as streamlining the prior authorization process to make it less cumbersome. Conversely, if the screening effect is more influential, regulations aimed at refining approval criteria to align with best practices will have a greater impact on the targeting of treatment.

We disentangle these two mechanisms by comparing the effects of prior authorization across patients based on their appropriateness for treatment. For patients who meet the prior authorization approval criteria (referred to as "appropriate patients"), prior authorization impacts access only through hassle costs, as their requests are expected to be approved as long as providers submit the necessary documentation. The hassles of submitting the documentation could deter physicians from prescribing the drug even if the patient is appropriate for treatment. In contrast, for patients who do not meet the approval criteria (referred to as "inappropriate patients"), the reduction in ADHD drug use stems from both the screening effect and the hassle cost effect. The hassle cost effect is likely similar for both groups since the prior authorization process itself is identical. By comparing the effects of prior authorization among appropriate and inappropriate patients, we can separately identify the contributions of the screening effect and the hassle cost effect.

We define a patient's appropriateness based on the presence of an ADHD diagnosis, which is the primary approval criteria in all prior authorization guidelines in Pennsylvania MMC plans. However, identifying ADHD diagnoses within our claims data is complicated by several challenges. These include the limited observation period of the dataset, the under-coding of ADHD diagnoses in administrative claims, and the fact that many mental health providers do not accept insurance and may not be included in the claims data. To address these challenges, we apply the LightGBM (Light Gradient-Boosting Machine) algorithm to predict whether a beneficiary had an ADHD diagnosis before the index age. The model uses a range of predictors, including demographic variables (gender, age, ZIP code, and enrolled managed care plan) and all prior non-ADHD diagnoses recorded before the index age from outpatient claims.[21] Patients who have an observed ADHD diagnosis or predicted ADHD diagnosis are considered as appropriate patients

[21] Diagnosis is observed in outpatient files but not in prescription drug files.

while those without an observed or predicted ADHD diagnosis are considered as inappropriate patients.

Table 5 shows the effect of prior authorization among appropriate and inappropriate patients using the aggregated RD from Eq. (2). Comparing column (1) which presents the effect among inappropriate patients, and column (2) which shows the effect among appropriate patients, we find that prior authorization reduces ADHD drug use by 17.6% for appropriate patients and by 24.2% for inappropriate patients. Based on these estimates, approximately 81% of the total utilization reduction stems from appropriate patients, primarily due to hassle costs in the prior authorization process, while the remaining 19% reflects reductions among inappropriate patients driven by both hassle costs effect and screening effects.[22] These results indicate that both the screening effect and hassle cost effect contribute to the reduction in drug use, with hassle costs accounting for a larger share. Reassuringly, we didn't observe any discontinuity for either appropriate or inappropriate patients among control plans, as shown in Panel B.

We also test alternative measures of patient appropriateness. Beyond restricting the sample to patients with an ADHD diagnosis, we further condition on prior use of ADHD drugs in column (3), as some prior authorization guidelines approve patients based on continuation of use or separately require documented failures of previous ADHD medications which would also necessitate prior use. Additionally, we restrict to patients whose primary provider during the study period is a pediatrician, psychologist, or neurologist in column (4), as these specialists are typically able to meet the requirement for an evaluation by a specialist.[23] As expected, tightening these criteria reduces the estimated prior authorization effect, as stricter appropriateness criteria identify patients least likely to face coverage denial. Nonetheless, the estimates remain directionally consistent across all specifications, reinforcing our conclusion that hassle costs constitute a

[22] Among the age group we study, which includes the majority of ADHD medication users, approximately 10% of enrollees have an ADHD diagnosis, while the remaining 90% do not. Among those diagnosed with ADHD, roughly 31% use ADHD medications, and prior authorization reduces use by 18%, yielding a total effect of $0.1 \times 0.31 \times 0.18 = 0.00558$. Among enrollees without an ADHD diagnosis, 0.6% use ADHD medications, and prior authorization reduces use by 24%, resulting in a total effect of $0.9 \times 0.006 \times 0.24 = 0.001296$. Thus, about 81% ($0.00558 / (0.00558+0.001296)$) of the total reduction in ADHD drug use comes from appropriate patients.

[23] The primary provider is defined as the provider who most frequently prescribed medications to each beneficiary across all prescription drug claims between 2017 and 2018.

substantial component of prior authorization's impact on ADHD drug access even for appropriate patients.

5.4 Spillover effects of prior authorization across patients

In this section, we examine potential spillover effects of prior authorization policies—another unintended impact of these policies which might also affect the targeting of prescription drug access. While prior authorization is designed to target specific patients or managed care plans, their impact may extend beyond the directly affected groups through changes in physician's prescribing behavior. Physicians handling prior authorization requests operate under resource constraints and limited attention. The administrative burden imposed by prior authorization can shape their prescribing practices by influencing how they allocate time and effort across patients. Physicians may also develop simplified prescribing heuristics in response to frequently encountered restrictions, applying similar prescribing patterns to all patients regardless of their specific insurance requirements. Such prescribing heuristics can cause prior authorization policies to influence those patients not directly subject to the restrictions.

To conduct this analysis, we exploit variation in physicians' patient composition based on insurance plans. Physicians see patients with coverage from multiple Medicaid managed care plans and there is significant variation across physicians in which plan is dominant for their patient pool. We examine whether prior authorization rules for a physician's dominant plan influences prescribing for patients in other plans not directly subject to those rules. We define a provider's dominant "modal" plan as the insurance plan under which the provider treats the highest number of patients. A physician's modal plan can then be classified as either a treated plan, experiencing a change in prior authorization for ADHD drugs, or a control plan. We compare how prior authorization impacts patients treated based on the treatment status of each patient's own and treatment status of their provider's modal plan.[24]

Table 6 presents the estimates of the impact of prior authorization on the probability of using any ADHD drugs pooled across all treatment cutoffs, stratified by the treatment status of the patient's plan and their provider's plan. Panel A focuses on patients whose own plans are treated

[24] To assign patients to a provider, we use the patient's modal provider, which we define as the provider from whom the patient receives the majority of their prescriptions during the study period.

and experience a change in prior authorization at the age cutoff. Comparing estimates in columns (1) and (2), we observe that the age discontinuity is twice as large when the provider's modal plan is treated (17.2%), compared to when the provider's modal plan is a control plan (8.1%). These results suggest that providers face resource constraints, and the cumulative administrative burden spills over across patients, which further reduces prescription rates. Moreover, the findings suggest an absence of a learning effect among providers. If treated providers became more proficient in navigating the prior authorization process and achieved higher approval rates, we would expect the opposite pattern.

Panel B presents the estimates for patients enrolled in control plans, who should not experience any change in utilization at the prior authorization age cutoff. As expected, we do not observe discontinuity when patients see a provider whose modal plan is also a control plan. However, we also do not find any evidence of spillovers for patients who see a provider whose modal plan is treated. In both cases, the estimated discontinuities are statistically insignificant, with a magnitude close to zero. This suggests that providers are unlikely to adjust their prescribing behavior for patients in control plans based on their experience with treated plans. The only spillovers we observe are for patients whose own plan requires prior authorization at the age cutoff. Seeing a provider whose dominant plan also requires prior authorization at the age cutoff makes it less likely that the provider will prescribe and seek approval for ADHD medications.

Although our spillover analysis is confined to Medicaid data and ADHD medications, this scope is still highly policy-relevant as Medicaid insures roughly 40 percent of U.S. children and ADHD medications are among the most frequently prescribed pediatric drugs. The absence of commercial plan prior authorization rules does not threaten our identification since physicians in our sample treat both Medicaid and commercially insured patients, yet we observe no corresponding discontinuities in control plans, implying that contemporaneous changes in commercial prior authorization rules cannot drive our findings. Assessing whether Medicaid prior authorization rules spill over to patients in commercial insurance remains a question for future research.

5.5 Does the Effect of Prior Authorization Persist?

Prior authorization can function either as a temporary hurdle which delays access until the paperwork is completed, or as a lasting barrier that permanently lowers utilization. To

distinguish between these possibilities, we re-estimate Equation (2) using outcome variables that equal one if a beneficiary fills any ADHD prescription within the next few months. If prior authorization merely postpones treatment, the discontinuities at these longer horizons should attenuate toward zero. In contrast, if the effect is enduring, the estimated jumps should be similar in magnitude to the effect around the age cutoff reported in Table 3. Appendix Figure A3 shows that the discontinuities persist for a few more months but generally shrink gradually over time. This pattern implies that prior authorization exerts a persistent constraint beyond the age cutoff, but its impact diminishes over time as patients and providers learn how to navigate the approval process.

6 Robustness

We conducted a series of robustness checks to validate our results. We began with several standard checks for our RD design. Additionally, we conducted several robustness tests of our empirical specification and potential alternative explanations.

6.1 RD Specification

First, we performed RD analyses at different placebo cutoffs among treated plans to ensure the observed discontinuities are not spurious. We estimate this for the pooled specification in Eq (2). Figure 5(a) demonstrates that no discontinuity is observed at any of the placebo cutoffs. Second, we estimated the effects using alternative bandwidths. Estimates using different bandwidths in Figure 5(b) are similar to our main estimates. Third, we use different functional forms, including global linear and local linear regressions. Figure 5(c) shows that estimates using different functional forms yield similar estimates as our main specification.

6.2 Impact of Copays

Prescription drugs copay schedules may change at ages 18 and 21 for different plans in the Pennsylvania Medicaid program. Around the age 6 cutoff, copays are zero across all plans. To rule out the possibility that our observed effect is driven by the copay change, we restricted the control plans to those with the same copay schedule as the treated plan around each age cutoff to isolate the impact of prior authorization from potential copay effects. As shown in Appendix Table A5, no

discontinuities were observed among control plans that have the same copay schedule as treated plans, suggesting that copay changes cannot explain the observed changes in prescribing.

6.3 Plan Switching

As beneficiaries face more than one managed care plan option in every service region in the Pennsylvania Medicaid program and they are allowed to change plan enrollment at any time[25], a potential concern is that beneficiaries would switch to a control plan without prior authorization after their access to ADHD is restricted by prior authorization. To address this concern, we examine whether there is a discontinuity in plan switching behavior around the age cutoff for prior authorization. As shown in Appendix Table A6, we find no evidence of any discontinuities in plan switching. This finding also aligns with our previous observation that ADHD drug use does not increase among control plans near the age cutoff. Although this exercise only rules out immediate switching in response to the prior authorization changes and beneficiaries may still switch plans over the longer term, but any long-term plan switching does not affect our RD estimates.

