Expected Insurance Coverage and Pharmaceutical Innovation: Evidence from China's National Drug Price Negotiation Policy

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Abstract

How can developing countries foster pharmaceutical innovation when drug price negotiations risk eroding firms' incentives? China's National Health Insurance Drug Price Negotiation addresses this challenge by pairing substantial price cuts with expanded insurance coverage for innovative drugs, enlarging the effective market size. We examine its impact on innovation using a difference-in-differences design that compares clinical trials of new drugs (treated) with those of vaccines (unaffected). The policy increases the number of trials by 0.56 per disease per year. The effects are especially pronounced for more novel innovations and similar for domestic and foreign firms. We also find that the policy induces more R&D pharmaceutical firms, especially those of small size, to enter the market. Finally, we document increased collaboration and outsourcing across firms. *JEL Codes:* I18, O31.

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1 Introduction

Pharmaceutical innovation is essential for improving population health, yet high drug prices have become a major and growing concern for healthcare systems worldwide. Spending on prescription drugs has risen rapidly, contributing to fiscal pressure on public insurance programs and limiting patient access to effective treatments. High prices largely reflect the economics of pharmaceutical R&D: drug development entails substantial fixed costs, a high risk of failure, and long development timelines, whereas successful drugs face low marginal production costs. Temporary market power and high prices during patent protection are therefore widely viewed as a key mechanism by which firms recover R&D investments and finance future innovation (Garthwaite, 2025).

This link between prices and innovation makes drug price regulation inherently controversial. Policies that limit or negotiate drug prices can improve affordability and expand access for current patients, but may also reduce firms' expected returns and weaken incentives to invest in R&D, potentially harming future innovation. These concerns have featured prominently in U.S. policy debates. Notably, when Medicare Part D was established, federal law explicitly prohibited the government from directly negotiating drug prices, reflecting concerns that centralized price bargaining could undermine pharmaceutical innovation. Similar arguments have re-emerged in recent debates over Medicare drug price negotiation, with critics emphasizing potential losses of innovation and proponents arguing that carefully designed policies can lower prices without discouraging innovation. Whether drug pricing policies can contain costs while preserving incentives for pharmaceutical innovation remains a central and unresolved question in health economics.

China's national drug price negotiation policy provides a unique institutional setting to study this question. Beginning in 2016, China initiated price negotiations for exclusive drugs on the market. The policy combines two interventions: first, the government bargains prices with firms for exclusive drugs. Second, if the price negotiation is successful, the drug will be included in the National Reimbursement Drug List (NRDL) at the negotiated price and will become eligible for generous coverage under the basic public health insurance program. By combining large price reductions with expanded market access and increased demand, the policy reshapes firms' expected returns in ways that are theoretically ambiguous, making it particularly well-suited for evaluating how drug price negotiation affects pharmaceutical innovation.

This paper first examines the impact of the negotiation policy on the revenues of successfully negotiated drugs. Using sales data from more than 500 representative public hospitals across

20 cities between 2013 and 2021, we employ a staggered difference-in-differences (DID) design to estimate the policy's effects on retail prices, out-of-pocket prices, quantities sold, and drug revenues. We find that the policy substantially reduces drug prices. At the same time, the availability of public health insurance coverage results in an even greater reduction in patients' out-of-pocket costs. We also find that the policy expands market size to a larger extent, resulting in a significant increase in overall drug revenues. These findings confirm that the policy increases firms' expected value of developing a new drug, thereby incentivizing their R&D.

Next, we examine the policy's impact on pharmaceutical innovation. We measure firms' innovation activities using comprehensive clinical trial data from the Center for Drug Evaluation (CDE) under the National Medical Products Administration (NMPA) covering the period from 2013 to 2023. We focus on clinical trials for new products that are not marketed anywhere globally. These trials are more likely to represent true innovation in new drugs than research efforts to bring existing products to China's markets. We employ a difference-in-differences design that compares innovation activity in chemical drugs and therapeutic biologics, both eligible for price negotiation and insurance coverage, with preventive vaccines, which are not covered by China's public health insurance system by law and therefore unaffected by the policy. Vaccines provide a natural control group because they share similar technologies, regulatory oversight, and exposure to major industry-wide reforms. We construct a disease-by-group-by-year panel, where a group is one of the following categories: chemical drugs, therapeutic biologics, or preventive vaccines. We then examine changes in the incidence and number of clinical trials following the 2016 introduction of the negotiation policy.

We find that the negotiation policy increases both the incidence and the number of clinical trials. For example, the number of clinical trials increase by 0.56 per disease per year after the policy, while the mean is only 0.18 before the policy. We also find that the effects are driven primarily by clinical trials of more innovative drugs. In contrast, the effects are almost zero among clinical trials of incremental changes to existing molecules. We conduct several robustness checks to validate the main findings. To address concerns that some clinical trials reflect research efforts to enter China's market rather than genuine innovations in new drugs globally, we examine the impacts on foreign and domestic firms separately. We find that policy impacts are larger among trials conducted by domestic firms whose primary market is China, and that these firms' clinical trials are more likely to be true innovations. To address concerns that the effects may be driven by other confounding policies implemented at a similar time, we demonstrate the robustness of our results by using therapeutic biologics as the treatment group, which is even more comparable to preventive vaccines. We also conduct robustness

checks using firm-level analysis, comparing clinical trials conducted by pharmaceutical firms with those conducted by vaccine firms. We find an increase in R&D for all pharmaceutical firms after the policy's implementation, and firms also experience an additional increase in the number of clinical trials conducted immediately after a successful negotiation.

Finally, we examine the policy's impact on industry dynamics. We show that the policy not only expands the scope of firms' R&D activities by increasing the number of research fields pursued by the average pharmaceutical firm, but also encourages entry into the pharmaceutical R&D market, with the increase driven primarily by small firms. In addition, collaboration and outsourcing among firms become more prevalent after the policy, while marketing authorization holders (MAHs) also strengthen their in-house innovation activities.

This paper contributes to the existing literature in several important ways. First, we contribute to the literature on the determinants of pharmaceutical innovation. Prior studies emphasize the roles of market size (Acemoglu and Linn, 2004; Blume-Kohout and Sood, 2013; Dubois et al., 2015; Agha, Kim and Li, 2022), intellectual property protection (Budish, Roin and Williams, 2015; Kyle and McGahan, 2012; Gaessler and Wagner, 2022; Budish et al., 2025; Dix and Lensman, 2025), and regulatory practices (Jia et al., 2023) in shaping innovation incentives in both developed and developing countries. In the context of China, prior studies find that insurance coverage increases pharmaceutical innovation (Zhang and Nie, 2021), while price controls reduce it (Geng and Shi, 2024). We contribute to the literature by providing new evidence from China on how a combined policy of both drug price negotiation and insurance coverage targeting novel drugs affects pharmaceutical innovation, highlighting the role of demand-side policies in shaping firms' R&D decisions.

Second, we contribute to the literature on the economics of pharmaceutical price regulation. While prior studies primarily examine competitive bidding and centralized procurement for generics (Cao, Yi and Yu, 2024; Liu, Lu and Yang, 2025) and medical equipment (Ding, Duggan and Starc, 2025), we offer new insights into the regulation of prices for innovative drugs. The paper most closely related to ours is Barwick, Swanson and Xia (2025), which studies the same policy and analyzes the optimal design of the bargaining policy, considering current consumer welfare. We differ from their framework and expand the focus from static price and welfare effects to dynamic responses to innovation. Our findings shed light on the potential implications of other price-regulation policies for innovative drugs. For example, in August 2022, the U.S. Inflation Reduction Act (IRA) authorizes Medicare to negotiate prices for a selected set of high-expenditure Part D drugs, with negotiated prices scheduled to take effect starting in 2026. Vogel et al. (2024) assess the policy's potential revenue exposure and

innovation implications, finding that its overall impact on pharmaceutical innovation is likely modest and highly heterogeneous. Complementing this work, our analysis provides direct empirical evidence that price negotiation, when combined with expanded insurance coverage, can shape firms' innovation responses, offering insights relevant to other similar policies.

The rest of the article is organized as follows. Section 2 describes the institutional background of China's national drug price negotiation policy and its effects on drug revenues. Section 3 presents the data, sample construction, and empirical strategy. Section 4 reports the baseline results, robustness checks, and the policy's impacts on industry dynamics. Section 5 concludes.

2 Institutional Background

2.1 Pharmaceutical Industry in China

China hosts one of the largest pharmaceutical markets in the world, yet domestic pharmaceutical firms historically invested little in innovative drug R&D and contributed minimally to global drug innovation (Friedman, 2010). R&D intensity among Chinese pharmaceutical firms has historically been low. As of the 2010s, China's pharmaceutical sector comprised more than 5,000 domestic manufacturers, yet large and medium-sized pharmaceutical firms spent less than 2% of sales on R&D by 2010, compared with a global average of around 8% and more than 15% in developed economies (Kanavos, Mills and Zhang, 2019; Qiu et al., 2014; Li, 2016). As a result, the pharmaceutical industry in China was dominated by generic production and incremental modifications, with relatively few innovative drugs developed domestically.

A key institutional feature shaping firms' innovation incentives is China's public health insurance system. The basic medical insurance programs primarily emphasize cost containment and broad population coverage, and historically focused on reimbursing essential drugs with available generic substitutes. Innovative drugs are typically priced at relatively high levels, raising concerns among the government about the fiscal sustainability of public health insurance programs. As a result, many innovative drugs have historically not been included in NRDL, leading to high out-of-pocket payments for patients before the implementation of national drug price negotiation (Barwick, Swanson and Xia, 2025).[1] This limited insurance coverage has constrained patients' ability to afford innovative treatments, thereby restricting drug sales and

[1]Before the negotiation policy, the NRDL had not been updated since 2009, leaving drugs launched between 2009 and 2016 uncovered by public health insurance and fully paid out of pocket by patients (Ministry of Human Resources and Social Security, 2017).

reducing the effective market size for innovative drugs. Consequently, firms' expected returns to R&D investment are diminished, weakening incentives to invest in new drug development. Existing studies provide empirical support for this mechanism, showing that expansions in insurance coverage are associated with increased pharmaceutical innovation in disease areas affected by the coverage expansion (Blume-Kohout and Sood, 2013; Zhang and Nie, 2021; Finkelstein, 2004; Agha, Kim and Li, 2022).

2.2 China's National Drug Price Negotiation Policy

China began to explore drug price negotiation policy in 2015. In February 2015, the General Office of the State Council proposed establishing an open and transparent price negotiation mechanism with multi-stakeholder participation for selected patented drugs and drugs with exclusive manufacturers. Following extensive expert assessment, patented drugs characterized by high prices, significant disease burden, and substantial clinical benefits, covering indications such as hepatitis B, lung cancer, and multiple myeloma, were selected as pilot candidates for price negotiation. In May 2016, the government released the results of the first pilot round of drug price negotiations, in which five drugs were selected; three were successfully negotiated, with negotiated prices and procurement periods publicly announced. Public hospitals are required to procure drugs at negotiated prices, and there are no requirements regarding procurement volumes.

During 2017-2019, the government invited drug manufacturers to negotiate annually. The list of candidate drugs is selected and voted on by clinical experts and pharmaceutical specialists, while health insurance and pharmacoeconomic experts assess and determine reference prices deemed appropriate for inclusion in the NRDL. If a pharmaceutical firm agrees to participate in the negotiation, the government bargains with the firm based on the assessed price. Upon successful negotiation, the drug is included in the NRDL at the negotiated price, either by the end of the same year or in the following year. Notably, the 2018 round focused exclusively on anticancer drugs.

