Joint Discussion Paper Series in Economics

by the Universities of
Aachen • Gießen • Göttingen
Kassel • Marburg • Siegen

ISSN 1867-3678

No. 05-2025

Maximilian M. Gail, Georg Götz, Daniel Herold, and Jan Schäfer

Evaluation of a Partial Ban of Rx-Rebates in Germany Using Difference-in-Differences

Coordination: Bernd Hayo
Philipps-University Marburg
School of Business and Economics
Universitätsstraße 24, D-35032 Marburg
Tel: +49-6421-2823091, Fax: +49-6421-2823088, e-mail: hayo@wiwi.uni-marburg.de

Evaluation of a Partial Ban of Rx-Rebates in Germany Using Difference-in-Differences

Maximilian M. Gail* Georg Götz* Daniel Herold*
Jan Schäfer*

May 19, 2025

Please do not quote, circulate or publish without the authors' permission

Abstract

We investigate patients' price sensitivity for prescription (Rx) drugs with regards to patronizing online or brick-and-mortar pharmacies. In doing so, we exploit a policy change in Germany that prohibited online pharmacies from granting rebates to one part of the population, the members of the statutory health insurance scheme. This policy change created a natural experiment, allowing us to analyze its impact on the pharmaceutical market using Difference-in-Differences. Utilizing a novel dataset obtained from merchandise information systems, we find that the ban led to a shift in consumer behavior, increasing offline pharmacy Rx sales by 1.36 % to 1.65 %. In a second step, we assess to what extent the policy change achieved its alleged goal of supporting brick-and-mortar pharmacies. Our findings indicate that pharmacies with low revenues, which are most exposed to market exit, saw only a minor increase in annual revenues of around € 1,360. At the same time, pharmacies in the highest decile gained more than five times that amount. This indicates that the introduction of VOASG alone was insufficient to reverse the declining trend in pharmacy numbers in Germany. To strengthen the comprehensive supply of pharmaceuticals to the general population, additional reforms seem necessary.

Keywords: Pharmacies, Prescription Drugs, Resale Price Maintenance, Regulation, Public Health

JEL Codes: L5, I18

*Chair for Industrial Organization, Regulation and Antitrust, Department of Economics, Justus Liebig University Giessen. Licher Strasse 62, 35394 Giessen. Corresponding author: daniel.herold@wirtschaft.uni-giessen.de.

Acknowledgements

The data used in our study was provided by the German suppliers of merchandise information systems (MIS): AWINTA, ADG and Pharmatechnik. We received funding from the Pharmacists Association Westfalen-Lippe (Apothekerverband Westfalen-Lippe e. V.) to buy the data.

Funding

The Pharmacists Association Westfalen-Lippe (AVWL) and pharmacists' cooperative NOWEDA are funding a research project at the Chair of Georg Götz. Our study is a product of this project. The project itself was scientific in nature (i. e., no commercial research project). To conduct this project, the positions of the co-authors Jan Thomas Schäfer and Daniel Herold were funded by the aforementioned parties.

Declarations of interest

The authors declare that they have no conflict of interest. This research was funded by AVWL and NOWEDA. The funding supported researcher positions, but the authors were granted full scientific freedom to conduct their research without any influence on the results or conclusions.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used OpenAI ChatGPT, Google Gemini and Writefull in order to improve language and GitHub Copilot in order to make coding more efficient. After using these services, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

1 Introduction

The accessibility of pharmaceutical products stands as a cornerstone of public health, directly influencing treatment availability and adherence (Mays et al., 2009; Herwartz and Schley, 2018; Haschka et al., 2020; Li and Liu, 2021; Atella et al., 2017). This availability is shaped by price and non-price factors of medications, such as the spatial density of brick-and-mortar pharmacies. The emergence and rapid growth of online pharmacies have introduced a significant shift in this landscape, offering consumers potentially lower prices, particularly for over-the-counter (OTC), and, in some countries, also for prescription (Rx) drugs, and increased convenience (Lostakova et al., 2012; Heinsohn and Flessa, 2013; Long et al., 2022). This enhanced accessibility, however, comes with potential trade-offs for the traditional brick-and-mortar pharmacy sector.