6.4 Impact of Eligibility Changes

Pennsylvania's Medicaid eligibility rules change at age 6, 18, 19, and 21[26]. Although these changes partly coincide with the prior authorization age cutoffs, they do not threaten our estimates for three reasons. First, although eligibility changes occur around the age cutoffs, the drop in plan enrollment is similar across both treated and control plans. To test this, we estimate the difference in discontinuity (RD-DID) in plan enrollments by age in months around the three age cutoffs using Eq. (3). As reported in Appendix Table A7, there is no meaningful or statistically significant differential change in plan enrollment between treated and control plans. Second, we re-estimate our main specification using a sample of individuals who remain continuously enrolled[27] in their plan across the age cutoff. The estimates in Appendix Table A8 show a similar reduction in ADHD drug use and spending as the main results among continuously enrolled beneficiaries in treated plans, despite reduced statistical power. We do not observe any discontinuity in outcomes among

[25] See the website of Pennsylvania Enrollment Services https://www.enrollnow.net/en/faq#:~:text=Can%20I%20change%20my%20health,plan's%20provider%20network%20(group)

[26] Pennsylvania Medicaid/Medical Assistance General Eligibility Requirements: https://www.pa.gov/agencies/dhs/resources/medicaid/medicaid-general-eligibility.html

[27] Continuously enrollment is defined as being enrolled in the treated/control plans at centered age -1, 0 and 1.

continuously enrolled beneficiaries in the control plans. Third, to address potential eligibility-code changes at age thresholds, we re-estimate the main specification with individual fixed effects to control for time-invariant individual factors. Appendix Table A9 shows the estimates are similar our main results.

6.5 Alternative Construction of Control Group

In our main specification, the control group consists of plans that either impose prior authorization at all ages ("always treated") or never impose prior authorization at any age ("never treated"). To address the concern that these two types of plans may differ substantially, we separately estimate the RD-DID discontinuities in drug use and spending using each control group separately. Appendix Table A10 shows that the RD-DID estimates are similar for both control groups.[28]

6.6 Impact of ADHD drug approval and school age

A potential concern for our estimates around age 6 is that the FDA approval age for most ADHD drugs and the start of compulsory schooling coincides with the age cutoff in prior authorization. This may confound our results due to increased ADHD medication use linked to school enrollment (Layton et al. 2018). Most ADHD drugs are approved for use at age 6 and above.[29] And age 6 is also the first year of compulsory schooling in Pennsylvania. However, these issues do not affect our estimates for two main reasons. First, our control plans act as a falsification test, ruling out the possibility that the observed effects are driven by FDA approval or school entry. Second, our running variable is measured in months. Although age 6 is when children are required to start school, they typically begin in September. Our estimates are based on the exact month children turn 6 and include year-quarter fixed effects, minimizing any impact from compulsory school entry.

6.7 Impact of prior authorization from other mental health drugs

[28] While the approval criteria may change at age cutoffs for "always treated" plans, that does not affect our estimates. Both control groups produce similar results.

[29] Adderall (Immediate Release), Procentra, and Zenzidi are approved for age 3 and above. Desoxyn and Mydayis are approved for age 13 and above. Among these exceptions, only Adderall IR is widely used; the combined market share of the other drugs is below 3%.

Another potential concern is that the estimated discontinuities could be driven by prior authorization requirements for other psychotropic agents, given the high comorbidity between ADHD and conditions such as depression or schizophrenia. We therefore reviewed prior authorization policies for antidepressants and antipsychotics over the study window and found that a subset of plans applied to single age-18 threshold to these drug classes.[30] To test for spillovers, we re-estimate equation (1) within the control sample, stratifying plans into those with and without an age-18 cutoff for antidepressants or antipsychotics, using any ADHD prescription as the outcome. Appendix Table A11 Column (2) shows that the estimated discontinuity among these control plans at age-18 is economically small and statistically indistinguishable from zero in both Panel A and Panel B. These null results rule out spillover effects from non-ADHD drug policies, confirming that the observed reduction in ADHD prescribing is attributable to the ADHD-specific prior authorization requirement rather than by concurrent restrictions from other psychotropic agents.

7 Conclusions

Medicaid increasingly relies on prior authorization, an administrative ordeal rather than prices, to manage prescription drug use. This type of non-price rationing can reallocate care by raising shadow prices in ways that are hard to observe but first-order for access. Despite the importance of these policies for Medicaid, there is limited evidence of their impact and underlying mechanisms. Leveraging the age discontinuities in prior authorization restrictions in Pennsylvania's Medicaid program, this study demonstrates that the prior authorization of ADHD drugs effectively reduces drug spending but restricts patient access to medications. The reduction in access is primarily driven by the hassle costs associated with filing prior authorization requests, which leads to poor targeting of treatment. And the growing administrative workload imposed by prior authorization likely strains physicians' capacity in managing prior authorization requests and maintaining optimal prescribing practices.

[30] In plans with an age-18 prior-authorization cutoff for antidepressants, prior authorization is required for enrollees younger than 18.

From a social welfare perspective, evaluating prior authorization policies requires balancing insurers' cost savings against potential patient health outcomes. Pennsylvania spent $1.5 billion on Medicaid prescription drugs in 2017, the first year of our study period, with ADHD medications accounting for approximately $90 million (6% of total prescription drug spending).[31] The implementation of prior authorization reduced ADHD medication expenditures by 13.7%, generating nearly $12.33 million in annual savings. We estimate that around 19% to 31% of savings ($2.3 to $3.8 million) comes from reductions in inappropriate use, which enhances welfare efficiency by preventing unnecessary use of ADHD drugs and by as much as 69% to 81% of savings ($8.5 to $10 million) could be from reductions in appropriate use, which is a result of hassle cost and creates treatment misalignment.[32] This suggests that hassle costs account for a larger share of the reduction in utilization and spending from prior authorization. This misalignment between clinical need and treatment access represents a welfare cost that must be weighed against the savings from reduced prescription drug spending.

This trade-off underscores the need for policymakers to carefully balance cost containment goals with ensuring access to necessary medications. The observed hassle costs for physicians, which play a significant role in driving reductions in access, point to inefficiencies in the current prior authorization system that may diminish patients' access to needed medications. In light of these findings, policy reforms should prioritize shrinking the upstream burden on prescribers, such as through "gold-card" programs, rather than focusing solely on narrower PA criteria or faster adjudication, which mainly act after a request has been filed. By reducing the paperwork required to start a request, policymakers can preserve screening mechanism while materially lowering the shadow price of access.

[31] See this report from Pennsylvania Department of the Auditor General. https://www.paauditor.gov/wp-content/uploads/audits-archive/Media/Default/Reports/RPT_PBM_rebates_022819_final.pdf#:~:text=Pennsylvania%20paid%20almost%20%243,the%20Department%20of%20Human%20Services

[32] Among the age group we study, which includes the majority of ADHD medication users, approximately 10% of enrollees have an ADHD diagnosis, while the remaining 90% do not. Among those diagnosed with ADHD, roughly 31% use ADHD medications, and prior authorization reduces use by 18%, yielding a total effect of $0.1 \times 0.31 \times 0.18 = 0.00558$. Among enrollees without an ADHD diagnosis, 0.6% use ADHD medications, and prior authorization reduces use by 24%, resulting in a total effect of $0.9 \times 0.006 \times 0.24 = 0.001296$. Thus, about 81% ($0.0051 / (0.00558+0.001296)$) of the total reduction in ADHD drug use comes from appropriate patients. Appendix Figure A4 presents the sensitivity analyses of the welfare calculations.

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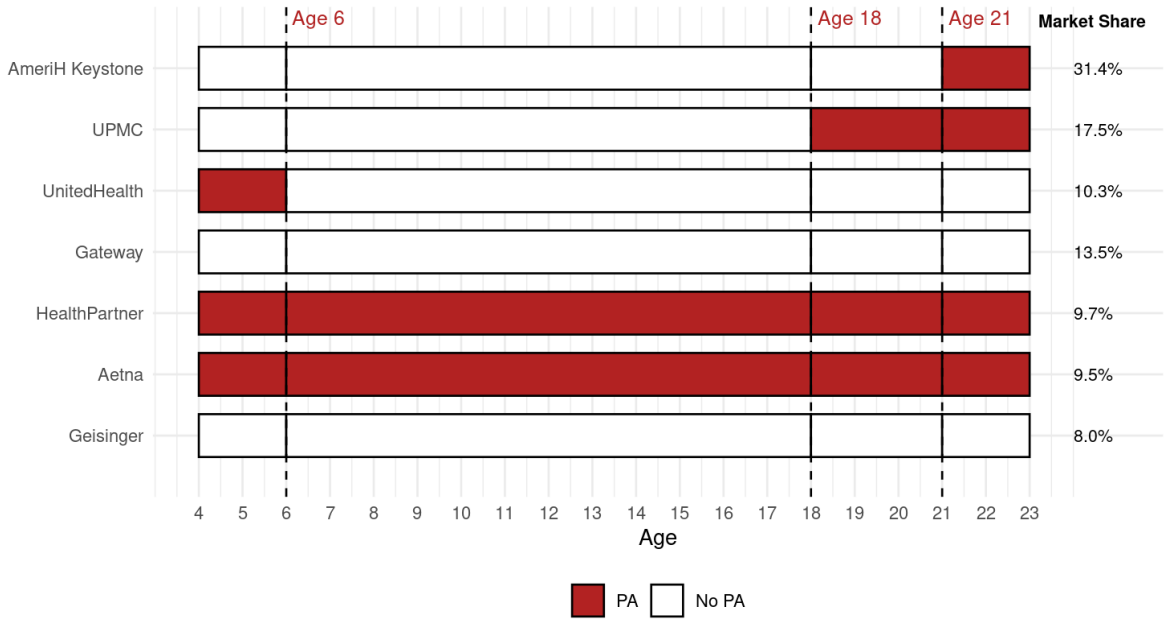
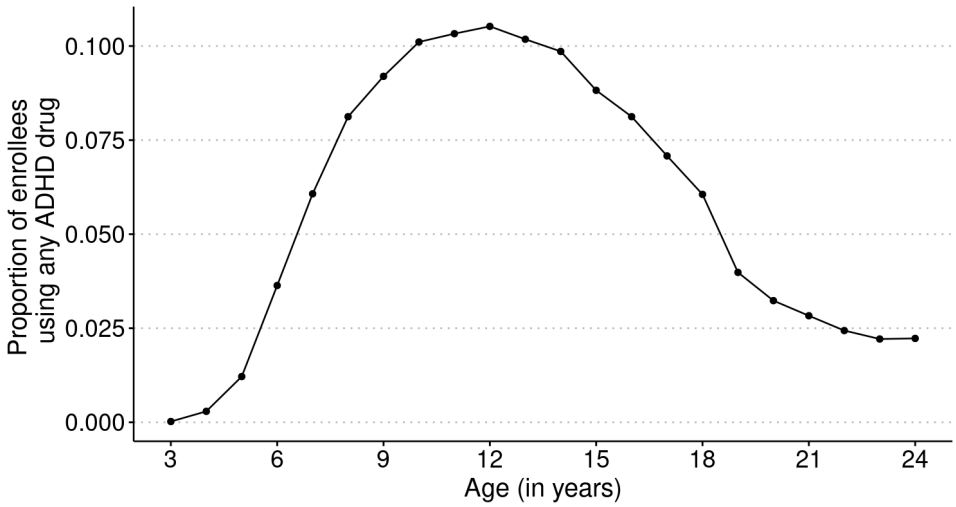
Figures and Tables