Starting in 2020, the drug price negotiation process changed to firm-initiated applications. Each year, the National Healthcare Security Administration (NHSA) issues application guidelines specifying eligibility criteria for drugs seeking inclusion in the NRDL. In addition to being exclusively supplied, eligible drugs must satisfy at least one of several conditions, such as being a new drug with a new generic name launched within the past five years, or having undergone a major change in approved indications within the past five years, among others; notably, drugs

launched within the past five years account for the majority of negotiated drugs. After firms submit applications within the designated period, the NHSA conducts a preliminary formal review and publicly discloses the submitted materials. This is followed by expert evaluation to identify eligible drugs for negotiation, and subsequent price negotiations between the government and pharmaceutical firms, conducted in accordance with procedures similar to those used in previous rounds.

Figure 1 illustrates the number of exclusive drugs launched within five years (thus eligible for negotiation), drugs selected by the government or passing the formal review after firm applications, and successfully negotiated drugs in China from 2016 to 2022. The number of exclusive drugs launched within the past five years has increased steadily and substantially, rising from 125 in 2016 to 312 in 2022. At the same time, the number of applied or invited drugs rises sharply after 2020. It remains above 100 thereafter, reflecting firms' increased participation following the shift to a firm-initiated application system. The number of successfully negotiated drugs included in the NRDL has increased steadily, from only a few in 2016 to 79 in 2022, highlighting the expanding scope and growing importance of China's national drug price negotiation policy.

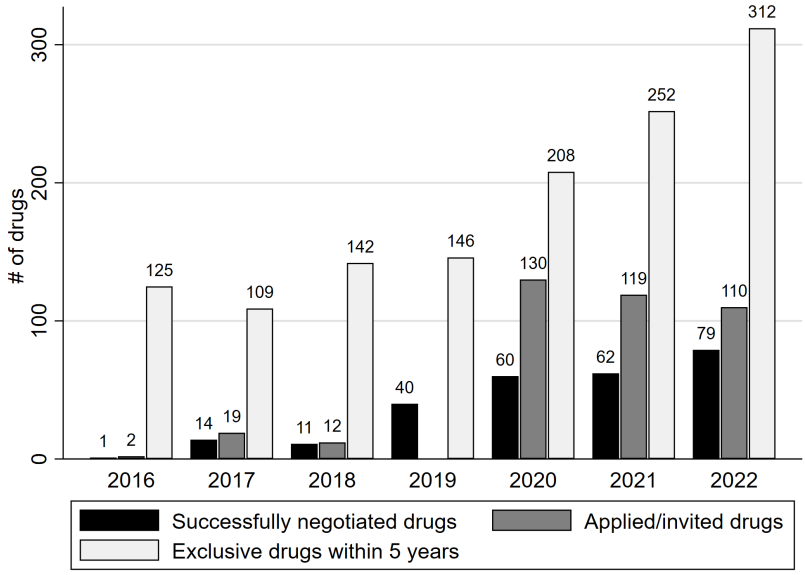


Figure 1: Trends in Drug Eligibility, Participation, and Success in China's National Drug Price Negotiation

Notes: This figure shows the evolution of drugs related to China's national drug price negotiation from 2016 to 2022, including exclusive drugs launched within the past five years, drugs selected by the government or passing the formal review following firm applications, and drugs that were successfully negotiated and included in the NRDL.

2.3 Stylized Facts: Changes in Revenues After Successful Negotiation

The policy's impact on firms' research and development activities depends crucially on how it alters firms' expectations of future revenues. Thus, we first document the policy impacts of successfully negotiating a drug on firm profits. Kremer (2002) has documented that marginal costs of production are negligible relative to high R&D costs in drug development. As a result, changes in firm revenues are a good proxy for firm profits, which we would focus on.

Data To evaluate the effect of the negotiation policy on firm revenue, we use a dataset on drug sales obtained from a consulting firm. The dataset records quarterly sales revenues and quantities, measured in the smallest unit of measurement, for drug products produced by pharmaceutical firms across 20 cities from 2013 to 2021.[2] The dataset is collected from more than 500 representative public hospitals, so the ratio of sales revenue and quantity of a product represents the retail price before insurance coverage. We aggregate the raw sales data at the quarter-by-quarter level. In our analyzed sample, we focus on exclusive drugs with a single seller. Thus, each drug corresponds to a single molecule.

We supplement the sales data with additional drug information obtained from government websites. We collect information on successfully negotiated drugs and the implementation dates of negotiated prices from the official websites of the Ministry of Human Resources and Social Security (MOHRSS) and the NHSA. We identify exclusive drugs that are eligible for negotiation using data on drug registrations obtained from the National Medical Products Administration (NMPA) website.

Empirical Strategy We estimate the impact of successful price negotiation on firms' revenues using a staggered DID design. The treatment group consists of drugs that have been successfully negotiated and added to the insurance coverage. We consider two never-treated groups. In the baseline analysis, we use drugs that are launched in China within five years (thus, eligible for the negotiation policy). We also construct an alternative never-treated group with drugs applied for or invited to negotiation but eventually failed (and thus not included in the insurance coverage). The results are similar for both groups.

There are two potential concerns regarding the empirical design above. First, successfully negotiated drugs may generate spillover effects on other drugs treating similar conditions, because

[2]The included cities are Beijing, Changchun, Changsha, Chengdu, Chongqing, Fuzhou, Guangzhou, Harbin, Hangzhou, Jinan, Nanjing, Shanghai, Shenyang, Shenzhen, Shijiazhuang, Taiyuan, Tianjin, Wuhan, Xi'an, and Zhengzhou.

the inclusion in insurance coverage could shift demand away from unsuccessfully negotiated or non-negotiated alternatives. To address this concern, we use the Anatomical Therapeutic Chemical (ATC) classification system to identify drugs that are close substitutes and remove from the control group those in the same ATC level 4 as the treatment group (Dubois and Lasio, 2018).

Second, the treatment and control groups may not be comparable before the policy implementation. We compare their baseline characteristics at the first appearance in our dataset. We find that the treated and never-treated drugs are similar with respect to domestic manufacturing, first-launch year, and quarterly revenues, suggesting that the treatment and control groups are ex ante comparable with respect to observables (see Appendix Table A1).

We use the staggered DID method to estimate the effects of the negotiation policy on drug prices, quantities, and revenue. Following Cengiz et al. (2019) and Deshpande and Li (2019), we reconstruct the sample as follows to address potential bias introduced by two-way fixed-effects estimators in staggered adoption settings. First, we divide the full sample into six datasets: five corresponding to the drugs successfully negotiated in each negotiation round, and one for the never-treated drugs. Second, for each subsample, we designate the successfully negotiated drugs in that round as the treatment group and construct the control group from drugs that are not negotiated in the focal year but will be negotiated in later rounds, as well as drugs that are never successfully negotiated. Third, for each subsample, we define the event quarters based on the implementation time of the negotiated price for the treatment drugs, and we restrict the observation window to periods before the control group becomes treated. Finally, we stack all subsamples to form the final analysis sample. The resulting dataset contains 215 drugs and, in our main sample, restricted to three years before and two years after the negotiation, a total of 11,819 drug–subsample-quarter observations.

We then estimate the following staggered DID specification:

$$\ln(y_{isq}) = \sum_{k \neq -1} \beta_k n_{is} \times \mathbf{1}\{q - \tau_s = k\} + \delta_{is} + \mu_{sq} + \varepsilon_{isq}, \tag{1}$$

where the subscript i denotes a drug, s denotes subsample, and q indexes the calendar quarter. The dependent variable, $\ln(y_{isq})$, represents the natural logarithm of the price, quantity, or revenue of drug i in subsample s and quarter q. The variable n_{is} indicates whether drug i in subsample s is in the treatment group, while τ_s denotes the quarter in which the negotiated price is implemented and insurance coverage becomes effective for subsample s. The interaction term $n_i \times \mathbf{1}\{q - \tau_s = k\}$ captures the dynamic effects relative to the implementation quarter.

δ_{is} and μ_{sq} denote drug-subsample and quarter-subsample fixed effects, respectively. Standard errors are clustered at the drug level.

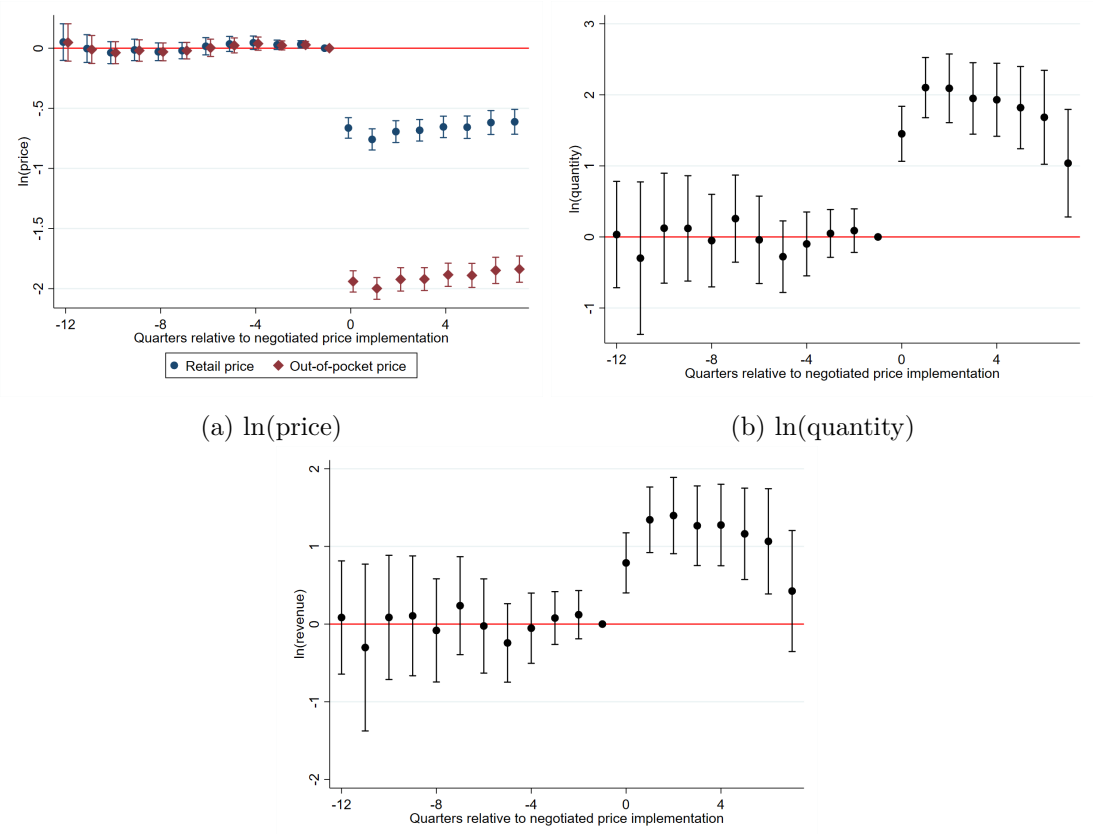
Results Figure 2 shows the result. In panel (a), we jointly present the estimated effects on retail prices and patients' out-of-pocket prices. We find that successful negotiation results in a substantial 50.2% reduction in retail price, suggesting that the negotiation is quite aggressive.[3] Combining with coinsurance rates for covered drugs in each city, we translate the reduction in retail price into an 85.5% decline in patients' out-of-pocket payments, which highlights the substantial financial relief brought to patients through insurance coverage. In panel (b), we find that the policy also increases the quantity by 476.6%, suggesting that the price reduction, along with insurance coverage, greatly expands the market size. The combined effects on log revenues are positive: we estimate that the revenue of successfully negotiated drugs increases by 187.2%, indicating a strong and persistent positive response.