The increasing competition from online retailers poses a challenge to the viability of offline pharmacies, potentially leading to closures as consumers seek lower online prices. This is a familiar pattern from other industries (An and Chung, 2023; Chava et al., 2024), and raises concerns about the geographic availability of physical pharmacies. A dense network of those pharmacies is shown to be vital for providing not only medications but also essential health advice and immediate pharmaceutical support (Di Novi et al., 2020; Catalano et al., 2024). The emergence of "pharmacy deserts" could disproportionately affect vulnerable populations, those with limited digital literacy, and individuals needing immediate access.

In this environment, regulatory bodies face the challenge of balancing the benefits of lower prices offered by online pharmacies with the need to maintain a robust and geographically diverse network of offline pharmacies.[1] One key regulatory lever involves interventions that influence drug prices or patient's co-payments across different sales channels. Understanding how consumers respond to payment differentials between online and offline pharmacies is therefore paramount for policymakers. By analyzing consumer behavior in the face of varying payments, this research aims to provide valuable insights into the potential consequences of different regulatory approaches and their impact on both market dynamics and public health outcomes.

Our paper uses the German market as an example. The German Pharmacy Act requires brick-and-mortar pharmacies to provide the general pop-

[1] This may include a reliable and safe supply with pharmaceuticals, especially in emergency situations or when pharmaceuticals are difficult to deliver (e.g., due cooling requirements).

ulation with access to medications. However, the number of pharmacies dropped by roughly 12.5% from 2010 (21,441) to 2020 (18,753), when the VOASG was introduced (ABDA, 2024, p. 9). This decline coincides with a rise in competition from foreign online pharmacies. Their market share for OTC drugs increased from around 5% in 2008 to 20% by 2020 (ABDA, 2021; Statista, 2024). Initially, regulation rendered prices for Rx drugs uniform, which limited price competition to OTC medications. However, a 2016 European Court of Justice ruling (Case No.: C-148/15) allowed online pharmacies to also offer discounts in the form of vouchers on Rx drugs (Albrecht et al., 2020). These vouchers indirectly reduced patients' co-payments.

In the light of these developments, in December 2020 the German government implemented the so-called Local Pharmacy Support Act ("Vor-Ort-Apotheken Stärkungsgesetz", henceforth VOASG), with the goal to strengthen brick-and-mortar pharmacies. This law prohibits online pharmacies from rewarding the majority of patients (those covered by the mandatory statutory health insurance scheme, making up roughly 90% of the population) with vouchers for purchasing prescription drugs. The other part of the population, privately insured individuals and self-pay patients, are still allowed to be granted vouchers. This law, by creating a differential impact on patients with statutory versus private insurance and self-pay, provides a natural experiment to study the effect of a ban on rebates on prescription drug sales.

We employ a novel dataset for this study, constructed from high-frequency sales data provided by the major merchandise information system (MIS) suppliers in Germany. This dataset encompasses individual transaction data from approximately 9,231 offline pharmacies, representing nearly half of all German pharmacies, for the period January 1, 2018, to October 31, 2022.

We find that rebates in the form of vouchers significantly affect patient's choice regarding online and offline pharmacies: the partial ban led to an increase in offline sales of around 1.36 to 1.65 % for an average brick-and-mortar pharmacy compared to a counterfactual scenario without the ban. This result shows that patients' choice regarding the two retail channels is affected by price differentials. This insight is particularly relevant in light of the 2016 European Court of Justice ruling mentioned above, which legalized vouchers granted by foreign online pharmacies. In this ruling, the judges claimed that the German government had failed to show that RPM was an effective tool to achieve the alleged goal of securing the comprehensive supply of pharmaceuticals to the general population. Our research provides empirical evidence regarding consumers' price-sensitivity, and therefore, suggesting that online rebates could potentially erode offline sales and profitability.

We further investigate whether the introduction of the VOASG successfully mitigated large-scale pharmacy closures. Economic theory posits that market exit occurs when opportunity costs exceed revenues, resulting in negative economic profits (Jehle and Reny, 2011, Ch. 4). Given that pharmacies with lower revenues are generally more susceptible to market exit, we stratified the sample into revenue deciles and calculated the DiD effect for each decile. We show that the effects for the lowest seven deciles are relatively similar, while the effect in the three highest deciles is around one point five to two-times stronger. This suggests that larger pharmacies benefited more strongly from the rebate ban than smaller pharmacies both in relative and absolute terms. We also estimated the additional *annual* profits generated by the rebate ban for pharmacies in the first and tenth deciles, which were approximately €1,360 and €7,690, respectively. Notably, the *additional annual profit* for the lowest decile equates to around one third of the average *monthly* income of an employee in Germany in 2021 (Destatis, `https://t.ly/N2dJq`). This aspect is particularly relevant because German law requires that pharmacies are owned and run by the pharmacists themselves (owner-management). The findings also indicate that the majority of pharmacies experienced only a mild increase in profits, with a median increase in profits of €3,246. Given these relatively modest gains, it seems unlikely that the policy had a substantial impact on pharmacies' decision to enter or exit the market. This is corroborated by the developments in 2021-2023, when another 6.3% of pharmacies closed.[2]