Figure 1: Prior Authorization Requirement by Age across Plans



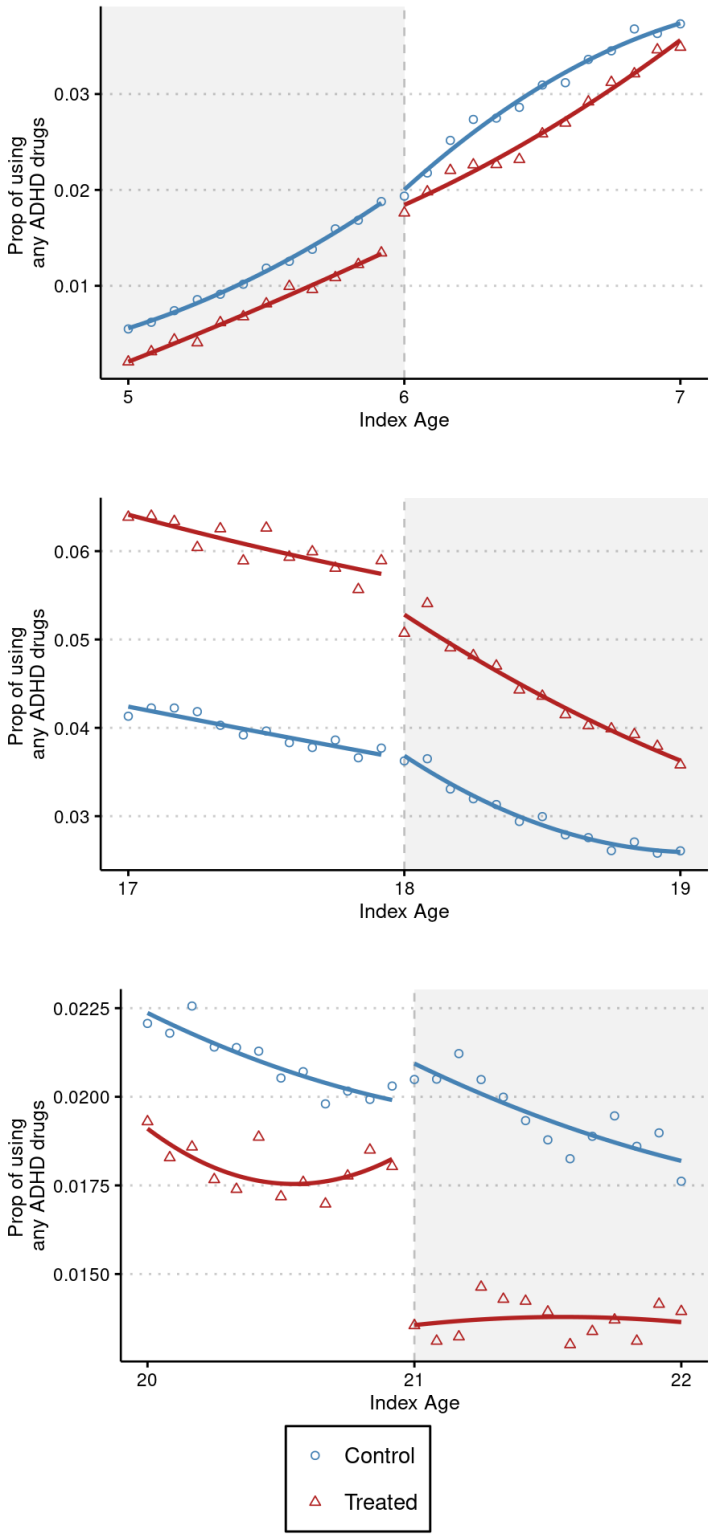
Note: Prior authorization requirement for ADHD drugs by age in all MMC plans in Pennsylvania Medicaid. Two age cutoffs are excluded: UPMC has prior authorizations for before age 4 and AmeriHelath Keystone has prior authorization before age 3. These age cutoffs are excluded in this study as there as few patients using ADHD drugs before age 4, as shown in Figure 2. Market share is the share of MMC enrollees in each plan.

Figure 2: ADHD Prescription Drug Use by Age



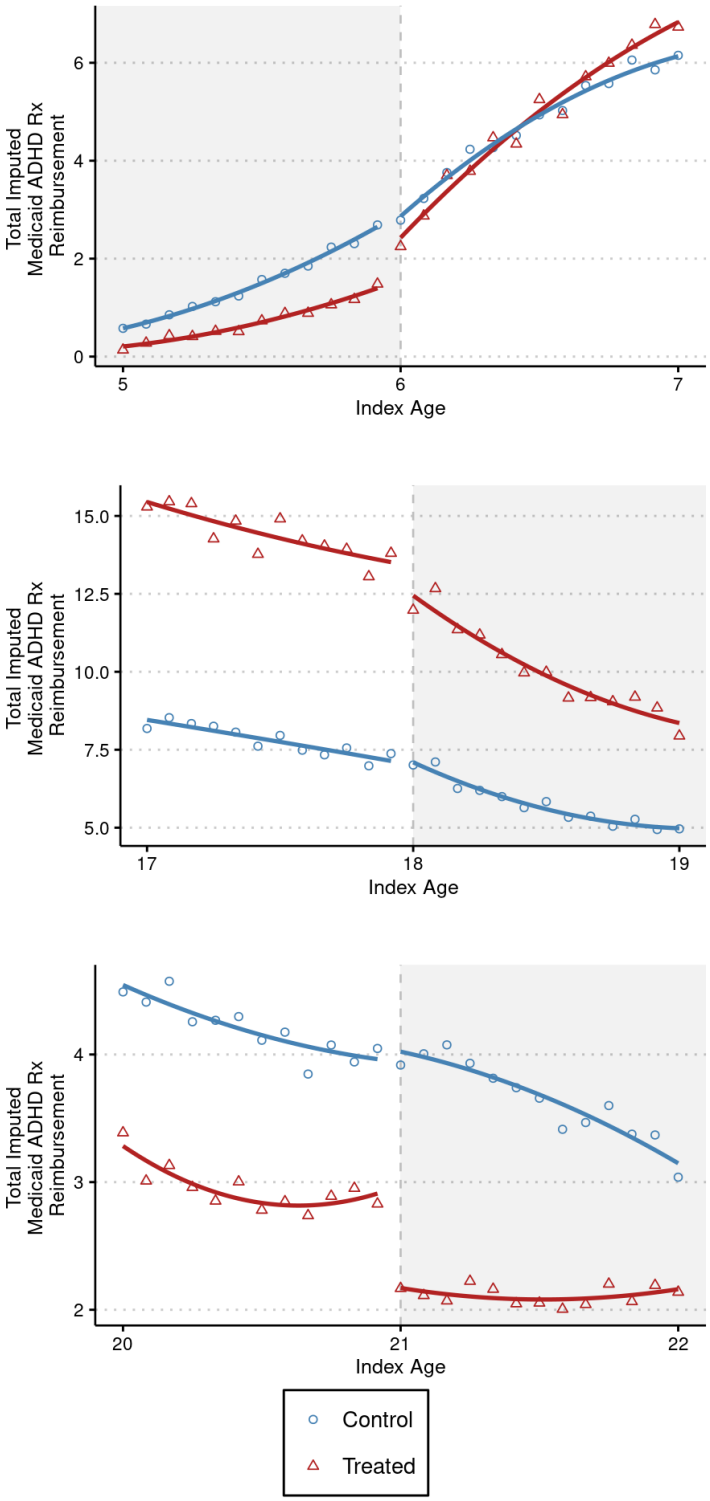
Note: The graph shows the probability of using any ADHD medication at each age in our sample. Age is measured in years

Figure 3: ADHD Prescription Drug Utilization in Treated and Control Plans by Age



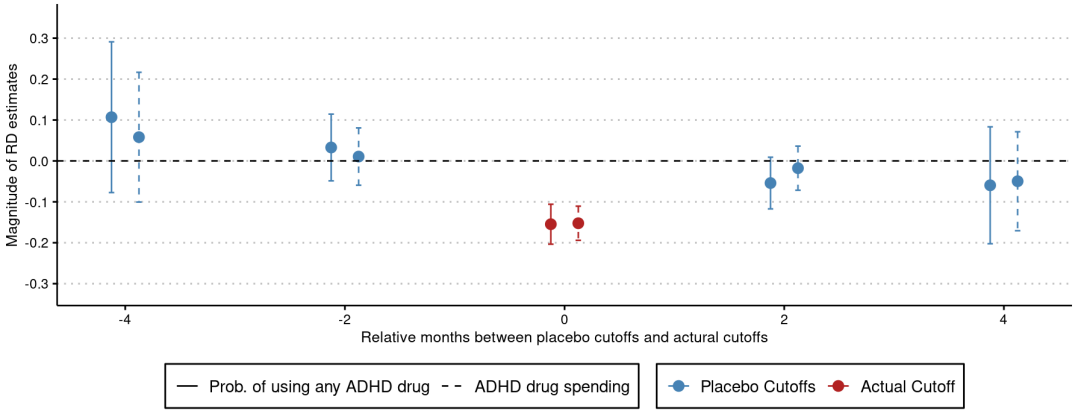
Note: Each graph displays the proportion of beneficiaries who filled any ADHD prescription drugs at different ages (measured in months). Shaded areas indicate that prior authorizations are required. Line fitted using a second-order polynomial regression to illustrate the relationship without adjusting for controls. The vertical dashed lines represent age cutoffs around which prior authorization requirements change in treated plans. Around age 6, United Health is the treated plan and beneficiaries under age 6 in this plan are subject to prior authorization, while all other plans (AmeriHealth/Keystone, UPMC, Aetna, Geisinger, Health Partner, Gateway) are control plans. At age 18, UPMC is the treated plan and beneficiaries above age 18 in this plan are subject to prior authorization, while all other plans (United Health, AmeriHealth/Keystone, Aetna, Geisinger, Health Partner, Gateway) are control plans. At age 21, AmeriHealth/Keystone is the treated plan and beneficiaries above age 21 in this plan are subject to prior authorization, while all other plans (United Health, UPMC, Aetna, Geisinger, Health Partner, Gateway) are control plans.