3 Empirical Strategy

The results in Section 2.3 show that the negotiation policy increases total revenues for the successfully negotiated drugs. The policy increases the expected return to drug development, as firms now have an opportunity to expand their market size through insurance coverage. Indeed, consulting reports and news reports document anecdotal evidence that both domestic and foreign firms are increasing their research and development of new drugs in response to the policy.[4] In this section, we systematically examine how the policy changes pharmaceutical firms' innovation activities.

[3]We transform the estimates into percentage changes using the formula $(e^{\hat{\beta}} - 1) \times 100\%$. Table A2 reports the aggregate effects for all post periods.

[4]China's national drug price negotiation policy has reshaped firms' expectations regarding the commercialization of innovative drugs, encouraging greater investment in R&D. For example, Keymend Biosciences, a domestic firm specializing in conducting clinical trials, stated that the company has invested more than RMB 2 billion since its establishment, and that the successful negotiation would generate a stable and sustained source of funding to support the development of over 50 products currently in its R&D pipeline (China Central Television News, 2025). Foreign pharmaceutical companies also have strong incentives to expand R&D activities in China, which is increasingly viewed as a strategically important and rapidly growing market supported by innovation-oriented policies (L.E.K. Consulting, 2023). For example, Roche Pharma China's General Manager noted that the successful price negotiation of bevacizumab signaled a more sustainable and predictable market environment, reinforcing Roche's commitment to long-term investment in China's innovation ecosystem (PharmaBoardroom, 2019), while AstraZeneca announced a USD 2.5 billion investment to establish a new global R&D center in Beijing (Li, 2025).



(a) ln(price)

(b) ln(quantity)

(c) ln(revenue)

Figure 2: Impacts of Successful Negotiation on Price, Quantity, and Revenue

Notes: These figures plot the estimated coefficients of the effects of successful negotiation on the log of retail price, out-of-pocket price, quantity, and revenue, along with their 95% confidence intervals. Standard errors are clustered at the drug level.

3.1 Data and Sample

Clinical Trials Data We use clinical trial data to assess a firm's research and development activities. The measure has been used in similar contexts, including China (Geng and Shi, 2024; Jia et al., 2023). The initiation of a new clinical trial represents the final and most expensive stage of a drug candidate's development (Finkelstein, 2004), and new clinical trials directly reflect firms' investment decisions under current market conditions (Yin, 2008). In contrast, other measures have limitations that are not suitable for our context. R&D expenditure measures innovative inputs rather than outputs (Griliches, 1990), and increases in spending do not necessarily translate into meaningful or high-quality innovation. Patent data also provide a noisy proxy for innovation: firms typically apply for patents well before clinical trials begin (Acemoglu and Linn, 2004), and patenting behavior often reflects strategic motives rather than genuine scientific progress (Budish, Roin and Williams, 2015). Likewise, using new drug approvals as an innovation measure is challenging in our sample period because the development process from initial discovery to market approval typically spans more than ten years (DiMasi, Hansen and Grabowski, 2003), implying that approval outcomes reflect R&D decisions made many years earlier and thus cannot capture firms' immediate responses to policy changes.

The clinical trial data are obtained from the Center for Drug Evaluation (CDE) under the NMPA. This data source has also been widely used in recent studies examining pharmaceutical innovation in China (Geng and Shi, 2024; Jia et al., 2023). Since 2013, all clinical trials conducted in China, including bioequivalence studies and Phase I-IV clinical trials, must be registered and disclosed on a public platform. We obtain detailed information on the active ingredient, dosage form, companies, registration category, indication, trial phase, date of first patient enrollment, and the first Institutional Review Board (IRB) approval date. We use the date of first patient enrollment as the clinical trial timestamp and conduct robustness checks using the IRB committee's first approval date.

We take the following data cleaning steps. First, we restrict our sample to clinical trials conducted since 2013, because earlier data are incomplete. Second, each clinical trial is assigned a registration category based on its marketing status in both domestic and international markets. We use this information to drop clinical trials for generic drugs (i.e., bioequivalence studies) and for diffused products already marketed in other countries (which still need to conduct clinical trials if they enter China). We also exclude Phase IV clinical trials, as these studies are conducted after market approval and do not reflect pre-approval R&D activities. Thus, our sample comprises clinical trials of new drugs and vaccines that have not been marketed in

any country at the time of trial application. Third, we drop COVID-19-related clinical trials. COVID-19 has spurred research activity, but the shock is unexpected and may interact with other policies. To ensure a clean identification, we exclude these trials from the sample.

We further classify the clinical trials into two types based on the novelty, following the registration category. Type I clinical trials are for new drugs with novel chemical entities and clearly defined structures, as well as new vaccines that embody substantial innovation, such as those featuring new antigen forms, new adjuvants or adjuvant systems, or new multivalent formulations incorporating new antigens. In contrast, Type II clinical trials are for new drugs or vaccines that are improved and refined versions of known active ingredients, such as modifications to their chemical structure, dosage form, formulation process, route of administration, or therapeutic indication. In general, type I clinical trials are more novel, while type II clinical trials are more incremental.

For each clinical trial, we map its indication on the application form to the National Clinical Version 2.0 of the Disease Coding System in China. This system is fully aligned with the ICD-10 framework while incorporating adjustments and refinements tailored to China's clinical practice. We use the ICD-10 three-character category level for disease classification, ensuring consistent, comparable classification across diseases.[5] We do not use the ATC system to classify drugs or vaccines because many trials are missing ATC codes.

Firm Characteristics The characteristics of firms involved in clinical trials are obtained from Qichacha and the Orbis database. Qichacha is a leading Chinese business information platform that compiles official registration records from the State Administration for Market Regulation and other government agencies. Orbis, maintained by Bureau van Dijk, provides standardized firm-level data from official registries and financial disclosures. From these two sources, we extract key firm characteristics, including the year of establishment, year of deregistration (if applicable), firm size category, ownership type, and country or region of registration.

3.2 Research Design: Disease-Level Analysis

We use a DID design to examine the policy's impact on innovation. In principle, all new exclusive drugs, including chemical drugs and therapeutic biologics, are eligible for inclusion

[5]The ICD-10 adopts a hierarchical structure consisting of four levels: (1) chapters, which group diseases into 21 broad categories identified by letters (A–Z); (2) blocks, which organize related diagnostic conditions within each chapter; (3) three-character categories, the level used in our analysis, each represented by one letter followed by two digits (e.g., C50); and (4) four-character subcategories, which add a decimal digit to provide more detailed diagnostic information (e.g., C50.1).

in the negotiation process. However, in China, preventive vaccines are not covered by the national health insurance program and are instead financed through public health expenditures.[6] Therefore, we treat clinical trials for new drugs as the treatment group and use vaccines as the control group. Vaccines are also an active area of research and development and share similar technologies and regulatory environments with new drugs. Using vaccines as the control group also helps to difference out other structural changes in this industry. For example, the 2015 regulatory reform aimed to address application backlogs and reduce administrative waiting times in the clinical trial application process for both drugs and vaccines. Likewise, in 2019, China implemented the Marketing Authorization Holder (MAH) system for drugs and vaccines.[7]

We construct a disease-by-group-by-year-level sample for analysis, where "group" refers to one of the two categories: drug/therapeutic biologics (treatment group) or vaccines (control group). The dependent variable is whether a clinical trial is conducted, or the number of clinical trials conducted, in each year for each disease-group. If no clinical trial is conducted for a given disease group in a particular year, the value is recorded as 0. In total, our dataset includes 6,962 diseases. According to the WHO, a preventive vaccine functions solely to prevent infectious diseases. Thus, we restrict the vaccine sample to infectious diseases.[8]

Figure 3 illustrates the raw pattern of the average number of clinical trials per disease. We find that before 2016, both groups follow a similar trend. However, after 2016, the number of clinical trials for drugs appears to have increased much more. We present the detailed summary stats for the treatment and control groups in Appendix Table A3.

We estimate the following model using two-way fixed effects:

$$y_{it} = \sum_{k \neq -1} \beta_k drug_i \times \mathbf{1}\{t - \tau = k\} + \zeta_i + \eta_t + \varepsilon_{it}, \tag{2}$$

where the subscript i denotes a disease-group, and t indexes year. The dependent variable y_{it} is either an indicator for whether any clinical trials were conducted or the total number of clinical trials, and the corresponding measures for Type I and Type II clinical trials. The variable $drug_i$ indicates the treatment group, and τ denotes the year in which the negotiation policy began (2016). The interaction term $drug_i \times \mathbf{1}\{t - \tau = k\}$ captures the dynamic effects relative to

[6] Article 8 of the Interim Measures for the Administration of Drugs under Basic Medical Insurance stipulates that preventive vaccines shall not be included in the National Reimbursement Drug List.

[7] The revised Drug Administration Law came into effect in December 2019 (see `https://www.nhc.gov.cn/fzs/c100048/201909/3a86b1c3ae204640acf57080a6486240.shtml`). Similarly, the Vaccine Administration Law was also implemented in December 2019 (see `https://www.samr.gov.cn/zw/zfxxgk/fdzdgknr/fgs/art/2023/art_dde03480953841a5912c864dc29003d0.html`).

[8] The definition of infectious diseases follows WHO's Global Health Estimates, covering 207 ICD-10 categories. See `https://www.who.int/data/global-health-estimates`.

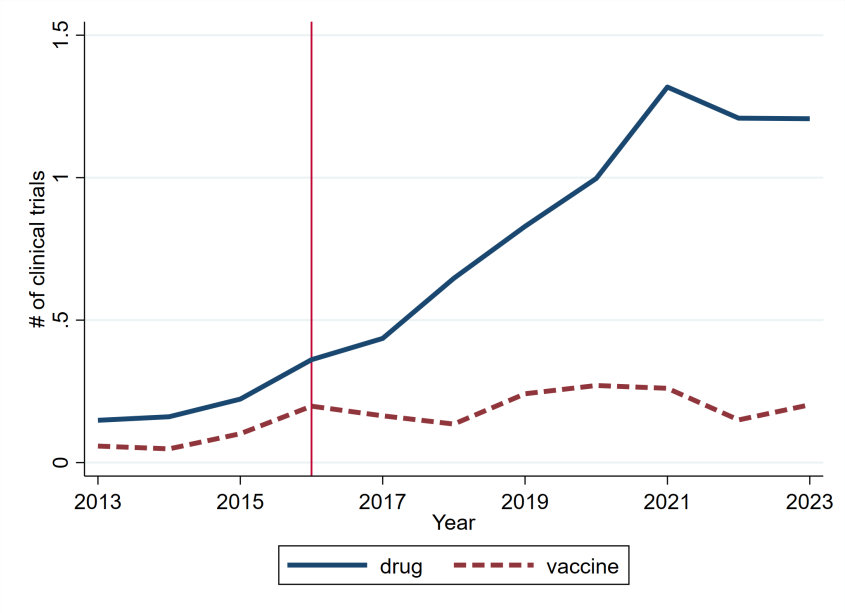


Figure 3: Raw Pattern of the Average Number of Clinical Trials per Disease

Notes: This figure shows the time-series pattern of the average number of drug or vaccine clinical trials, measured at the disease level.

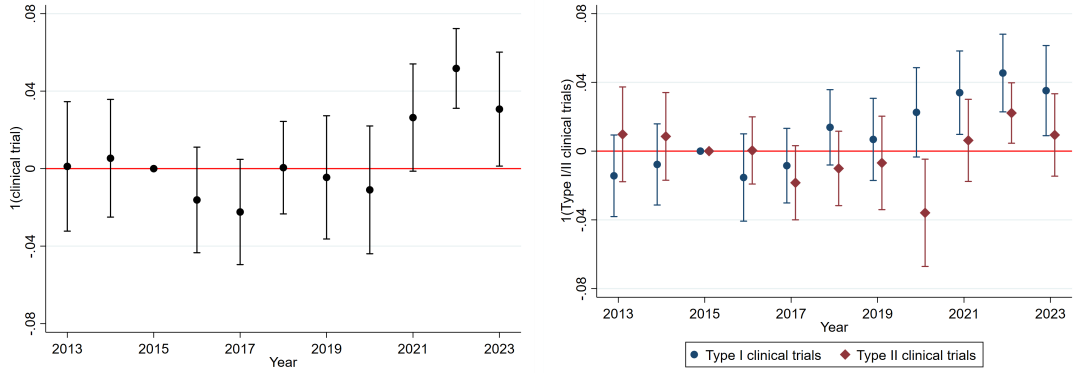
the implementation year. ζ_i and η_t denote disease-group and year fixed effects, respectively. Standard errors are clustered at the disease-group level.