This article complements the growing body of research on public health service provision. While many studies have focused on hospitals or physicians in specific countries such as the US (Mays et al., 2009; Duminy et al., 2022), China (Li and Liu, 2021), and Germany (Herwartz and Schley, 2018; Haschka et al., 2020), our research examines the role of pharmacies. These establishments often serve as the final link in the pharmaceutical supply chain, delivering medications to the general public (Inoue et al., 2016; Raza et al., 2022). Previous research on pharmacies has investigated specific services, such as their role in delivering primary care, improving adherence or providing non-prescription medications (Smith, 2009; Agomo, 2012; Perraudin et al., 2016; Costa et al., 2019; Di Novi et al., 2020). Our research, in contrast, analyzes how price competition with online pharmacies affects pharmacy profitability and, consequently, the financial sustainability of their services.

We also contribute to the literature on digitization, particularly the de-

[2]The number of pharmacies decreased to 18,461 in 2021 and further to 17,571 in 2023 (ABDA, 2024, p. 9).

bate surrounding the substitutability of offline and online services (Brynjolfsson and Smith, 2000; Brown and Goolsbee, 2002; Sinai and Waldfogel, 2004; Jin and Kato, 2007; Goldmanis et al., 2010; Cavallo, 2017; Couture et al., 2021) and "digital public health", which explores how digitization can improve population health (Iyamu et al., 2022; Wong et al., 2022; Yurkovich et al., 2024). In that respect, we investigate the extent to which online pharmacies complement or substitute traditional brick-and-mortar pharmacies in supplying pharmaceuticals to the public (Coenen et al., 2011; an der Heiden and Meyrahn, 2017). Given that patients are price sensitive, policymakers should take into account that price competition between the offline and online channel can have a detrimental effect on the network of brick-and-mortar pharmacies.

2 Reimbursement, Remuneration and Vouchers

This section outlines relevant background information on Germany's health insurance system with regards to patient reimbursement and co-payments (Section 2.1) and the regulations governing pharmacy remuneration for dispensing Rx drugs (Section 2.2). Furthermore, we discuss the role of vouchers issued by online pharmacies within our analyses (Section 2.3).

2.1 Patient Reimbursement and Co-payments for Rx Drugs in Germany

In Germany, most residents are mandated to hold health insurance.[3] This system offers two primary options: statutory health insurance and private health insurance. As of 2021, around 73.3 Mio. and 8.7 Mio. citizens were members of the statutory and private health insurance scheme, respectively.[4] Rx drugs are prescribed by physicians and dispensed by both traditional and online pharmacies. This holds irrespective of the patients' insurance. Reimbursement, however, differs between statutory and private health insurance.

Members of the statutory health insurance are typically required to make co-payments, contributing a portion of the drug's cost. These co-payments are calculated based on the retail price, the so-called pharmacy selling price

[3]Federal Ministry of Health, `https://t.ly/8Ev6L`.

[4]Statista, `https://t.ly/pyzwt`.

("Apothekenverkaufspreis", AVP).[5] If the AVP is ...

- ... below EUR 5 the co-payment equals the AVP,
- ... between EUR 5 and EUR 50 the co-payment equals EUR 5,
- ... between EUR 50 and EUR 100 the co-payment equals 10% of the AVP,
- ... above EUR 100 the co-payment is capped at EUR 10.

Further payments beyond the aforementioned co-payments are possible, which depend on rebates between the patients' insurance company and the drug manufacturers.[6] The remaining difference between the price of a prescribed drug and the co-payment and any applicable rebates is typically covered by the insurance provider.

Privately insured individuals can select from a range of insurance contracts, each offering distinct reimbursement structures. Typically, these schemes require patients to initially cover costs out-of-pocket, followed by reimbursement from the insurance provider upon submission of invoices. Contracts can be customized to accommodate individual needs, such as making exceptions for high-cost hospitalizations.