Figure 4: ADHD Prescription Drug Spending in Treated and Control Plans by Age

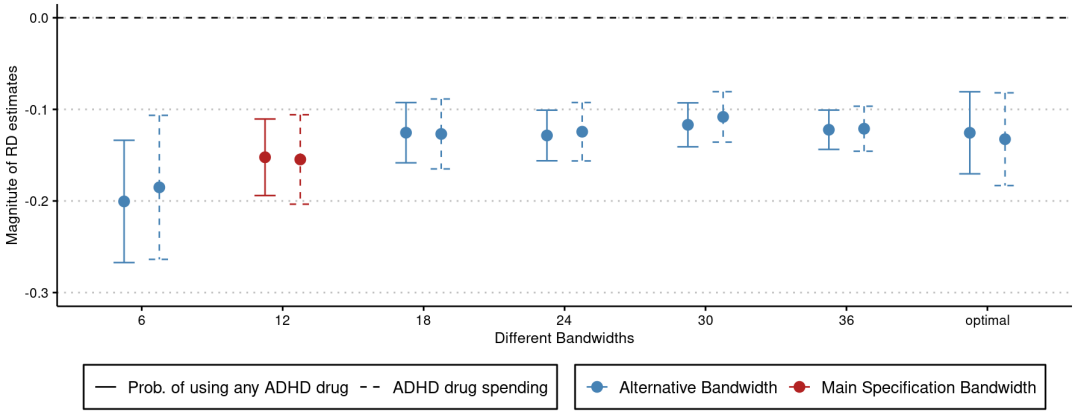


Note: Each graph displays the average of total Medicaid spending on ADHD prescription drugs at different ages (measured in months). Shaded areas indicate that prior authorizations are required. Line fitted using a second-order polynomial regression to illustrate the relationship without adjusting for controls. Medicaid spending is zero when a patient doesn't use any ADHD prescription drug. The vertical dashed lines represent age cutoffs around which prior authorization requirements change in treated plans. Around age 6, United Health is the treated plan and beneficiaries under age 6 in this plan are subject to prior authorization, while all other plans (AmeriHealth/Keystone, UPMC, Aetna, Geisinger, Health Partner, Gateway) are control plans. At age 18, UPMC is the treated plan and beneficiaries above age 18 in this plan are subject to prior authorization, while all other plans (United Health, AmeriHealth/Keystone, Aetna, Geisinger, Health Partner, Gateway) are control plans. At age 21, AmeriHealth/Keystone is the treated plan and beneficiaries above age 21 in this plan are subject to prior authorization, while all other plans (United Health, UPMC, Aetna, Geisinger, Health Partner, Gateway) are control plans.

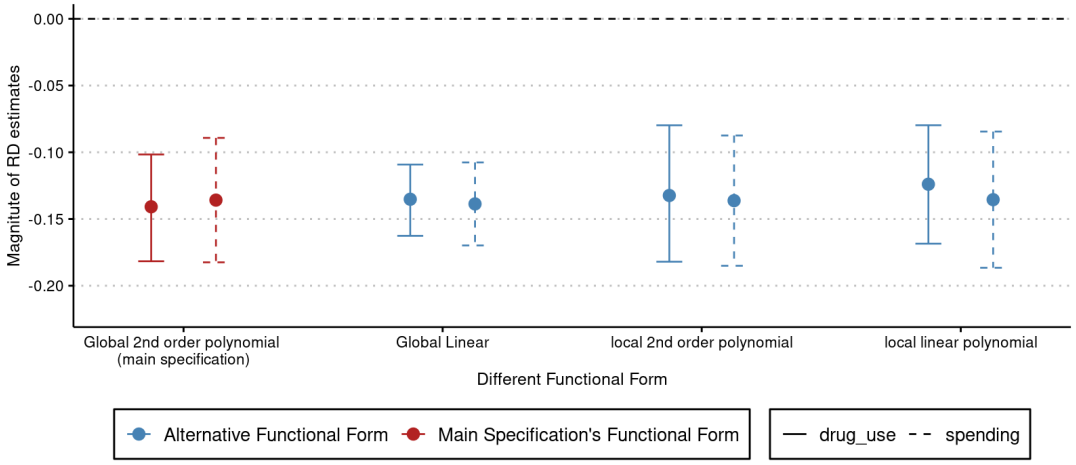
Figure 5: Robustness checks



(a) Placebo Cutoffs



(b) Alternative Bandwidths



(c) Alternative Functional Form

Note: Panel (a) presents the estimates of Eq.(2) using placebo age cutoffs. For example, "-2" indicates the discontinuity is estimated two months before the actual age cutoff, while "2" indicates it is estimated two months after the cutoff. Panel (b) displays the estimates of Eq.(2) using different bandwidths, measured in months. “Optimal bandwidth” denotes the local-linear estimate obtained using the optimal bandwidth of Calonico et al. (2020). Panel (c) shows the estimates of Eq. (2) using alternative functional forms, including global linear regression, local linear and local second-order polynomial regression.

Table 1: Summary Statistics

	Age 5-7		Age 17-19		Age 20-22	
	Treated	Control	Treated	Control	Treated	Control
Demographic variables						
Female	0.4761	0.4778	0.4824	0.4884	0.574	0.5718
	(0.4994)	(0.4995)	(0.4997)	(0.4999)	(0.4945)	(0.4948)
White	0.4316	0.4776	0.764	0.4671	0.4117	0.5704
	(0.4953)	(0.4995)	(0.4246)	(0.4989)	(0.4921)	(0.495)
Zipcode AGI	54092.8537	50818.4061	52148.4576	52480.6661	53616.3984	50662.5579
	(20472.6017)	(19163.9568)	(15585.0967)	(20957.7531)	(23063.5251)	(18071.2562)
Eligibility						
Under Age 19	0.8045	0.7963	0.6979	0.7129	0.0025	0.0023
Poverty	0.0794	0.0818	0.1269	0.1084	0.4415	0.4241
SSI	0.0467	0.0519	0.0957	0.1045	0.0759	0.0746
Pregnancy	0.000	0.000	0.0005	0.0005	0.0817	0.0904
Other	0.0693	0.0701	0.0791	0.0737	0.3985	0.4086
Outcome variables						
Prob of using any ADHD drugs	0.0173	0.0206	0.0527	0.035	0.016	0.0202
	(0.1305)	(0.1419)	(0.2235)	(0.1838)	(0.1256)	(0.1408)
Average ADHD drug claims in the population	0.021	0.0256	0.0661	0.0436	0.0192	0.0245
Average ADHD drug claims conditional on using any ADHD drug	(0.1696)	(0.1912)	(0.3046)	(0.2486)	(0.1611)	(0.1828)
Average ADHD drug claims conditional on using any ADHD drug	1.2116	1.2442	1.2534	1.2452	1.1958	1.2101
	(0.4666)	(0.5111)	(0.5208)	(0.5185)	(0.462)	(0.4661)
ADHD diagnosis	0.0608	0.0705	0.1174	0.0905	0.0358	0.0449
	(0.2389)	(0.256)	(0.3219)	(0.2869)	(0.1859)	(0.2071)
ADHD drug spending	2.7697	3.1004	12.361	6.8365	2.5612	3.9355
	(26.0493)	(26.803)	(58.3899)	(42.1666)	(24.5734)	(32.0937)
Number of unique patients	24361	223774	35889	167364	55631	128485
Number of observations	227105	2241111	341271	1661878	490248	1121062

Note: Summary statistics are calculated at the beneficiary-age level separately for treated and control plans. Age is measured in months. Standard deviations are shown in parentheses. The treated plan is United Healthcare around age 6, UPMC around age 18, and AmeriHealth/Keystone First around age 21. Control plans are those without changes in prior authorization requirements around each cutoff age. These plans consistently have prior authorization on both sides of the age threshold or lack prior authorization on both sides. ADHD drug spending represents total Medicaid reimbursement for prescriptions at each age.

Table 2: Covariates Tests

	Female	Zipcode Median Household Income	White	SSI
	(1)	(2)	(3)	(4)
Panel A: Treated Plans				
Prior Authorization	-0.0049**	-8.3879	-0.0008	-0.0000
	0.0017	7.2982	0.0010	0.0009
Pre-mean	0.5033	53511.0132	0.5363	0.0698
Magnitude	-0.97%	-0.02%	-0.16%	-0.05%
Obvs.	1028092	1022425	1028092	1028092
Panel B: Control Plans				
Prior Authorization	-0.0021	-4.2777	-0.0005	-0.0018**
	0.0011	3.4575	0.0007	0.0006
Pre-mean	0.5067	51435.2558	0.5068	0.076
Magnitude	-0.42%	-0.01%	-0.1%	-2.41%
Obvs.	4820032	4800903	4820032	4820032
Panel C: RD-DID				
Prior Authorization	-0.0051	-7.8005	-0.0016	-0.0044**
	0.0026	8.1794	0.0016	0.0014
Pre-mean	0.5033	53511.0132	0.5363	0.0698
Magnitude	-1.01%	-0.01%	-0.3%	-6.26%
Obvs.	5848124	5823328	5848124	5848124

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Columns (1), (3), and (4) use individual-level gender, race, and eligibility information from Medicaid enrollment files as outcomes. The outcome in column (2) is ZIP code-level median household income for 2017-2018 from the American Community Survey. Controls include managed care plan fixed effects, quarter-year fixed effects, and ZIP code fixed effects for column (1), and gender, managed care plan fixed effects, quarter-year fixed effects, and ZIP code fixed effects for columns (2)-(4). Results are RD estimates from Eq.(2) in Panel A and B and RD-DID estimates from Eq.(3) for each outcome.

Table 3: Impact of Prior Authorization on ADHD Drug Use by Age Cutoff

	Prob of using any ADHD drug			ADHD drug spending		
	Treated (1)	Control (2)	RD-DID (3)	Treated (4)	Control (5)	RD-DID (6)
Panel A: All ages						
Prior Authorization	-0.0052***	0.0006	-0.0053***	-1.0148***	0.1377	-0.9624***
	(0.0007)	(0.0004)	(0.0009)	(0.182)	(0.0765)	(0.1965)
Pre-Treatment Mean	0.0353	0.0303	0.0352	7.4301	5.5335	7.414
Magnitude	-14.73%	1.98%	-15.06%	-13.66%	2.49%	-12.98%
Obvs.	1028092	4820032	5818475	1028092	4820032	5818475
Panel B: Age 6						
Prior Authorization	-0.0021	-0.0001	-0.0018	-0.7963**	-0.0131	-0.6732*
	(0.0014)	(0.0005)	(0.0018)	(0.3026)	(0.0948)	(0.3384)
Pre-Treatment Mean	0.0274	0.0309	0.0274	4.9292	4.9285	4.9292
Magnitude	-7.66%	-0.32%	-6.57%	-16.15%	-0.27%	-13.66%
Obvs.	196573	2241111	2437684	196573	2241111	2437684
Panel C: Age 18						
Prior Authorization	-0.0064***	0.0002	-0.0066***	-1.4458**	0.0592	-1.4954***
	(0.0016)	(0.0007)	(0.0017)	(0.4463)	(0.1585)	(0.4005)
Pre-Treatment Mean	0.0606	0.039	0.0606	14.4129	7.4645	14.4129
Magnitude	-10.56%	0.51%	-10.89%	-10.03%	0.79%	-10.38%
Obvs.	341271	1457859	1799130	341271	1457859	1799130
Panel D: Age 21						
Prior Authorization	-0.0053***	-0.0002	-0.005***	-0.8792***	-0.2291	-0.6521**
	(0.0008)	(0.0006)	(0.0011)	(0.1673)	(0.1371)	(0.2376)
Pre-Treatment Mean	0.018	0.021	0.018	2.9483	4.2076	2.9483
Magnitude	-29.44%	-0.95%	-27.78%	-29.82%	-5.44%	-22.12%
Obvs.	490248	1121062	1611310	490248	1121062	1611310

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Panel A presents the estimates of Eq.(2) (the first two columns under each outcome) and Eq.(3) (the last column under each outcome) for all ages, comparing treated and control plans separately. Panels B through D present the estimates of Eq.(1) (the first two columns under each outcome) and Eq.(3) (the last column under each outcome) for patients around age cutoffs at 6, 18, and 21, respectively, with treated and control plans reported separately in each case. Controls include female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects.