4 Results

4.1 Baseline Results

Figure 4 presents the event study estimates of the policy impacts on the incidence of conducting any clinical trials (panel (a)) and separately for the more novel types (Type I, panel (b)) and the less novel types (Type II, panel (b)). We find that the two groups exhibit parallel trends prior to 2016, and that the policy increases the probability of initiating clinical trials for drugs starting in 2022. We also find that the policy effect is more pronounced for Type I drugs, with a statistically significant increase of 3.40% in 2021.

Figure 5 presents the event study estimates of the effects of China's negotiation policy on the number of clinical trials for all types (panel (a)) and separately for Type I and Type II clinical trials (panel (b)). We find that the number of clinical trials began to rise steadily in 2017 and has remained at nearly one clinical trial per disease per year since 2021. We also find that the policy effects are solely driven by Type I clinical trials. The findings are consistent with the observation that Type I new drugs often have higher clinical values and enjoy longer patent protection (i.e.,



(a) All New Clinical Trials (b) Type I and Type II Clinical Trials

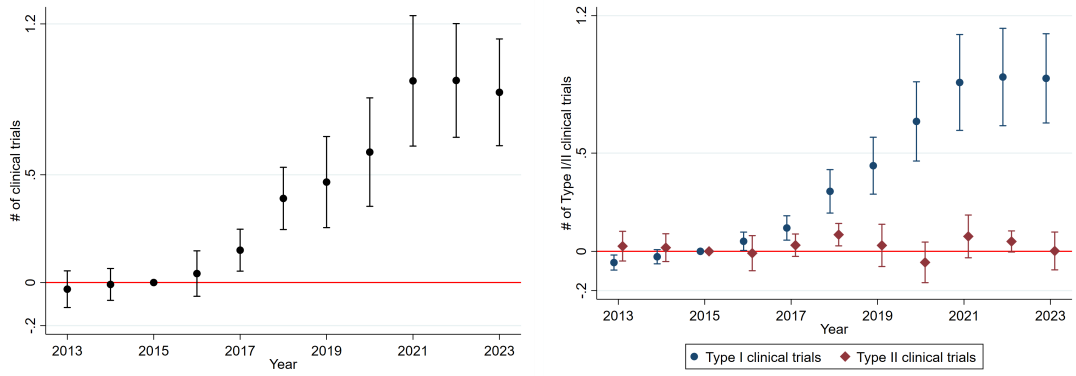
Figure 4: Parallel Trends and Dynamic Effects for the Incidence of Conducting Clinical Trials

Notes: These figures plot the estimated event study coefficients of the effects of China's negotiation policy on the incidence of conducting clinical trials (Panel a) and on the incidence of Type I and Type II new drugs (Panel b), together with their 95% confidence intervals. Standard errors are clustered at the disease-treatment level.

are more likely to receive patent extension approval). Thus, Type I new drugs may incur a larger revenue increase if successfully negotiated. Overall, these patterns indicate that the negotiation policy primarily stimulates more innovative drug development. Table A6 presents the baseline DID estimates. We conduct a series of robustness checks, including alternative definitions of clinical trial timing and an examination of the policy's effects on the number of clinical trial projects.[9] Appendix Table A4 and A5, as well as Figure A1, A2, A3, and A4, present the results. The estimated policy effects remain robust across these alternative specifications and are primarily driven by increases in the innovation activities of Type I new drugs.

Further, we compute the number of Phase I-III clinical trials conducted for drugs and vaccines. When a trial simultaneously covers multiple phases (e.g., a combined Phase I/II study), we count it as contributing to both the Phase I and Phase II trial totals. Figure 6 presents the event study estimates by clinical phase. The results show lagged treatment effects across later-stage trials: the largest increase occurs in Phase I, followed by Phase II, whereas Phase III exhibits a comparatively modest response. This pattern is consistent with Blume-Kohout and Sood (2013), which documents similar phase-specific responses in pharmaceutical R&D to Medicare Part D.

[9] As a robustness check, we use IRB approval dates to define the start of clinical trials and alternatively measure innovation using the number of active clinical projects, defined at the active ingredient–dosage form–firm level. The results remain qualitatively unchanged.



(a) All New Clinical Trials (b) Type I and Type II Clinical Trials

Figure 5: Parallel Trends and Dynamic Effects for the Number of Clinical Trials

Notes: These figures plot the estimated event study coefficients of the effects of China's negotiation policy on the number of clinical trials (Panel a) and on the number of Type I and Type II new drugs (Panel b), together with their 95% confidence intervals. Standard errors are clustered at the disease-treatment level.

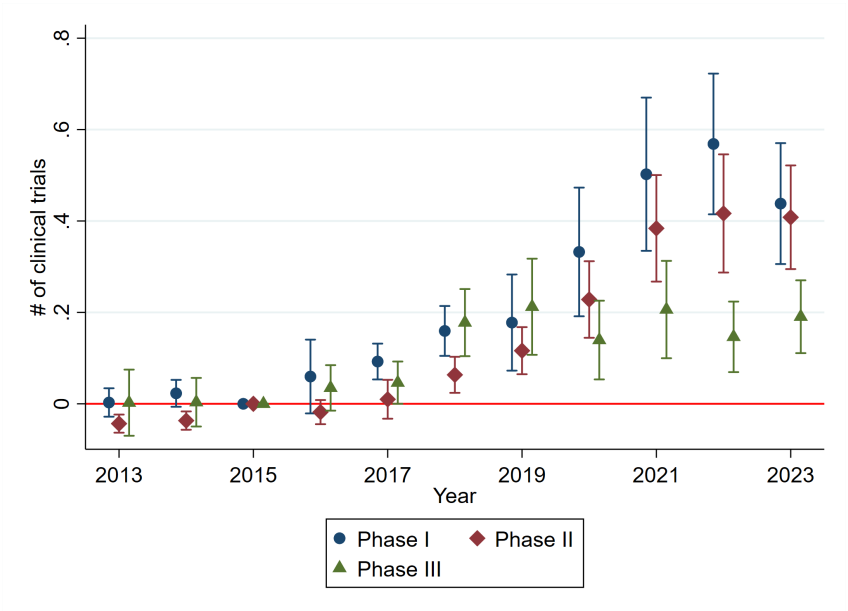


Figure 6: Event Study for Number of Clinical Trials in Different Phases

Notes: This figure presents the estimated coefficients of the yearly effects of the negotiation policy on the number of Phase I, II, and III clinical trials, with 95% confidence intervals.

4.2 Robustness Checks

We conduct a series of robustness checks, including dividing the treatment group into chemical and therapeutic biological drugs, alternative estimation methods, and performing firm-level analysis. All results consistently confirm the robustness of our baseline findings.

4.2.1 Chemical and Therapeutic Biological Drugs

The key issue for identification is whether vaccines are truly comparable to drugs. To address the concern, we separate the treatment group into chemical drugs and therapeutic biological drugs. The latter group is even more similar to preventive vaccines with respect to R&D processes, manufacturing complexity, and clinical evaluation standards. Comparing therapeutic biological drugs with preventive vaccines also more directly addresses concerns about other confounding policies. For example, during this period, China has gradually implemented bioequivalence evaluation, beginning with chemical generic drugs and subsequently extending the quality consistency requirements to therapeutic biologics and vaccines. In addition, China implemented central procurement for selected generic drugs, which targeted only chemical products, leaving therapeutic biologic drugs and vaccines unaffected during the sample period.

Figure 7 presents the event study results. Consistent with the baseline estimates, both the probability of conducting clinical trials and the number of trials increase for chemical drugs and therapeutic biological drugs following the negotiation policy, relative to vaccines. Moreover, the policy effect is noticeably larger for therapeutic biological drugs.

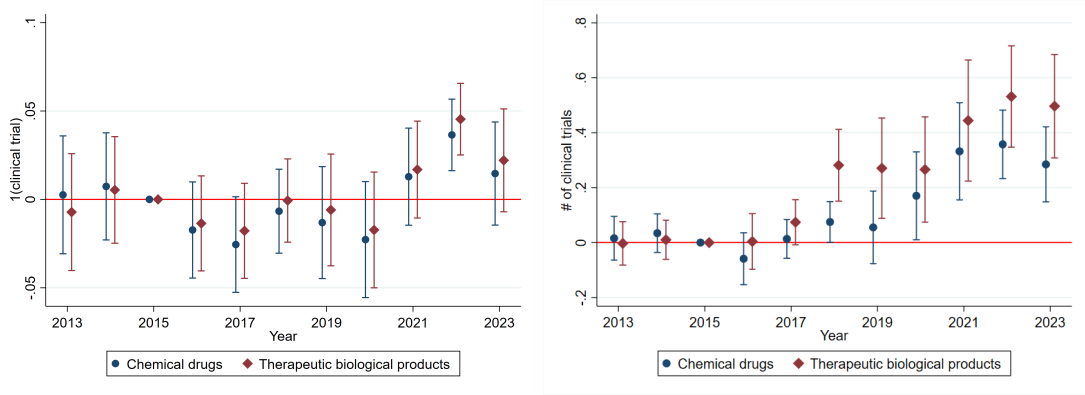
4.2.2 Poisson Regression Model

We quantify the effect of the negotiation policy on the proportional change of clinical trials using a Poisson regression model. Specifically, we estimate the following DID specification:

$$y_{it} = exp(\sum_{k \neq -1} \beta_k drug_i \times \mathbf{1}\{t - \tau = k\} + \zeta_i + \eta_t) + \xi_{it}, \tag{3}$$

where the coefficient β_k represents the proportional change in the outcome variable. Its magnitude can be interpreted as a percentage change, calculated as $(e^{\psi_k} - 1) \times 100\%$. All other variables are defined as in Eq. (2).

Table A7 presents the Poisson regression results, and Figure A5 presents the event study estimates. The number of clinical trials for all drugs increases by 68.4%, while Type I clinical trials rise by 125.2%. In contrast, the number of Type II clinical trials does not change sig-



(a) Incidence of conducting clinical trials (b) Number of clinical trials

Figure 7: Event Study for Negotiation Policy on Clinical Trials: Chemical and Therapeutic Biological Drugs

Notes: These figures plot the estimated event study coefficients of the effects of the negotiation policy on the likelihood of conducting clinical trials (Panel a) and on the number of clinical trials (Panel b), dividing the treatment group into chemical drugs and therapeutic biological drugs, together with their 95% confidence intervals.

nificantly. Overall, our findings remain robust when the model is estimated using a Poisson specification.

4.2.3 Firm-Level Analysis

We replicate the disease-level analysis using firm-level regressions to provide further insight into the potential mechanisms underlying the effects. The sample includes pharmaceutical and vaccine firms that conducted clinical trials in our baseline sample and firms that were invited to or applied for the negotiation policy during 2016-2023. For each firm, we determine its establishment and deregistration year (if applicable) and calculate the number of clinical trials conducted during this period. We impute zeros for no trial years. Following the baseline classification, firms that conducted only vaccine clinical trials during 2013-2023 serve as the control group, as they were not affected by the negotiation policy. All other firms engaged in drug R&D constitute the treatment group.[10] Appendix Table A8 reports summary statistics at the firm level, including characteristics of treatment and control firms and their R&D activities. In general, vaccine firms are more likely to be domestic, but are similar in size.