2.2 Pharmacy Remuneration for Rx Drugs

Pharmacies' remuneration for the dispensation of Rx drugs in Germany is regulated. Pharmacists receive a fixed fee of € 8.35 per package, in addition to a variable component that constitutes 3 % of the so-called pharmacy purchase price ("Apothekeneinkaufspreis", AEP). The AEP is defined in the pharmaceutical price regulation and can be broadly referred to as the wholesale price.

Over time, several components have been introduced which either increase or decrease remuneration. These components and, as a prerequisite for the analyses presented in Section 5.3, a detailed description on how to compute a pharmacy's remuneration for a given prescription, are presented in the Appendix (Section A.1).

[5] A more detailed description of the relevant price measures can be found in the Appendix, Section A.1.

[6] These rebates fluctuate frequently, often on a quarterly basis, and systematic data on their exact amounts is generally unavailable.

2.3 Online Pharmacy Vouchers

Patients ordering their prescribed Rx drugs from online pharmacies were rewarded with vouchers. Prior to the introduction of the VOASG, basically all prescriptions were eligible. Since the introduction of the law, online pharmacies are no longer allowed to give vouchers for prescriptions that are covered by the statutory health insurance. These vouchers typically offer a value ranging from € 2.50 to € 10. They are redeemable against the purchase of non-prescription products or can be credited to the customer's account.[7]

In economic terms, these vouchers function similarly to a rebate on Rx drugs, with the distinction that their application is restricted to lowering the price of OTC drugs bought from the specific online pharmacy. Given the typically low price elasticity of demand for Rx drugs (see Section 4.1), such a rebate primarily represents a transfer from the pharmacy to the patient, thereby functioning as a mechanism for price competition. However, it is crucial to consider that patients' out-of-pocket payments are only a fraction of the total cost of an Rx drug – the co-payments (see Section 2.1). These government-mandated co-payments serve as an incentive structure for cost sharing, aiming to discourage unnecessary treatment and ultimately contain healthcare expenditures (Austvoll-Dahlgren et al., 2008; Farbmacher and Winter, 2013; Herr and Suppliet, 2017). Moreover, a stated policy objective is to ensure comprehensive pharmaceutical access for the general population through pharmacies, with the insurance system responsible for pharmacy remuneration. Thus, any rebates extended to patients must be financially balanced, typically through mechanisms like increased insurance premiums. Consequently, interpreting rebates on Rx drugs in the same manner as rebates on conventional goods is inappropriate. Further discussions on distributional effects of the partial ban of vouchers can be found in Section 5.3.

3 Data and Descriptive Statistics

This section outlines the raw data sets used for our analyses and the data handling procedures that led to our final data set (Section 3.1). Additionally, descriptive statistics are presented (Section 3.2).

[7]For a detailed description, see the homepage of the two largest online pharmacies active in Germany, *Shopapotheke* and *DocMorris*, `https://www.docmorris.de/rezepte/rezept-bonus` and `https://www.shop-apotheke.com/lp/rezeptbonus/`. The voucher schemes of the two are fairly similar.

3.1 Data Handling

Our analyses are based on three data sets. First, and central to the analyses, is a unique data set that comprises information on sales of German brick-and-mortar pharmacies. The data were obtained from three major suppliers of merchandise information systems (MIS) AWINTA, ADG and Pharmatechnik.[8] MIS oversee the entire system of inventory management and provide both hardware and software solutions to pharmacies, essentially handling the IT infrastructure. Our data includes all transactions conducted by a pharmacist with a customer. Only specialty drugs (e.g. cytostatics) are excluded. The data also contain information on AVP, transaction revenue, patient co-payments, and the central pharmaceutical number (PCN) that uniquely identifies each product. To ensure customer anonymity and protect trade secrets, pharmacy location information is limited to the first two digits of the zip code. In Germany, there are 95 two-digit zip code regions.

The MIS dataset encompasses transactions of 9,231 brick-and-mortar pharmacies, covering nearly half of all pharmacies in Germany. The data capture individual sales transactions from January 1, 2018, to October 31, 2022. As a result of data preparation (in particular, balancing the MIS data and merging them with the following two data sets), the number of observations in the actual analyses is lower, as will be explained below.