Table 4: Impact of Prior Authorization on Drug Fill Time

	Number of days (1)	Same day (2)	Within 7 days (3)
Panel A: Treated Plans			
Prior Authorization	2.4306**	-0.0998***	-0.0806***
	(0.7494)	(0.0165)	(0.017)
Controls	Yes	Yes	Yes
Pre-Treatment Mean	14.0135	0.3382	0.621
Magnitude	17.34%	-29.51%	-12.98%
Obvs.	27828	27828	27828
Panel B: Control Plans			
Prior Authorization	0.3418	-0.0066	-0.0162*
	(0.3366)	(0.0084)	(0.0082)
Controls	Yes	Yes	Yes
Pre-Treatment Mean	13.5065	0.3532	0.6269
Magnitude	2.53%	-1.87%	-2.58%
Obvs.	115155	115155	115155

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Panel A presents the estimates of Eq.(2) among treated plans and Panel B presents these estimates among control plans. The outcome is the number of days between the prescription date and drug fill date in column (1), whether Rx is filled on the same day as the prescription date in column (2) and whether Rx is filled within 7 days of the prescription date in column (3). The sample includes beneficiary–age–month observations with at least one ADHD prescription. Controls include female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects.

Table 5: Impact of Prior Authorization on ADHD Drug Utilization by Patient's Appropriateness

	Inappropriate Patients	Appropriate Patients		
	No Diagnosis	Diagnosis	Diagnosis + Use History	Diagnosis + Use History + Specialist
	(1)	(2)	(3)	(4)
Panel A: Treated Plans				
Prior Authorization	-0.0014***	-0.0539***	-0.0448***	-0.0523***
	(0.0003)	(0.0076)	(0.0073)	(0.011)
Pre-Treatment Mean	0.0057	0.3059	0.2757	0.3447
Magnitude	-24.22%	-17.63%	-16.24%	-15.18%
Obvs.	786222	71436	68849	36218
Panel B: Control Plans				
Prior Authorization	0.0002	-0.0033	0.0001	0.0058
	(0.0001)	(0.0034)	(0.0033)	(0.0049)
Pre-Treatment Mean	0.0041	0.2903	0.2616	0.3243
Magnitude	4.55%	-1.13%	0.04%	1.8%
Obvs.	3673398	358685	344490	182217

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Appropriate patients are defined as: those with an observed ADHD diagnosis in their outpatient claims at or before their age in column (1); those with ADHD diagnosis and with ADHD drug filled before the age in column (2); those with with ADHD diagnosis, with ADHD drug filled before the index age and main prescriber is pediatrics, psychologists or neurologists in column (3). Inappropriate patients are defined as those who do not have an ADHD diagnosis in their claims at or before their index age and are also predicted by our ML algorithm not to have an ADHD diagnosis. The outcome variable indicates whether the beneficiary filled any ADHD medication prescription at a given age. Controls include female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects.

Table 6: Spillover Effect of Prior Authorization on ADHD Drug Utilization

	Prescriber's Modal Plan	
	Treated	Control
	(1)	(2)
Panel A: Patient's plan is treated		
Prior Authorization	-0.0094***	-0.0041*
	(0.0013)	(0.0016)
Pre-Treatment Mean	0.0548	0.0503
Magnitude	-17.18%	-8.12%
Obvs.	470228	226272
Panel B: Patient's plan is control		
Prior Authorization	-0.0006	0.0008
	(0.0015)	(0.0005)
Pre-Treatment Mean	0.0509	0.0457
Magnitude	-1.23%	1.73%
Obvs.	348836	2929476

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Panel A presents the RD estimates for patients enrolled in treated plans around their age cutoff. Panel B presents the RD estimates for patients enrolled in control plans around their age cutoff. A patient's prescriber is defined as the most frequent prescriber for a patient across all prescription claims during the study period. Patients with fewer than five prescription claims are excluded due to insufficient data. A prescriber's modal plan refers to the Medicaid MMC plan with the highest number of patients for that prescriber. Prescribers with a tie in patient frequency across plans are excluded. The outcome variable indicates whether the beneficiary filled any ADHD medication prescription at a given age. Controls include female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects.

Appendix

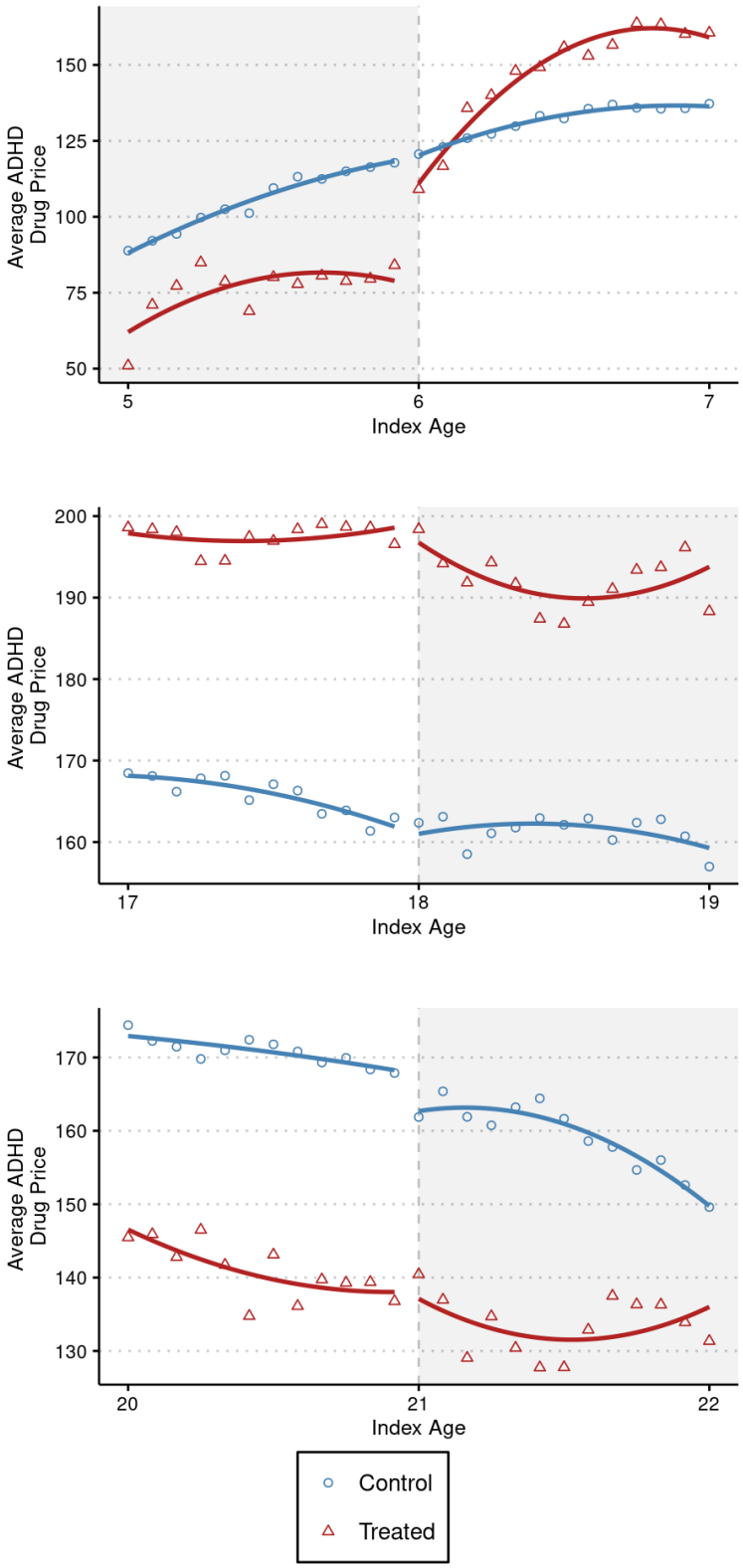
A Additional Tables and Figures

Figure A1: Example of Prior Authorization Guideline

Field Name	Field Description
Prior Authorization Group Description	**ADHD Medications**
Drugs	
Covered Uses	Medically accepted indications are defined using the following sources: the Food and Drug Administration (FDA), Micromedex, American Hospital Formulary Service (AHFS), United States Pharmacopeia Drug Information for the Healthcare Professional (USP DI), the Drug Package Insert (PPI), or disease state specific standard of care guidelines.
Exclusion Criteria	N/A
Required Medical Information	See "other criteria"
Age Restrictions	Members ≥ 21 years old (See other Criteria)
Prescriber Restrictions	N/A
Coverage Duration	If the criteria are met, the request will be approved with up to a 6 month duration; if the criteria are not met, the request will be referred to a clinical reviewer for medical necessity review.
Other Criteria	**Initial Authorization:** **For members 21 and older:** o Appropriate diagnosis/indication for requested ADHD medication o For use in adults for Attention Deficit Hyperactivity Disorder, the DSM-V criteria must be met: 5 symptoms are required (see attachment 1).