We distinguish the effects across all pharmaceutical firms and separately for those that successfully negotiate a contract. All pharmaceutical firms are affected by the negotiation policy because of a change in expectations. Moreover, a subset of firms successfully negotiate

[10] 1.36% of firms conduct both pharmaceutical and vaccine clinical trials in our sample. Our results are robust excluding these firms, as shown in Appendix Figure A6.

contracts and experience a substantial increase in revenue. These firms may increase their research activities more than the other pharmaceutical firms if they form a different belief about the policy, or if they are financially constrained and benefit from immediate cash flow. To separately identify these two effects, we first estimate the overall effects on all pharmaceutical firms using a two-way fixed effects model and vaccine firms as the control group:

$$y_{ft} = \sum_{k \neq -1} \beta_k drug_f \times \mathbf{1}\{t - \tau = k\} + \theta_f + \lambda_t + \nu_{ft}, \tag{4}$$

where the subscript f denotes a firm, and t indexes year. The dependent variable y_{ft} is either an indicator for whether any clinical trials were conducted or the total number of clinical trials, and the corresponding measures separately for Type I and Type II clinical trials. The variable $drug_f$ indicates whether firm f is in the treatment group. The coefficient β_k captures the effect of negotiation policy for all pharmaceutical firms. θ_f and λ_t denote firm and year fixed effects, respectively. Standard errors are clustered at the firm level.

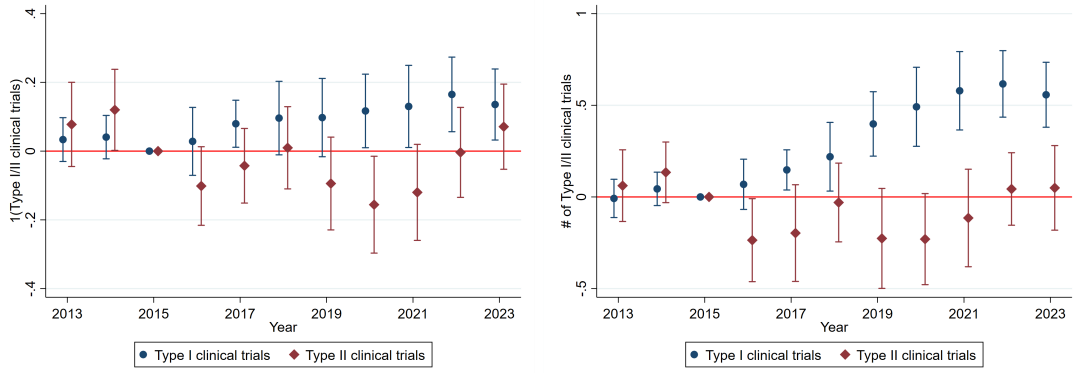
We then estimate the effects of successful negotiation using a staggered DID approach, comparing successfully negotiated firms with invited or applied firms after reconstructing the sample. The estimation equation is specified as:

$$y_{fmt} = \sum_{k \neq -1} \gamma_k n_{fm} \times \mathbf{1}\{t - \tau_m = k\} + \theta_{fm} + \lambda_{mt} + \nu_{fmt}, \tag{5}$$

where f indexes firms, m denotes the subsample after sample reconstruction mentioned above, and t indexes years. The indicator variable n_{fm} equals one if firm f in subsample m successfully negotiates during the sample period, and τ_m denotes the year in which the negotiated price becomes effective for subsample m. The coefficients γ_k capture the dynamic treatment effects relative to the year before implementation. Firm-by-subsample fixed effects θ_{fm} and subsample-by-year fixed effects λ_{mt} are included, and standard errors are clustered at the firm level.

Figure 8 presents the event study estimates of the negotiation policy's effects for all pharmaceutical firms (Eq. (4)). The results are consistent with the disease-level baseline results: the policy increases both the likelihood and the number of Type I trials conducted by drug firms. In 2017, the average drug firm is 8% more likely to conduct a Type I clinical trial, and the number of Type I trials increases by 0.147 on average. In contrast, no significant changes are observed for Type II clinical trials.

Figure 9 reports the event study estimates of the effects of successful negotiation (equation (5)). Compared with firms that did not successfully negotiate, successfully negotiated firms

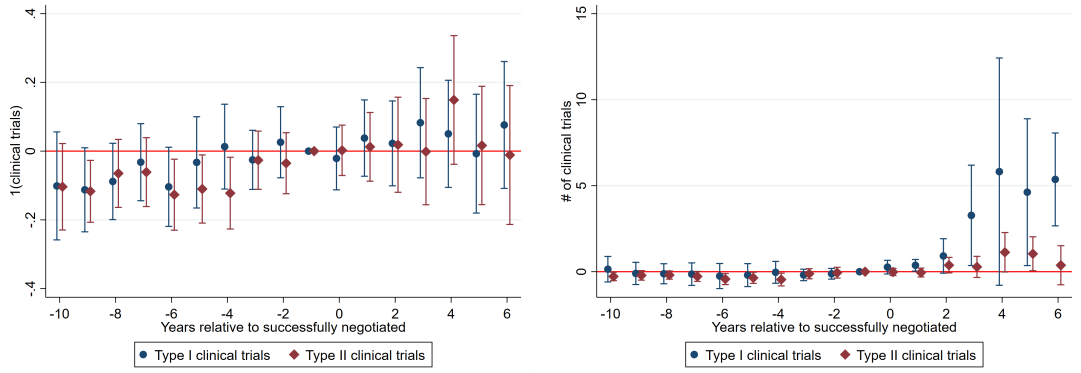


(a) Incidence of Conducting Clinical Trials (b) Number of Clinical Trials

Figure 8: Event Study of the Negotiation Policy's Effects on Firm-Level Clinical Trial Activity

Notes: These figures plot the estimated coefficients of the annual effects of the negotiation policy on clinical trials, together with their 95% confidence intervals. Panel (a) presents the estimated policy effects on the likelihood that a firm conducts clinical trials, while Panel (b) shows the effects on the number of Type I and Type II clinical trials conducted by each firm.

do not exhibit a significant increase in the overall probability of conducting clinical trials after negotiation. However, they experience a noticeable rise in the number of Type I clinical trials they conduct, as shown in Panel (b) of Figure 8. The estimates are noisy, though, maybe due to the small sample size. A plausible explanation is that successfully negotiated firms realize substantial revenue gains following the implementation of the negotiated price, which may provide greater financial resources for investing in innovative R&D activities.



(a) Incidence of Conducting Clinical Trials (b) Number of Clinical Trials

Figure 9: Event Study of the Successful Negotiation on Clinical Trials

Notes: These figures plot the estimated coefficients of the annual income shock effects of the negotiation policy on the incidence of conducting clinical trials (Panel a) and the total number of clinical trials by firms, along with their corresponding 95% confidence intervals.

4.3 Impacts on Industry Dynamics

Understanding how the negotiation policy reshapes industry dynamics is crucial for interpreting its broader economic consequences (Lenox, Rockart and Lewin, 2007). Beyond influencing firms' incentives to undertake innovation activities, the policy may also modify the competitive environment (Acemoglu and Linn, 2004), affect firm entry and exit (Parker, 2025), and reorganize the division of labor and collaborative relationships among firms (Cunningham and Gök, 2016). Moreover, its impacts are likely to vary across different types of firms, for example, by firm size (Acemoglu and Linn, 2004) or by ownership structure (Geng and Shi, 2024). These structural adjustments shape not only the aggregate level of innovation but also the long-run configuration of the pharmaceutical industry.

In this section, we examine how the negotiation policy shapes the evolution of industry structure along several key dimensions. We begin by analyzing its effects on firm behavior, including the number of firms operating within each "market", defined as a disease-by-group cell, as well as patterns of entry and firms' innovation activities. We then turn to the division of labor and collaborative relationships among firms, and finally investigate the heterogeneity of policy impacts across domestic and foreign firms.

4.3.1 Firm Entry

Our baseline results indicate that the negotiation policy increases the number of clinical trials per disease per year. We decompose the increase into the intensive and extensive margins. On the intensive margin, we find that each firm conducts a similar number of clinical trials for a given disease each year. In contrast, on the extensive margin, we find that there are more firms conducting clinical trials for a disease in a year. Figure 10 shows that following the implementation of the negotiation policy, more firms conduct Type I clinical trials for drugs relative to vaccines, whereas no significant effect is observed for Type II trials. Overall, these results indicate that the policy impacts primarily come from the extensive margin, and the market becomes more competitive.

We find that the extensive margin changes come from two sources. First, incumbent firms seem to expand the research fields by conducting trials for more diseases per year (see Figure 11). Second, there is also substantial new firm entry. Figure 12 presents the number of firms that conduct Phase I clinical trials for the first time in each year. Before 2016, the number of first-time entrants into clinical trials of drugs or vaccines remained relatively stable. After 2016, however, the number of firms conducting clinical drug trials increased markedly, particularly

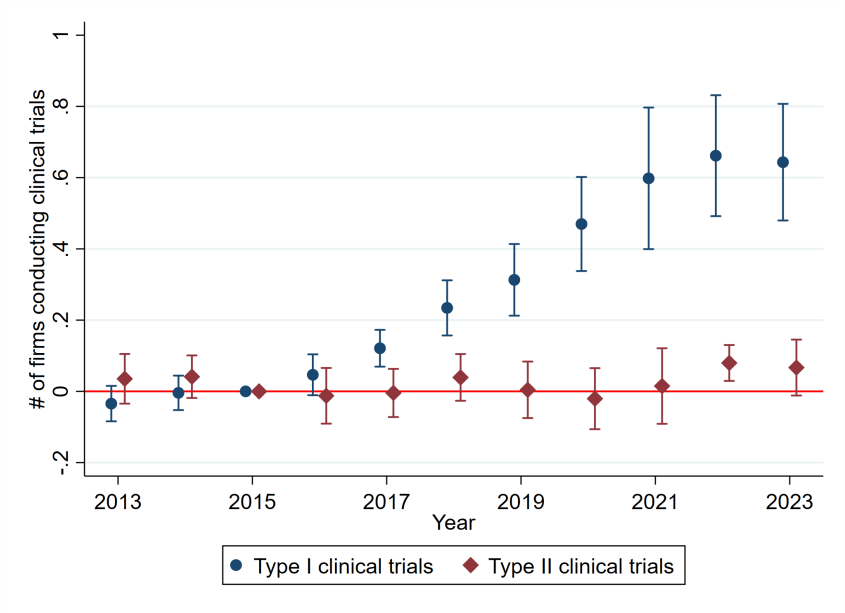


Figure 10: Event Study for Negotiation Policy on Number of Firms Conducting Clinical Trials

Notes: This figure presents the estimated event study coefficients of the effect of the negotiation policy on the number of firms conducting clinical trials, together with 95% confidence intervals.

those of micro or small size.[11]

4.3.2 Collaboration Mode of Clinical Trials

We also observe changes in how firms collaborate in research and development after the negotiation policy. There are two main types of firms involved in the research and development of drugs and vaccines. A marketing authorization holder (MAH) is a firm or research institution that has obtained marketing authorization for a drug. The MAH bears primary responsibility for the entire product life cycle, including clinical trials, manufacturing and commercialization, post-marketing studies, and the monitoring, reporting, and management of adverse drug reactions. In addition, there are firms that specialize in the operational execution of clinical development, providing services such as trial management, site coordination, and manufacturing-related support. In our dataset, we observe the MAH firm as the entity that applies for the clinical trial (which, under the regulation, becomes the MAH upon market approval). We also observe a separate variable indicating which firms conduct clinical trials.