The second data set contains information on package sizes or doses, which are classified using the N-classification system established by the Federal Institute for Drugs and Medical Devices (BfArM) in Germany.[9] The N-classification system categorizes pharmaceutical packages into three size classes based on estimated daily doses: N1 (approximately 10 days), N2 (approximately 30 days), and N3 (approximately 100 days).[10] Data on N-classification were obtained from IQVIA and from the largest German health insurance company *Techniker Krankenkasse*.[11]

Data on package sizes is used for three reasons. First, package sizes are used as controls in our estimations (see Section 4.3). Second, to ensure our analyses are restricted to pharmaceuticals, we excluded all items from the

[8]See `https://www.awinta.de`, `https://www.adg.de` and `https://www.pharmatechnik.de`.

[9]See `https://www.bfarm.de/DE/Arzneimittel/Arzneimittelinformationen/Packungsgroessen/_node.html`.

[10]An alternative would be to use the concept of daily defined doses (DDD) (see, e.g., WHO Collaborating Centre for Drug Statistics Methodology (2024) for more information). However, the availability of information on DDD is limited in in our data set.

[11]See `https://www.tk.de/resource/blob/2058850/3f65533a18b118a9ebcf585ef2830c40/rabattvertraege-pzn-liste-gesamt-data.pdf`.

MIS dataset lacking package size information, i.e., medical devices such as prescribed face-masks, anti-thrombosis stockings and ventilators, or other special items such as Covid-19 vaccines. Third, a robustness check is performed where sales are measured in terms of doses instead of packages (see Appendix, Section A.3).

The third data set comprises information on the evolution of health insurance memberships. The data are obtained from the Federal Ministry of Health and the Association of Private Health Insurance.[12]

As a first step of this process of preparing the data, we balanced the MIS data set. To ensure a consistent sample, we excluded pharmacies that were not continuously active throughout the entire observation period. Pharmacies could have exited the sample due to closure or inactivity, a change in legal name, or a switch in their MIS provider. We also excluded pharmacies with minimal sales and those specializing in the supply of expensive medications. To mitigate volatility in prescription data, which can, for instance, be attributed to seasonal patterns (e.g., influenza waves) and the effects of the COVID-19 pandemic (e.g., lockdowns, infection waves), we aggregated the data to an annual level. We excluded 2022 from the analysis, as the data set covers only the first three quarters of that year. As a second step, and as explained above, we used data on N-classifications to ensure that the data set only contains sales of actual pharmaceuticals.[13] In a third step, we removed the 2.5% of pharmacies with the highest and lowest sales from the sample to minimize the influence of outliers. We also excluded sales via courier services and to nursing homes.

As a result of that procedure, the final data set ranges from 2018–2021 and contains information on 5,487 pharmacies. This represents around 30 % of the total number of pharmacies in Germany over the course of our sample.[14]

Figure 1 visualizes the geographic scope of pharmacy sales data across Germany. The left panel illustrates the overall sample coverage, encompassing 9,231 pharmacies (roughly 50 % of all German pharmacies during the observation period). The right panel zooms in on the coverage of the fi-

[12]See `https://www.bundesgesundheitsministerium.de/themen/krankenversicherung/zahlen-und-fakten-zur-krankenversicherung/mitglieder-und-versicherte` and `https://www.pkv-zahlenportal.de/werte/2012/2022/12/pers-kkv/basket/result`

[13]To further validate that, in particular, medical devices are excluded from the data set, we used the German pharmaceutical directory *Gelbe Liste Pharmaindex* (`https://www.gelbe-liste.de/`).

[14]Note that the estimations presented below are either conducted on the two-digit zip code-level or on the pharmacy-level.

nal sample, which comprises 5,487 pharmacies (roughly 30 % of all German pharmacies observation period). The color intensity within each region corresponds to the percentage of coverage, with darker shades signifying higher data representation. A comparison of both panels reveals that, despite data balancing and processing, our sample retains coverage across all two-digit zip codes in Germany, with a median coverage of approximately 29 % per two-digit zip code.