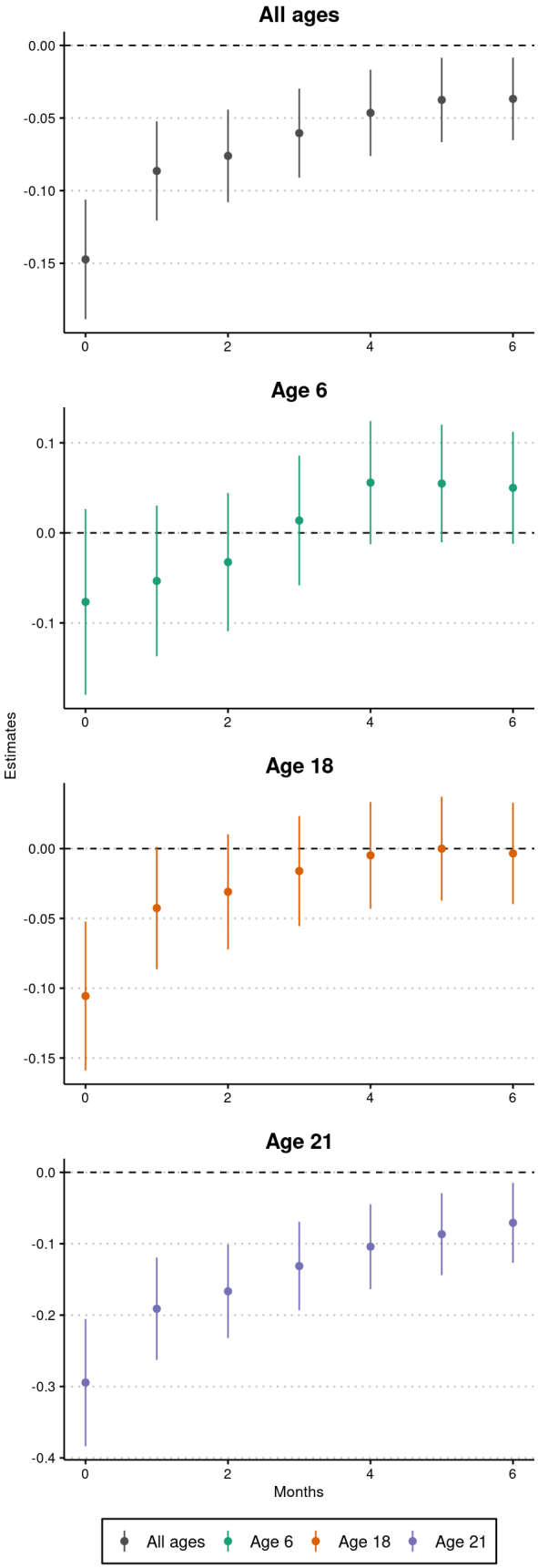
Note: Amerihealth/Keystone First's prior authorization guideline for ADHD Medications.

Figure A2: ADHD Prescription Drug Prices in Treated and Control Plans by Age



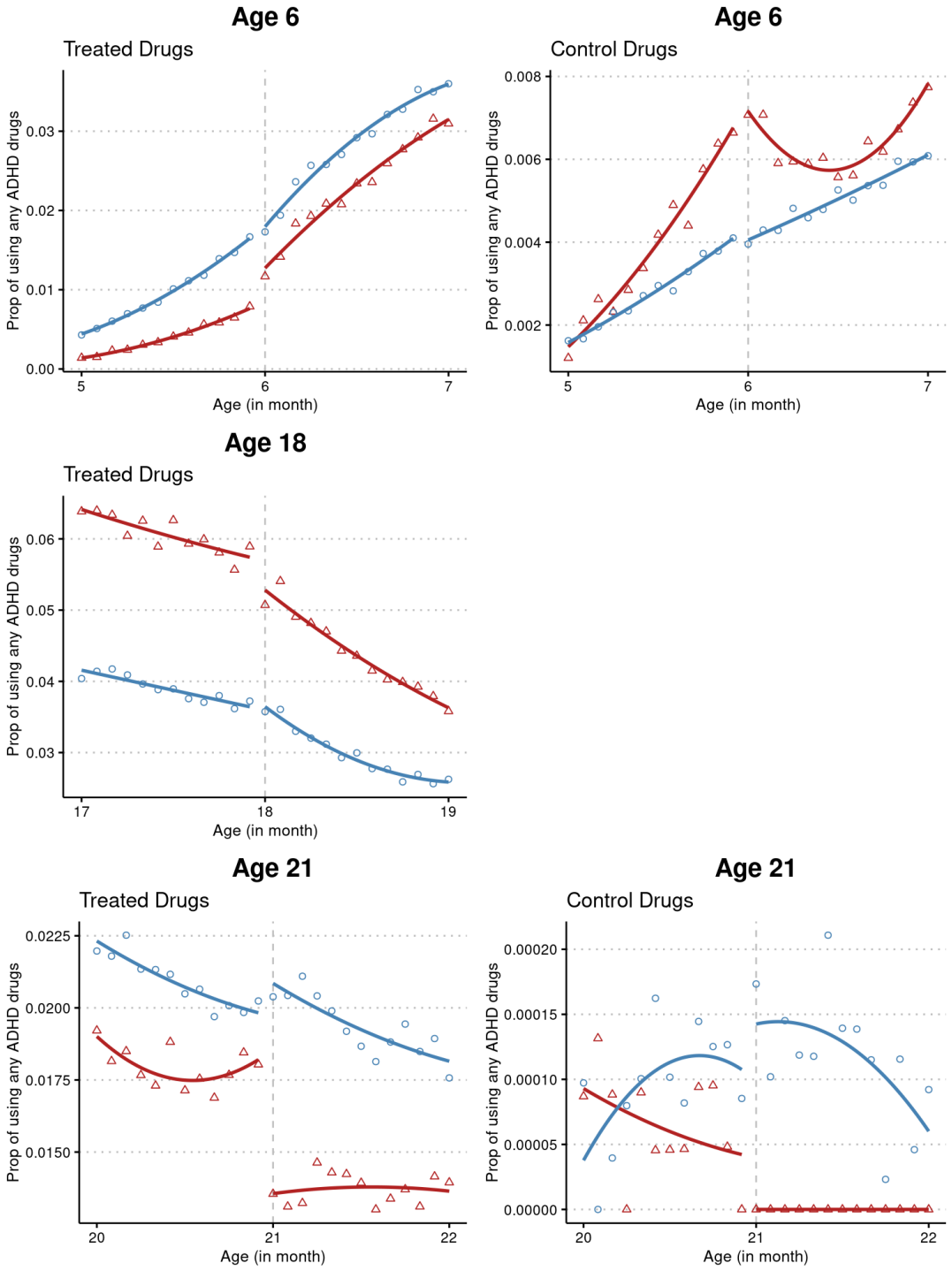
Note: Each graph displays the average price of ADHD prescription drugs at different indexed ages. Price is imputed using the total amount of Medicaid reimbursement divided by the total number of prescriptions among MMCs in the Pennsylvania Medicaid program using the State Drug Utilization Dataset. Shaded areas indicate that prior authorizations are required. Line fitted using a second-order polynomial regression to illustrate the relationship without adjusting for controls. The vertical dashed lines represent age cutoffs around which prior authorization requirements change in treated plans.

Figure A3: Impact of Prior Authorization on the Probability of Using ADHD Drug in the Next 1-6 Months



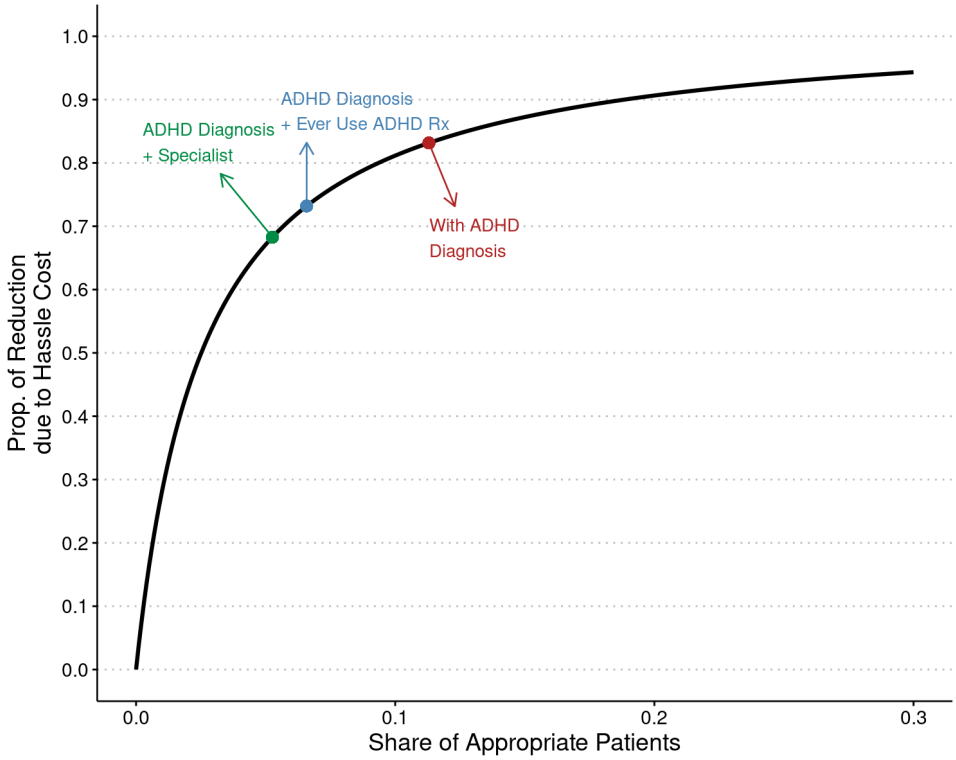
Note: *** p < 0.001; ** p < 0.01; * p < 0.05. The top panel reports RD estimates from Eq. (2) for the probability of filling any ADHD prescription within the *next* X months for analysis around age 18 and age 21, and the probability of filling any ADHD prescription over the *previous* X months for analysis around age 6. Each estimate is normalized by the pre-treatment mean of the outcome. The rest three graphs present the corresponding RD estimates for beneficiaries within the bandwidths surrounding the age cut-offs at 6, 18, and 21 years, respectively.

Figure A4: Robustness check: Directly Treated Drugs vs. Not Directly Treated Drugs.



Each graph displays the proportion of beneficiaries who filled any treated or control ADHD prescription drugs at different ages. Treated drugs are those directly subject to prior authorization changes at the age cutoff, while control drugs are not subject to prior authorization changes. For UPMC, all drugs become subject to prior authorization at age 18. Line fitted using a second-order polynomial regression to illustrate the relationship without adjusting for controls. The vertical dashed lines represent age cutoffs around which prior authorization requirements change in treated plans.