We classify all clinical trials into three categories. In-house trials are conducted by a single firm; collaborative trials are jointly conducted by the MAH and non-MAH firms; and outsourced

[11] Firm size is classified according to the *Standards for the Classification of Large, Medium, Small, and Micro Enterprises* issued by the National Bureau of Statistics of China in 2017. We map the Orbis categories into the same four size groups to ensure consistency with the domestic classification.

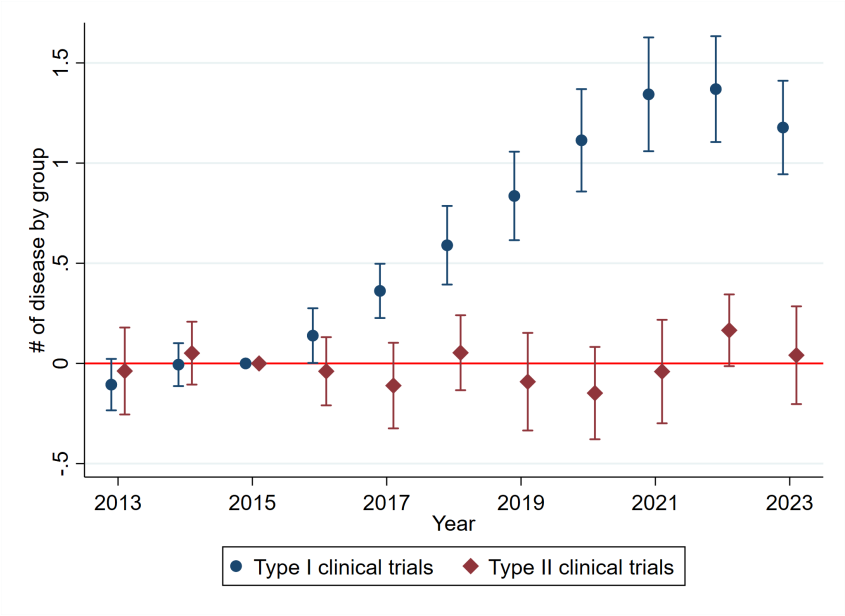


Figure 11: Event Study of the Negotiation Policy's Effects on Firms' Research Fields

Notes: This figure plots the estimated coefficients of the annual effects of the negotiation policy on the number of diseases by group for each firm, together with their 95% confidence intervals.

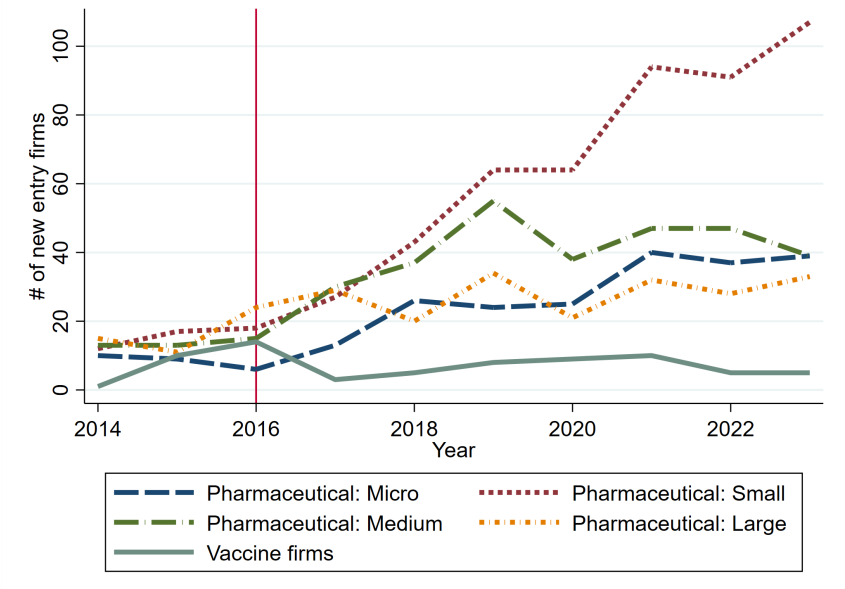
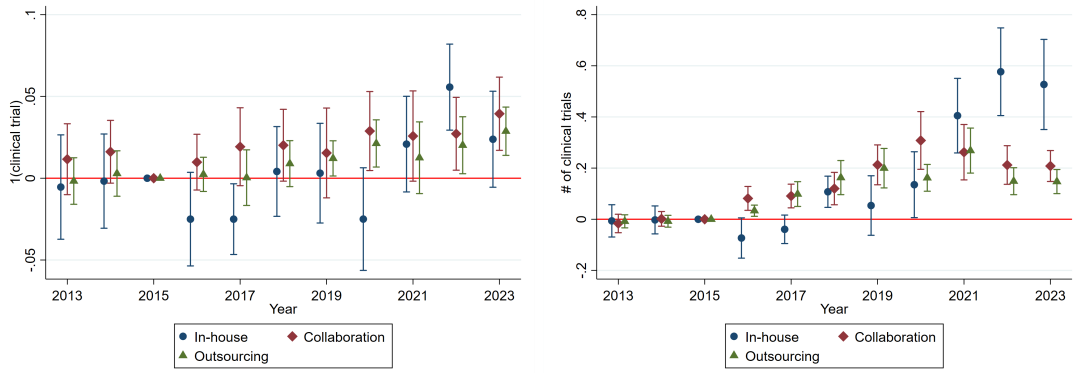


Figure 12: Number of New Firm Entries

Notes: This figure shows the time-series pattern of the number of firms first conducting Phase I clinical trials for drugs or vaccines.

trials are carried out exclusively by non-MAH firms without the MAH's direct involvement. MAHs can reduce development costs by outsourcing clinical activities to these specialized service providers (Steadman, 2018). Outsourcing allows firms to avoid the substantial fixed costs associated with maintaining in-house clinical operations, including dedicated personnel, clinical infrastructure, and quality-management systems. Moreover, non-MAH firms enhance efficiency and data quality by supplying scalable clinical labor, accelerating trial timelines, providing independent monitoring, standardizing multi-center processes, and ensuring regulatory-compliant data collection (Roberts, Kantarjian and Steensma, 2016).

Figure 13 presents the event study estimates of the negotiation policy's effects on the incidence of conducting clinical trials (Panel a) and on the number of clinical trials (Panel b), separately for the three types of collaboration mode. We find that both the likelihood and the total number of collaborated and outsourced clinical trials increase following the negotiation policy. A plausible explanation is twofold. First, collaboration and outsourcing to specialized service providers reduce the financial burden of conducting clinical trials. Second, these firms can accelerate trial implementation, enabling drugs to progress through development more quickly, reach the market sooner, enter negotiations earlier, and ultimately generate returns at an earlier stage. For in-house trials, the likelihood rises modestly, but the number of in-house clinical trials increases markedly after 2021. It suggests a strengthening of firms' internal innovation efforts.



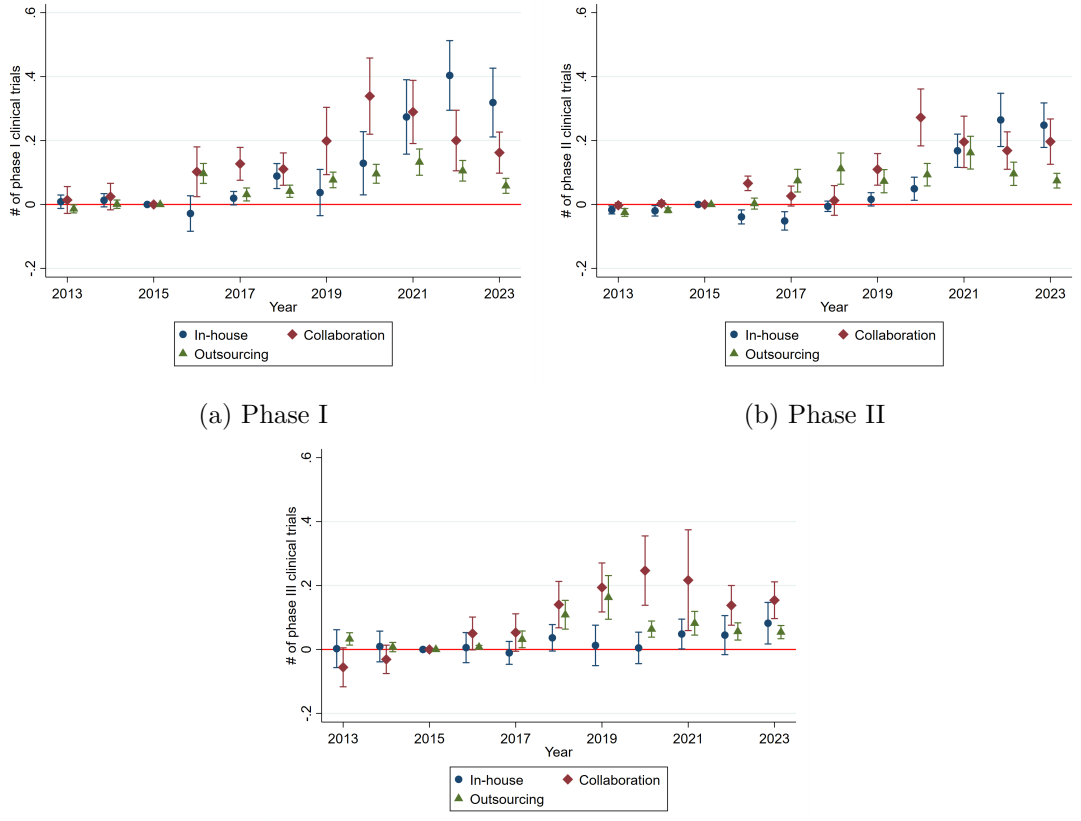
(a) Incidence of Conducting Clinical Trials (b) Number of Clinical Trials

Figure 13: Event Study of the Negotiation Policy's Effects on Different Collaboration Modes of Clinical Trials

Notes: These figures plot the estimated event study coefficients of the negotiation policy's effects on the incidence of conducting clinical trials (Panel a) and the number of clinical trials (Panel b), separately for in-house, collaboration, and outsourcing modes, along with their corresponding 95% confidence intervals.

Furthermore, to rule out the possibility that our results are driven by differences in the

stage of clinical development, we separately examine collaboration modes for clinical trials across different phases. Compared with early-stage trials (Phases I and II), Phase III trials require substantially larger budgets and greater operational capacity, making collaboration or outsourcing to non-MAH firms a more cost-effective strategy for MAHs following the negotiation policy. In addition, at later stages of clinical development, larger firms may acquire or license promising drug candidates originally developed by smaller firms, further reinforcing the role of collaboration and outsourcing in Phase III trials. Figure 14 reports the event-study estimates by phase. The results show that, in early-stage clinical trials, the number of in-house trials conducted by MAH firms increases significantly under the negotiation policy. In contrast, for Phase III trials, the number of in-house trials shows statistically significant increases only in 2021 and 2023, and the magnitudes are substantially smaller than those for collaboration and outsourcing.



(a) Phase I

(b) Phase II

(c) Phase III

Figure 14: Event Study of the Negotiation Policy's Effects on Different Collaboration Modes of Clinical Trials in Different Phases

Notes: These figures plot the estimated event-study coefficients of the negotiation policy's effects on the number of clinical trials across different development modes (in-house, collaboration, and outsourcing), along with their corresponding 95% confidence intervals. Panel (a) reports results for Phase I trials, Panel (b) for Phase II trials, and Panel (c) for Phase III trials.