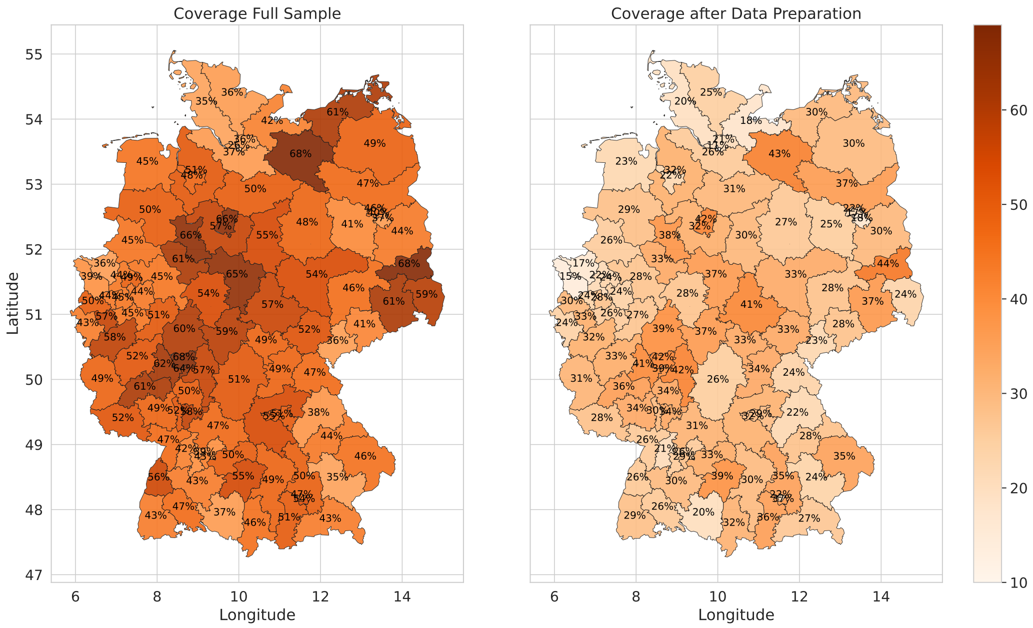

Figure 1: Coverage of Pharmacy Sales Data Across German Regions. Source: MIS suppliers and web page of *Apothekenumschau* (`https://www.apotheken-umschau.de/apothekenfinder/`), scraped on September 29, 2020.

3.2 Descriptive Statistics

Tables 1 and 2 report summary statistics at the two-digit zip code and pharmacy levels, respectively, differentiated between private and statutory health prescriptions.

	Private Prescriptions						Statutory Health Prescriptions					
	N	Mean	SD	Min	Median	Max	N	Mean	SD	Min	Median	Max
Sales per 2-digit-zip code and Year in Packages	380	274,393	126,162	33,328	274,106	709,750	380	1,670,946	647,546	177,155	1,594,334	3,948,482
Sales per 2-digit-zip code and Year in Doses	380	17,088,357	7,877,312	1,958,510	16,797,645	46,334,170	380	1.19e+08	47,241,362	11,561,710	1.16e+08	3.06e+08
Gross Revenue per 2-digit-zip code and Year in Euro	380	14,668,064	6,949,777	1,775,727	14,312,372	39,087,452	380	93,061,340	36,210,488	11,564,190	92,083,137	2.39e+08
Net Revenue per 2-digit-zip code and Year in Euro	380	12,366,244	5,861,491	1,492,210	12,104,528	32,847,140	380	78,456,469	30,537,605	9,717,812	77,561,420	2.01e+08
Net Revenue (w.o. lump sum fees) per 2-digit-zip code and Year in Euro	380	12,314,791	5,837,464	1,486,483	12,050,517	32,691,821	380	75,653,612	29,463,615	9,425,507	7.5e+07	1.94e+08
Total Remuneration per 2-digit-zip code and Year in Euro	380	2,583,160	1,191,630	315,717	2,574,276	6,706,106	380	13,332,543	5,159,417	1,454,439	12,815,406	31,943,711
Average Remuneration per 2-digit-zip code and Year in Euro	380	9.4	0.084	9.15	9.41	9.71	380	7.98	0.0927	7.77	7.97	8.33
Gross AVP per 2-digit-zip code and Year in Euro/Package	380	53	3.38	42.7	53.1	65.7	380	55.9	3.75	47.2	55.5	69.3
Net AVP per 2-digit-zip code and Year in Euro/Package	380	44.7	2.89	35.9	44.8	55.2	380	47.1	3.19	39.7	46.8	59
Number of Pharmacies per 2 digit zip-code	380	57.8	21.8	9	54	121	380	57.8	21.8	9	54	121
Quantity weighted average doses	380	62.2	2.61	54.2	62.4	68.2	380	71.3	3.06	64	71	78.8

Table 1: Summary statistics on the two-digit-zip code sample. 760 observations in total.