Figure A5: Back-of-Envelop Calculation



This figure shows the proportion of drug utilization reduction attributable to appropriate patients due to prior authorization hassle costs. Among appropriate patients, 31% use ADHD medications in the absence of prior authorization, while only 0.6% of inappropriate patients use these medications. Table 5 indicates that prior authorization reduces drug utilization by 18% among appropriate patients and 24% among inappropriate patients.For a population with share x of appropriate patients, the reduction in drug utilization equals $x \times 0.31 \times 0.18$ for approperiate patients, and $x \times 0.006 \times 0.24$ for inappropriate patients. The proportion of total reduction attributable to appropriate patients is therefore: $\frac{x \times 0.31 \times 0.18}{(x \times 0.31 \times 0.18) + (x \times 0.006 \times 0.24)}$. Three reference points are as follows: the red dot represents patients ever diagnosed with ADHD between ages 0-24; the blue dot represents patients both diagnosed with ADHD and having used ADHD medications at least once between ages 0-24; and the green dot represents patients diagnosed with ADHD whose primary provider is a specialist (defined as the provider prescribing the most medications for that patient).

Table A1: Impact of Prior Authorization on ADHD Drug Use: Heterogeneity

Panel A: By Gender		
	Female	**Male**
Prior Authorization	-0.0034***	-0.0077***
	(0.0009)	(0.0014)
Pre-Treatment Mean	0.0235	0.0465
Magnitude	-14.47%	-16.56%
Obvs.	2,949,486	2,868,989
Panel B: By Race/Ethnicity		
	White	**Non-White**
Prior Authorization	-0.0072***	-0.0028**
	(0.0014)	(0.001)
Pre-Treatment Mean	0.0478	0.0206
Magnitude	-15.06%	-13.59%
Obvs.	2,920,549	2,897,926
Panel C: By Modal Provider's Type		
	Physicians	**Non-physicians**
Prior Authorization	-0.011***	-0.0025
	(0.0018)	(0.0016)
Pre-Treatment Mean	0.0637	0.0307
Magnitude	-17.27%	-8.14%
Obvs.	2,399,874	1,184,217

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. The outcome variable is whether a beneficiary uses any ADHD drug at a given age. Modal providers in Panel C is defined as the prescriber who gives the highest number of prescriptions for each patient during the study period. Patients with fewer than five prescription claims are excluded due to insufficient data. Beneficiaries without any prescription records in our data are also excluded. Controls include female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects.

Table A2: Impact of Prior Authorization on the Price of Used ADHD Drugs

	ADHD Drug Price		
	Treated	Control	RD-DID
Panel A: Age 6			
	(7)	(8)	(9)
Prior Authorization	-34.0484***	-2.3849	-27.2803***
	(6.7555)	(1.6535)	(6.8034)
Controls	Yes	Yes	Yes
Pre-Treatment Mean	149.2609	132.3814	149.2609
Magnitude	-22.81%	-1.8%	-18.28%
Obvs.	3,336	46,046	49,382
Panel B: Age 18			
	(13)	(14)	(15)
Prior Authorization	-0.5057	-0.4174	0.2062
	(1.9169)	(1.1559)	(2.2846)
Controls	Yes	Yes	Yes
Pre-Treatment Mean	197.4721	161.6391	197.4721
Magnitude	-0.26%	-0.26%	0.1%
Obvs.	17,999	50,459	68,458
Panel C: Age 21			
	(19)	(20)	(21)
Prior Authorization	-1.3193	1.2097	-1.1573
	(2.6182)	(1.6802)	(3.3239)
Controls	Yes	Yes	Yes
Pre-Treatment Mean	140.9636	170.7824	140.9636
Magnitude	-0.94%	0.71%	-0.82%
Obvs.	7,856	22,682	30,538

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. The outcome variable is the average price of ADHD prescription drugs at different indexed ages. Price is imputed using the total amount of Medicaid reimbursement divided by the total number of prescriptions among MMCs in the Pennsylvania Medicaid program using the State Drug Utilization Dataset. The sample includes beneficiary–age–month observations with at least one ADHD prescription. Controls include female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects.

Table A3: Robustness Check: ADHD Diagnosis Changes Around Age Cutoffs.

	Treated (1)	Control (2)	RD-DID (3)
Panel A: All ages			
Prior Authorization	-0.0004	0.0012*	-0.0007
	(0.0009)	(0.0005)	(0.0013)
Pre-Treatment Mean	0.083	0.0804	0.0828
Magnitude	-0.48%	1.49%	-0.85%
Obvs.	1028092	4820032	5818475
Panel B: Age 6			
Prior Authorization	-0.003	-0.0001	-0.0017
	(0.0021)	(0.0008)	(0.0028)
Pre-Treatment Mean	0.0831	0.094	0.0831
Magnitude	-3.61%	-0.11%	-2.05%
Obvs.	196573	2241111	2437684
Panel C: Age 18			
Prior Authorization	0.0005	0.0014	-0.0005
	(0.0017)	(0.0009)	(0.0021)
Pre-Treatment Mean	0.1277	0.0985	0.1277
Magnitude	0.39%	1.42%	-0.39%
Obvs.	341271	1457859	1799130
Panel D: Age 21			
Prior Authorization	0.0001	0.0004	0.0003
	(0.0009)	(0.0007)	(0.0013)
Pre-Treatment Mean	0.0381	0.0486	0.0381
Magnitude	0.26%	0.82%	0.79%
Obvs.	490248	1121062	1611310

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. The outcome variable is whether an ADHD diagnosis is recorded in outpatient claims at or before the given age for each beneficiary. Panel A presents the estimates of Eq.(2) (the first two columns under each outcome) and Eq.(3) (the last column under each outcome) for all ages, comparing treated and control plans separately. Panels B through D present the estimates of Eq.(1) (the first two columns under each outcome) and Eq.(3) (the last column under each outcome) for patients around age cutoffs at 6, 18, and 21, respectively, with treated and control plans reported separately in each case. Controls include female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects.

Table A4: Robustness check: Directly Treated Drugs vs. Not Directly Treated Drugs.

	Treated Plan		Control Plan	
	Treated drugs (1)	Control drugs (2)	Treated drugs (3)	Control drugs (4)
Panel A: Age 6				
Prior Authorization	-0.0044***	0.0012	-0.0004	0.0003
	(0.0012)	(0.0008)	(0.0005)	(0.0002)
Pre-Treatment Mean	0.0238	0.0064	0.0293	0.0051
Magnitute	-18.49%	18.75%	-1.37%	5.88%
Obvs.	227105	227105	1992555	1992555
Panel B: Age 18				
Prior Authorization	-0.0064***	-	-0.0001	-
	(0.0016)	-	(0.0007)	-
Pre-Treatment Mean	0.0606	-	0.0396	-
Magnitute	-10.56%	-	-0.25%	-
Obvs.	341271	-	1661878	-
Panel C: Age 21				
Prior Authorization	-0.0053***	0.0000	0.0001	0.0000
	(0.0008)	(0.0000)	(0.0007)	(0.0001)
Pre-Treatment Mean	0.0179	0.0001	0.0234	0.0001
Magnitute	-29.61%	0.00%	0.43%	0%
Obvs.	490248	490248	949645	949645

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Treated drugs are those directly subject to prior authorization changes at the age cutoff, while control drugs are not subject to prior authorization changes. For UPMC, all drugs become subject to prior authorization at age 18. The outcome variable indicates whether a beneficiary fills a treated or control drug at a given age. Controls include female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects.

Table A5: Robustness Check: Copay Changes.

	Prob of using any ADHD drug		ADHD drug spending	
	Treated (1)	Control (2)	Treated (3)	Control (4)
Panel A: Age 18				
Prior Authorization	-0.0064***	-0.0004	-1.4458**	-0.0963
	(0.0016)	(0.0007)	(0.4463)	(0.1673)
Pre-Treatment Mean	0.0606	0.0401	14.4129	6.7111
Magnitute	-10.56%	-1.1%	-10.03%	-1.43%
Obvs.	341271	1504612	341271	1203963
Panel B: Age 21				
Prior Authorization	-0.0053***	-0.0002	-0.8792***	-0.0714
	(0.0008)	(0.0007)	(0.1673)	(0.1569)
Pre-Treatment Mean	0.018	0.0219	2.9483	3.8863
Magnitute	-29.44%	-0.76%	-29.82%	-1.84%
Obvs.	490248	967061	490248	754231

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. The outcome variable indicates whether the beneficiary filled any ADHD medication prescription and the total Medicaid spending on ADHD drugs at a given age. Controls include female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects. Copay changes occur at age 18 in AmeriHealth/Keystone, Geisinger, UPMC, and UnitedHealth, and at age 21 in Aetna, Health Partners, and Gateway. Since UPMC is the treated group at age 18 with a copay change, control plans are restricted to AmeriHealth/Keystone, Geisinger, and UnitedHealth, which also experience copay changes at age 18. For age 21, AmeriHealth/Keystone is the treated group without a copay change, so control plans are restricted to Geisinger, UPMC, and UnitedHealth, which similarly do not have copay changes at age 21. Results in columns (2) and (4) show no discontinuity in these newly constructed control groups, indicating that our findings are not driven by underlying copay changes.

Table A6: Robustness check: Impact of Prior Authorization on Plan Switching

	Prob of Switching Plan		Prob of Switching Plan (ever)	
	Treated (1)	Control (2)	Treated (3)	Control (4)
Prior Authorization	0.0000	0.0003	0.0008	0.0007
	(0.0004)	(0.0002)	(0.0006)	(0.0004)
Pre-Treatment Mean	0.0039	0.0035	0.0328	0.0297
Magnitude	0%	8.57%	2.44%	2.36%
Obvs.	1028092	4820032	1028092	4820032

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Plan switching is defined as enrollment in a different plan compared to the previous age (columns 1-2), and ever switching plans at a given age or before (columns 3-4). 2.7% of beneficiaries ever switched plans in our sample. Controls include female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects.

Table A7: RD-DID Estimates on the Number of Plan Enrollees

	Age 6 (1)	Age 18 (2)	Age 21 (3)
Prior Authorization	-54.4995	-5.4081	-0.7326
	(74.1102)	(84.9554)	(21.5692)
Pre-Treatment Mean	7414.8333	15011.4167	21831
Magnitude	-0.74%	-0.04%	0%
Obvs.	175	150	175

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Estimation using Eq.(3). The outcome is the total number of enrollees for at plan-age level. No controls are included.

Table A8: Robustness check: Impact of Prior Authorization among Continuously Enrolled Beneficiaries

	Prob of using any ADHD drug		ADHD drug spending	
	Treated (1)	Control (2)	Treated (3)	Control (4)
Panel A: All ages				
Prior Authorization	-0.0024	0.0007	-1.0131**	0.1714
	(0.0018)	(0.0004)	(0.3501)	(0.0898)
Pre-Treatment Mean	0.0294	0.0322	5.3716	5.867
Magnitude	-8.16%	2.17%	-18.86%	2.92%
Obvs.	83908	1996064	94199	2090185

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Controls include female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects. The sample is restricted to those who are enrolled in Medicaid one month before and age cutoff and one month after the age cutoff. The outcome variable indicates whether the beneficiary filled any ADHD medication prescription at a given age in column (1) and (2), and the total ADHD drug spending at a given age in column (3) and (4).