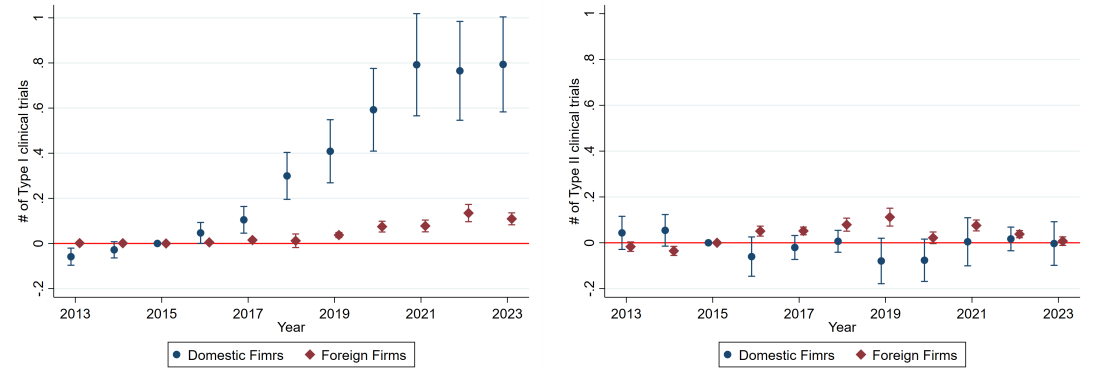
4.3.3 Firm Origin

To examine how the negotiation policy affects firms' R&D behavior, we conduct separate analyses for domestic and foreign pharmaceutical companies. Although we exclude diffused drugs from the sample, clinical trials conducted by foreign firms may still primarily reflect efforts to enter the Chinese market rather than genuinely new innovations developed exclusively for China. In contrast, innovation by domestic firms is more likely to be directly driven by the negotiation policy, given that China constitutes their primary market. These considerations motivate us to separately examine the average number of clinical trials conducted by domestic and foreign firms at the disease level. Based on the country in which the firm is located and whether the drug under development is domestically developed or imported, we classify firms as domestic or foreign.

Figure 15 reports the event study estimates of the average number of Type I and Type II drug clinical trials conducted by domestic and foreign firms, compared with vaccine clinical trials per disease. Following the implementation of the negotiation policy, innovation activity in Type I drugs increased for both domestic and foreign firms, with domestic firms exhibiting a markedly larger rise in the average number of clinical trials per disease. For Type II clinical trials, the policy has no statistically significant effect on domestic firms but significantly promotes innovation among foreign firms. These heterogeneous effects may be explained by differences in R&D capabilities and strategic responses across firm types and innovation categories. Domestic firms, which have historically focused on building original innovation capacity, may therefore react more strongly to the negotiation policy by increasing Type I clinical trial activity. In contrast, Type II innovation, often involving incremental modifications of existing drugs, requires relatively lower R&D risk and technological uncertainty. Foreign firms, which possess extensive global pipelines and accumulated experience in incremental development, may be better positioned to rapidly adapt existing products or indications to the Chinese market in response to improved reimbursement prospects. As a result, the policy significantly stimulates Type II clinical trials among foreign firms, while domestic firms exhibit no comparable response.

5 Conclusion

This study provides novel empirical evidence on the effects of China's national drug price negotiation policy on pharmaceutical innovation in a developing-country context. Using drug sales data, we show that the negotiation policy significantly reduces drug prices while expand-



(a) Type I

(b) Type II

Figure 15: Event Study of the Negotiation Policy's Effects on Different Firm Origin

Notes: These figures plot the estimated coefficients of the annual effects of the negotiation policy on the number of Type I (Panel a) and Type II (Panel b) clinical trials conducted by domestic and foreign firms separately per disease, together with their 95% confidence intervals.

ing market size and increasing drug revenues, thereby improving firms' expected returns from innovation. Leveraging detailed clinical trial data, we further document that the policy substantially stimulates pharmaceutical R&D activity relative to vaccine development, with particularly pronounced effects for more innovative Type I drugs and for early-stage clinical trials. These increases are observed for both domestic and foreign firms conducting R&D in China, suggesting that the policy reshapes innovation incentives across a broad set of market participants.

We also show that the expansion in innovation is driven primarily by the entry of pharmaceutical firms and the reallocation of R&D efforts. In particular, small and micro firms play an important role in driving innovation, and pharmaceutical firms expand their R&D scope into new research fields. At the same time, firms respond to the policy by adjusting their organizational strategies, increasing collaboration and outsourcing, and strengthening their internal R&D activities. Further research is needed to elucidate the underlying drivers of these structural changes in the industry.

In the context of a developing country, China's drug price negotiation policy combines price reductions with expanded insurance coverage, thereby increasing consumer surplus and fostering incentives for innovation. Our findings provide empirical evidence for other countries considering the adoption of similar drug price negotiation policies. One limitation of this study is that we do not conduct a full welfare evaluation: the policy's cost is the increase in the government budget. Future research is needed to evaluate the program's overall welfare effects.

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Appendix A. Supplementary Analysis

Table A1: Comparison between successfully negotiated and control drugs

	Treatment group	Control group		Robustness check	
	(1)	(2)	(3)	(4)	(5)
	Negotiated drugs	Exclusive drugs	Difference	Invited/applied drugs	Difference
ln(revenue)	10.751	10.467	0.285	11.549	-0.798*
	(2.019)	(2.358)	(0.30)	(2.404)	(0.44)
First launch year	2017.257	2014.609	2.648***	2016.892	0.365
	(2.144)	(3.285)	(0.38)	(3.332)	(0.59)
1(Domestic drug)	0.352	0.382	-0.029	0.351	0.001
	(0.480)	(0.488)	(0.07)	(0.484)	(0.09)
N	105	110	215	37	142

Notes: This table reports the summary statistics of key characteristics for the treatment group (negotiated drugs) and two control groups (exclusive drugs and invited/applied drugs), as well as the mean differences between each control group and the treatment group in the first observed quarter of the sample. Reported values are sample means, with standard deviations in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A2: Effects of successful negotiation on log of price, quantity, and revenue

	(1)	(2)	(3)	(4)
	ln(retail price)	ln(OOP price)	ln(quantity)	ln(revenue)
negotiated × post	-0.697***	-1.934***	1.752***	1.055***
	(0.049)	(0.052)	(0.264)	(0.264)
Observations	11819	11819	11819	11819
Mean of Dep. Var.	4.696	4.529	8.914	13.610
SD of Dep. Var.	2.730	2.763	3.418	2.592
Adj. R^2	0.992	0.992	0.895	0.831
Within R^2	0.148	0.564	0.050	0.020

Notes: The table reports regression results comparing the log of quarterly retail price, out-of-pocket price, quantity, and revenue between successfully negotiated drugs and exclusive new drugs. Standard errors are clustered at the drug level.

Table A3: Descriptive Statistics at the Disease Level

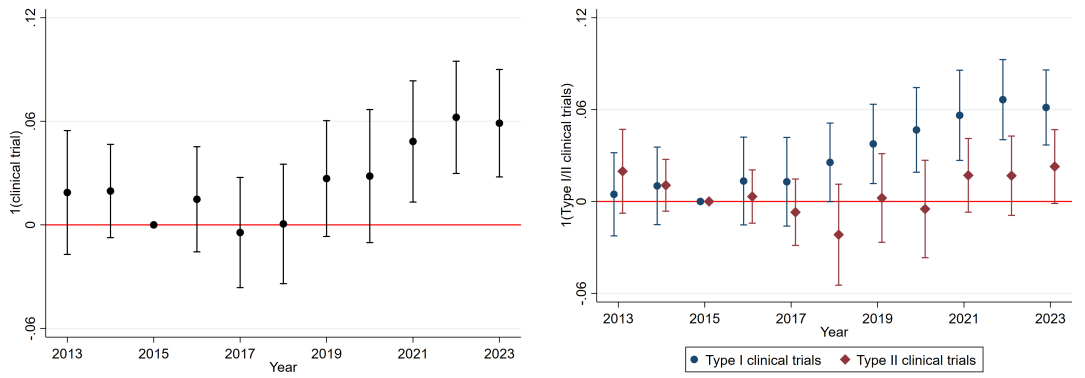
	Drug		Vaccine	
	(1)	(2)	(3)	(4)
	2013-2015	2016-2023	2013-2015	2016-2023
1(clinical trial)	0.048	0.080	0.040	0.068
	(0.213)	(0.271)	(0.197)	(0.251)
1(Type I clinical trial)	0.032	0.068	0.014	0.027
	(0.177)	(0.253)	(0.120)	(0.161)
1(Type II clinical trial)	0.028	0.042	0.027	0.052
	(0.164)	(0.201)	(0.163)	(0.222)
# of clinical trials	0.177	0.875	0.069	0.203
	(1.273)	(7.120)	(0.402)	(1.015)
# of Type I clinical trials	0.115	0.701	0.019	0.053
	(0.902)	(6.017)	(0.169)	(0.400)
# of Type II clinical trials	0.063	0.174	0.050	0.150
	(0.522)	(1.419)	(0.358)	(0.807)
# of Phase I clinical trials	0.072	0.427	0.014	0.086
	(0.569)	(3.446)	(0.120)	(0.509)
# of Phase II clinical trials	0.060	0.311	0.005	0.028
	(0.526)	(2.886)	(0.069)	(0.196)
# of Phase III clinical trials	0.049	0.232	0.050	0.091
	(0.473)	(2.097)	(0.330)	(0.551)
N	10,443	27,848	621	1,656

Notes: The table shows the summary statistics of characteristics for drugs and vaccines separately.

Table A4: Robustness Results: Redefinition of Clinical Trial Start Date

	1(clinical trial)			# of clinical trials		
	(1)	(2)	(3)	(4)	(5)	(6)
	Any	Type I	Type II	All	Type I	Type II
drug × post	0.017	0.035***	-0.007	0.709***	0.665***	0.044
	(0.010)	(0.009)	(0.008)	(0.119)	(0.097)	(0.034)
Observations	40568	40568	40568	40568	40568	40568
Mean of Dep. Var.	0.074	0.060	0.041	0.761	0.603	0.158
SD of Dep. Var.	0.262	0.237	0.199	6.905	5.852	1.331
Adj. R^2	0.658	0.651	0.556	0.668	0.632	0.603
Within R^2	0.000	0.001	0.000	0.000	0.000	0.000

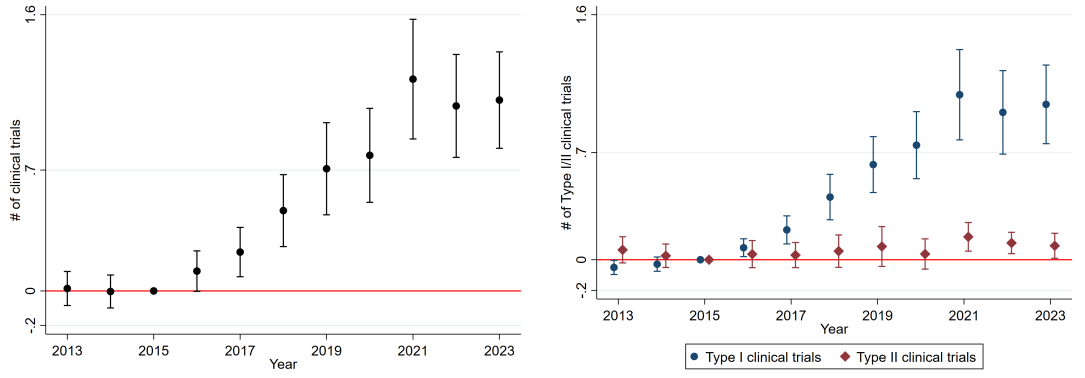
Notes: The table reports regression results comparing the conduct of clinical trials for drugs and vaccines. Columns (1)-(3) present the estimated policy effects on the likelihood of conducting clinical trials, while columns (4)-(6) present the effects on the number of clinical trials.