Table A9: Impact of Prior Authorization on ADHD Drug Use - with Individual Fixed Effects

	Prob of using any ADHD drug			ADHD drug spending		
	Treated	Control	RD-DID	Treated	Control	RD-DID
	(1)	(2)	(3)	(4)	(5)	(6)
Prior Authorization	-0.0049***	0.0002	-0.0052***	-0.9547***	0.0228	-0.9992***
	(0.0007)	(0.0003)	(0.0007)	(0.1675)	(0.0645)	(0.1634)
Pre-Treatment Mean	0.0353	0.0303	0.0352	7.4301	5.5335	7.414
Magnitude	-13.88%	0.66%	-14.77%	-12.85%	0.41%	-13.48%
Obvs.	1,028,092	4,820,032	5,818,475	1,028,092	4,820,032	5,818,475

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Controls include female, managed care plan fixed effects, quarter-year fixed effects, zipcode and beneficiary fixed effects. The outcome variable indicates whether the beneficiary filled any ADHD medication prescription at a given age in column (1) and (3), and the total ADHD drug spending at a given age in column (4) and (6).

Table A10: Robustness check: RD-DID Estimates Using Alternative Construction of Control Group Based on Prior Authorization Requirement.

	Prob of using any ADHD drug		ADHD drug spending	
	Control (Always Treated) (1)	Control (Never Treated) (2)	Control (Always Treated) (3)	Control (Never Treated) (4)
Panel A: All Ages				
Prior Authorization	-0.0046***	-0.0063***	-0.922***	-1.1503***
	(0.0009)	(0.001)	(0.1952)	(0.2229)
Pre-Treatment Mean	0.0352	0.0352	7.414	7.414
Magnitute	-13.07%	-17.9%	-12.44%	-15.52%
Obvs.	3087114	3729804	3087114	3729804
Panel B: Age 6				
Prior Authorization	-0.0006	-0.003	-0.602*	-0.8494*
	(0.0018)	(0.0018)	(0.2957)	(0.367)
Pre-Treatment Mean	0.0274	0.0274	4.9292	4.9292
Magnitute	-2.19%	-10.95%	-12.21%	-17.23%
Obvs.	858358	1775899	858358	1775899
Panel C: Age 18				
Prior Authorization	-0.0071***	-0.0061***	-1.6393***	-1.3846**
	(0.0019)	(0.0018)	(0.4567)	(0.4493)
Pre-Treatment Mean	0.0606	0.0606	14.4129	14.4129
Magnitute	-11.72%	-10.07%	-11.37%	-9.61%
Obvs.	859925	1280476	859925	1280476
Panel D: Age 21				
Prior Authorization	-0.0049***	-0.0057***	-0.7384**	-0.3165
	(0.001)	(0.0016)	(0.2268)	(0.3616)
Pre-Treatment Mean	0.018	0.018	2.9483	2.9483
Magnitute	-27.22%	-31.67%	-25.04%	-10.73%
Obvs.	1398480	703078	1398480	703078

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. RD-DID estimates of Equation (3). Treated plans are United Healthcare at age 6, UPMC at age 18, and Amerihealth/Keystone at age 21. The outcome variable indicates whether the beneficiary filled any ADHD medication prescription at a given age. Control groups vary by columns: columns (1) and (3) use plans with prior authorization both one year before and after the age cutoff (Always Treated), while columns (2) and (4) use plans without prior authorization in either period (Never Treated). Control variables include female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects.

Table A11: Robustness check: Impact of Prior Authorization Age Restrictions for Antidepressants and Antipsychotics.

	ADHD Drug: Treated (1)	ADHD Drug: Control (2)
Panel A: Antidepressants and Antipsychotics: With PA Age Cutoff		
Prior Authorization	-0.0064***	0.0008
	(0.0016)	(0.0008)
Pre-Treatment Mean	0.0606	0.0323
Magnitute	-10.56%	2.48%
Obvs.	341271	988953
Panel B: Antidepressants and Antipsychotics: No PA Age Cutoff		
Prior Authorization	-	-0.001
	-	(0.0013)
Pre-Treatment Mean	-	0.0528
Magnitute	-	-1.89%
Obvs.	-	468906

Notes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. RD estimates of Equation (1). The outcome variable indicates whether the beneficiary filled any ADHD medication prescription at a given age. Column (1) reports estimates for beneficiaries enrolled in a treated plan with an age-18 prior-authorization cutoff for ADHD medications (UPMC). Column (2) reports estimates for beneficiaries in control plans without age-based prior-authorization cutoffs for ADHD medications. In Panel A, the control group consists of plans that impose an age-18 cutoff for prior authorization of antidepressants or antipsychotics (Aetna, AmeriHealth/Keystone, UnitedHealthcare, and Health Partners). In Panel B, the control group consists of plans with no age-based prior-authorization cutoffs for neither antidepressants or antipsychotics (Geisinger and Gateway). Control variables include female, managed care plan fixed effects, quarter-year fixed effects and zipcode fixed effects.

B A Model

In this section, we develop a simple model to clarify how prior authorization reduces drug use through hassle cost effect and screening effect.

The appropriateness of prescribing the drug for patient i is v_i. The benefit of prescribing drug to patient i for physician is $f_v(vi)$, and the cost of prescribing is c_i. Without prior authorization, physicians prescribe the drug and patient get the drug when

$$f_v(v_i) - c_i \geq 0$$

Prior authorization introduces an additional administrative burden a_i in prescribing. It also introduces a probability that the prior authorization is denied. Insurers approve the prior authorization when $f_v(v_i) - p_i \geq 0$ where $f_v(v_i)$ is the value of providing the drug to patients (note: could be a different function such as $g_v(v_i)$) and p_i is the cost of the drug for the insurer. Then, the probability that the physician prescribes the drug and the patient gets the drug is

$$\mathbf{1}\{f_v(v_i) - c_i \underbrace{-a_i}_{\text{Hassle Cost}} \geq 0\} \quad \text{and} \quad \underbrace{\mathbf{1}\{f_v(v_i) - p_i \geq 0\}}_{\text{Screening effect}}$$

Scenario 1. When $p_i < c_i$, all reduction in drug use comes from hassle cost. We rule out this possibility because we observe a reduction among those who don't meet the approval criteria.

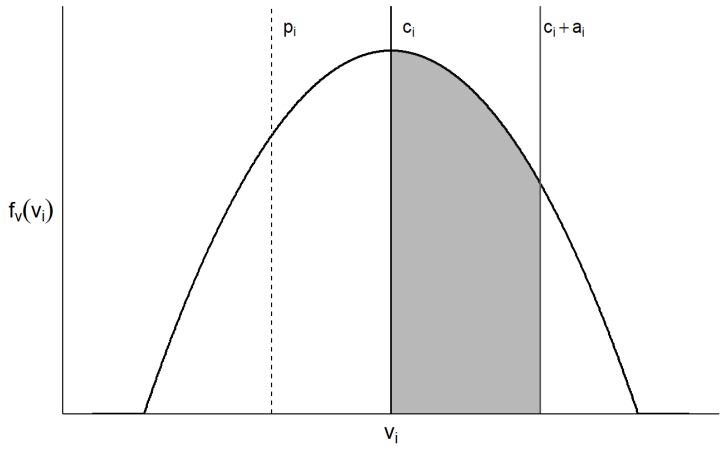


Figure A6: Scenario 1: Lenient approval threshold

Scenario 2. When $c_i < p_i < c_i + a_i$, the reduction in drug use in A comes from both hassle cost and screening effect, and the reduction in B comes from just hassle costs.

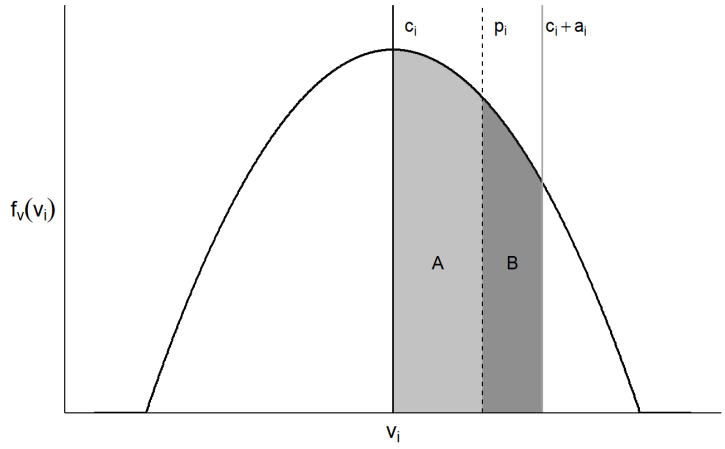


Figure A7: Scenario 2: Intermediate approval threshold

Scenario 3. When $p_i > c_i + a_i$, the reduction in drug use in A comes from both hassle cost and screening effect, and the reduction in B comes from just the screening effect. We can rule out this effect because if this scenario is true, we should not observe anyone who meet the approval criteria but experiences a reduction in drug use.

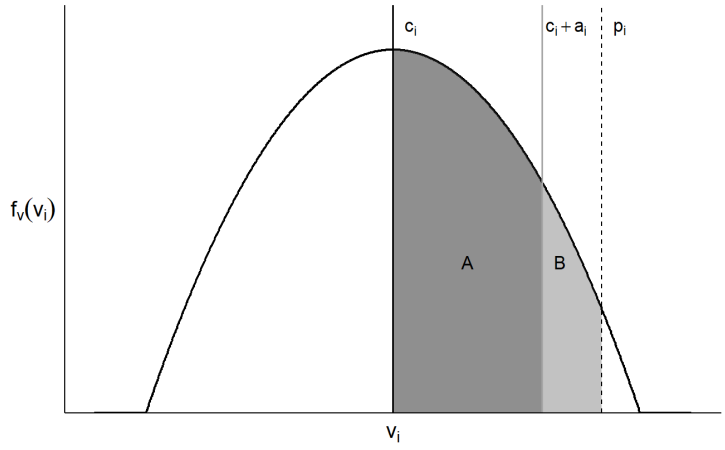


Figure A8: Scenario 3: Stringent approval threshold

Takeaway: Our model illustrates three scenarios: reductions in drug use can arise purely from prior authorization's hassle costs or from a combination of hassle costs and screening effect. Our evidence is consistent with Scenario 2. If we interpret p_i, insurer's coverage threshold, as the socially optimal marginal cost of covering the drug utilization without PA, the utilization of ADHD medication exceeds the socially efficient level in the absence of PA. Introducing PA adds both a hassle cost a_i and a screening mechanism. The resulting decline in use is welfare-improving in Area A (where expected benefit is below p_i) but welfare-reducing in Area B (where expected benefit exceeds p_i). Policy should therefore minimize a_i (streamline administrative frictions) while preserving screening so that utilization aligns with p_i.