(a) All Clinical Trials (b) Type I and Type II Clinical Trials

Figure A1: Event Study for the Incidence of Conducting Clinical Trials

Notes: These figures plot the estimated event study coefficients of the effects of China's negotiation policy on the incidence of conducting new clinical trials (Panel a) and on the incidence of conducting Type I and Type II clinical trials separately (Panel b), together with their 95% confidence intervals.



(a) All Clinical Trials (b) Type I and Type II Clinical Trials

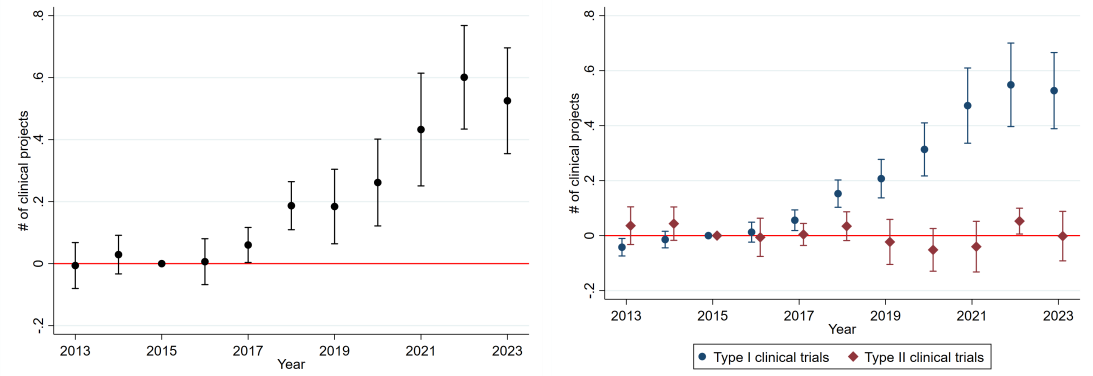
Figure A2: Event Study for the Number of Clinical Trials

Notes: These figures plot the estimated event study coefficients of the effects of China's negotiation policy on the number of new clinical trials (Panel a) and on the number of Type I and Type II clinical trials separately (Panel b), together with their 95% confidence intervals.

Table A5: Robustness Results: Negotiation Policy Effect on Number of Clinical Projects

	# of clinical projects			# of active clinical projects		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Type I	Type II	All	Type I	Type II
drug × post	0.275***	0.305***	-0.031	0.292***	0.370***	-0.078*
	(0.058)	(0.045)	(0.024)	(0.080)	(0.056)	(0.042)
Observations	40568	40568	40568	40568	40568	40568
Mean of Dep. Var.	0.371	0.296	0.075	0.451	0.358	0.093
SD of Dep. Var.	3.149	2.760	0.521	3.790	3.306	0.634
Adj. R^2	0.639	0.592	0.665	0.665	0.620	0.711
Within R^2	0.000	0.000	0.000	0.000	0.000	0.001

Notes: The table reports regression results comparing the number of clinical projects and active clinical projects for drugs and vaccines per disease.



(a) All

(b) Type I and Type II

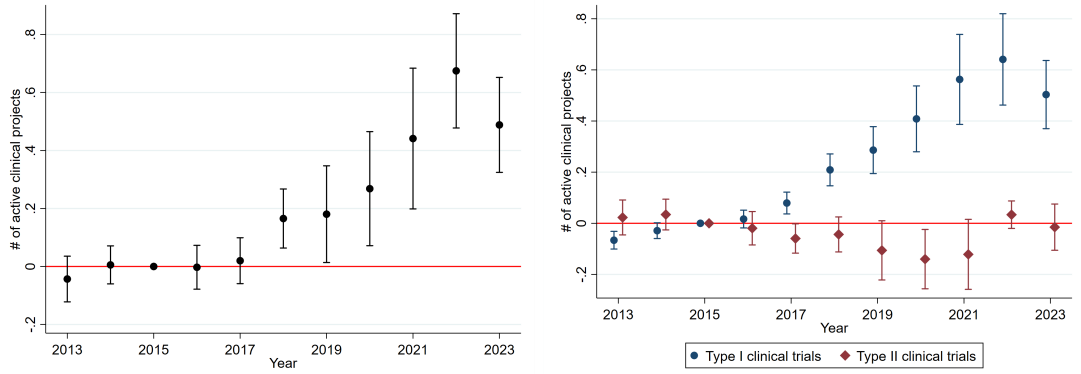
Figure A3: Event Study for the Number of Clinical Projects

Notes: These figures plot the estimated event study coefficients of the effects of China's negotiation policy on the number of clinical projects (Panel a) and on the number of Type I and Type II clinical projects (Panel b), together with their 95% confidence intervals.

Table A6: Effect of the Negotiation Policy on Clinical Trials

	1(clinical trial)			# of clinical trials		
	(1)	(2)	(3)	(4)	(5)	(6)
	Any	Type I	Type II	All	Type I	Type II
drug × post	0.005	0.024***	-0.010	0.564***	0.553***	0.011
	(0.010)	(0.008)	(0.008)	(0.103)	(0.082)	(0.034)
Observations	40568	40568	40568	40568	40568	40568
Mean of Dep. Var.	0.071	0.057	0.039	0.656	0.513	0.143
SD of Dep. Var.	0.256	0.231	0.193	5.947	5.015	1.218
Adj. R^2	0.653	0.639	0.554	0.670	0.615	0.633
Within R^2	0.000	0.000	0.000	0.000	0.000	0.000

Notes: The table reports regression results comparing the conduct of clinical trials for drugs and vaccines. Columns (1)–(3) present the estimated policy effects on the likelihood of conducting clinical trials, while columns (4)–(6) present the effects on the number of clinical trials. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.



(a) All (b) Type I and Type II

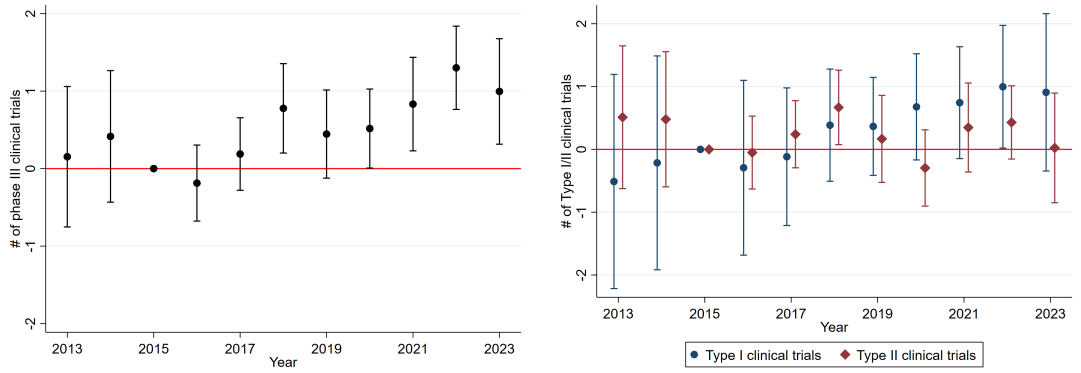
Figure A4: Event Study for the Number of Active Clinical Projects

Notes: These figures plot the estimated event study coefficients of the effects of China's negotiation policy on the number of active clinical projects (Panel a) and on the number of Type I and Type II active clinical projects (Panel b), together with their 95% confidence intervals.

Table A7: Robustness Results: Poisson Regression Model

	(1) All	(2) Type I	(3) Type II
drug × post	0.521***	0.812*	-0.083
	(0.153)	(0.442)	(0.140)
Observations	5830	4686	3982
Mean of Dep. Var.	4.565	4.443	1.455
SD of Dep. Var.	15.108	14.153	3.635

Notes: The table reports Poisson regression results comparing the number of clinical trials for drugs and vaccines per disease.



(a) All New Clinical Trials (b) Type I and Type II Clinical Trials

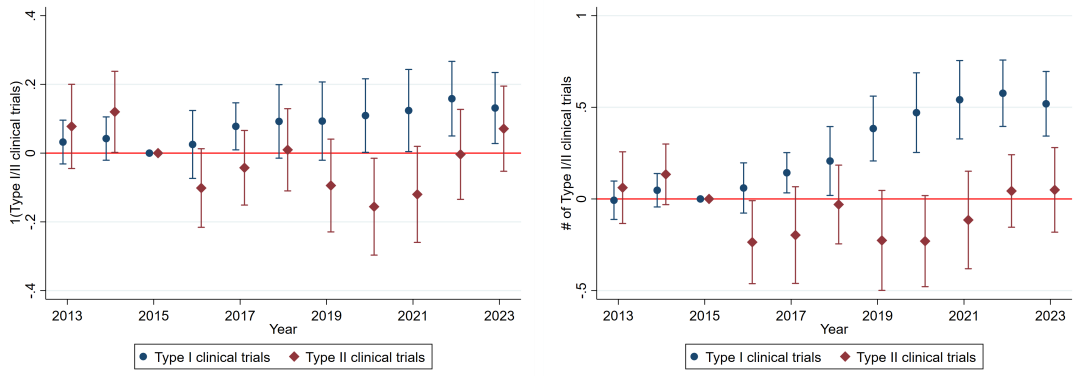
Figure A5: Event Study for the Number of Clinical Trials by Poisson Regression Model

Notes: These figures plot the estimated event study coefficients of the effects of China's negotiation policy on the number of clinical trials (Panel a) and on the number of Type I and Type II new drugs (Panel b) using Poisson regression model, together with their 95% confidence intervals. Standard errors are clustered at the disease-treatment level.

Table A8: Descriptive Statistics at the Firm Level

	Pharmaceutical firm		Vaccine firm	
	(1)	(2)	(3)	(4)
	2013-2015	2016-2023	2013-2015	2016-2023
1(domestic firm)	0.835	0.787	0.963	0.960
	(0.371)	(0.409)	(0.189)	(0.197)
1(MAH)	0.662	0.655	0.798	0.767
	(0.473)	(0.475)	(0.403)	(0.423)
1(clinical trial)	0.113	0.282	0.129	0.337
	(0.317)	(0.450)	(0.336)	(0.473)
1(Type I clinical trial)	0.076	0.233	0.037	0.130
	(0.266)	(0.423)	(0.189)	(0.337)
1(Type II clinical trial)	0.045	0.079	0.104	0.240
	(0.208)	(0.270)	(0.307)	(0.427)
# of clinical trials	0.211	0.695	0.196	0.557
	(0.842)	(2.418)	(0.576)	(1.000)
# of Type I clinical trials	0.135	0.543	0.049	0.170
	(0.652)	(2.095)	(0.268)	(0.479)
# of Type II clinical trials	0.076	0.152	0.147	0.386
	(0.440)	(0.755)	(0.474)	(0.848)
1(Micro firm)	0.136	0.158	0.135	0.132
	(0.343)	(0.365)	(0.343)	(0.339)
1(Small firm)	0.341	0.369	0.301	0.317
	(0.474)	(0.482)	(0.460)	(0.466)
1(Medium firm)	0.288	0.268	0.288	0.289
	(0.453)	(0.443)	(0.454)	(0.454)
1(Large firm)	0.234	0.205	0.276	0.262
	(0.424)	(0.404)	(0.448)	(0.440)
N	3,482	13,982	163	546

Notes: The table shows the summary statistics of characteristics for treatment group and control group of firms separately.



(a) Incidence of Conducting clinical Trials

(b) Number of Clinical Trials

Figure A6: Event Study of the Negotiation Policy's Effects on Firm-Level Clinical Trial Activity

Notes: These figures plot the estimated coefficients of the annual effects of the negotiation policy on clinical trials excluding firms which develop both drugs and vaccines, together with their 95% confidence intervals. Panel (a) presents the estimated policy effects on the likelihood that a firm conducts clinical trials, while Panel (b) shows the effects on the number of Type I and Type II clinical trials conducted by each firm.