	Private Prescriptions						Statutory Health Prescriptions					
	N	Mean	SD	Min	Median	Max	N	Mean	SD	Min	Median	Max
Sales per Pharmacy and Year in Packages	21948	4,751	2,685	385	4,162	25,207	21948	28,930	12,278	6,591	26,688	74,147
Sales per Pharmacy and Year in Doses	21948	295,862	167,431	22,640	259,715	1,530,590	21948	2,066,169	912,123	385,530	1,907,845	5,777,330
Gross Revenue per Pharmacy and Year in Euro	21948	253,958	170,740	12,770	213,515	2,359,418	21948	1,611,232	763,634	313,249	1,458,762	7,044,259
Net Revenue per Pharmacy and Year in Euro	21948	214,105	143,972	10,731	180,068	1,982,707	21948	1,358,368	643,953	263,235	1,228,696	5,919,541
Net Revenue (w.o. lump sum fees) per Pharmacy and Year in Euro	21948	213,214	143,510	10,636	179,253	1,981,299	21948	1,309,840	625,601	251,675	1,183,001	5,820,396
Total Remuneration per Pharmacy and Year in Euro	21948	44,724	25,607	3,605	39,117	242,996	21948	230,835	98,256	51,762	212,854	594,033
Average Remuneration per Pharmacy and Year in Euro	21948	9.39	0.385	8.62	9.32	24.1	21948	7.98	0.279	7.41	7.92	9.84
Gross AVP per Pharmacy and Year in Euro/Package	21948	52.4	15.7	21.3	49.7	652	21948	55.8	11.3	32.5	53.4	132
Net AVP per Pharmacy and Year in Euro/Package	21948	44.2	13.2	17.9	41.9	548	21948	47.1	9.57	27.3	45	111
Quantity weighted average doses	21948	62.3	5.16	30	62.8	78.7	21948	71.1	5.64	36	71.7	85

Table 2: Summary statistics on the pharmacy level sample. 43,896 observations in total.

The descriptive statistics include the number of observations (N), mean, standard deviation (SD), median, minimum, and maximum for annual sales in packages or doses, gross revenue, net revenue, net revenue excluding lump sum fees, total remuneration, quantity weighted average doses, average remuneration, and both gross and net AVP, presented separately for two-digit zip codes and pharmacies.

Table 3 shows the evolution of memberships in the statutory and private health insurance. It can be observed that membership shares remain stable over the observed period.

Year	Members in Private Insurances (in Mio.)	Members in Statutory Health Insurance (in Mio.)	Share of Private Insured Members (in %)	Share of Statutory Health Insured Members (in %)
2018	8.736	72.80	10.71	89.29
2019	8.732	73.01	10.68	89.32
2020	8.724	73.36	10.63	89.37
2021	8.717	73.32	10.63	89.37

Table 3: Evolution of private and statutory health insured members.

To wrap up this section, Table 4 provides an overview of the variables we used in this article. Most of these variables are also used in the estimations presented below.

Variable name	Description
Sales in Packages	Annual amount of prescribed drugs denoted in packages
Sales in Doses	Annual amount of prescribed drugs denoted in doses (see Section 3.1)
Two digit zip code	The initial two digits in Germany's five-digit postal code system, often referred to as the postal code region
Pharmacy ID	Pseudonymized identifiers on the two digit zip code level for each pharmacy
Time	Time in years from 2018 – 2021
Prescription type	Statutory health or private prescription
Weighted average of Doses	Quantity-weighted average doses based on the Germany's N-classification system, which resemble the average package size dispensed
Share of Statutory Health Insured Members	Annual, nationwide proportion of people covered by statutory health insurance relative to the total number of people with either statutory and private health insurance
Deciles	Categorical variable dividing pharmacies into ten revenue-based bins of equal size, evaluated annually
Apothekenverkaufspreis (AVP)	Retail or selling price per drug (in Euro per package)
Apothekeneinkaufspreis (AEP)	Wholesale list price per drug (in Euro per package)
Gross and net revenue	Gross and net revenue (in Euro) are calculated by multiplying the AVP (either net or gross) by the number of packages sold
Net revenue w.o. lump sum fees	Net revenue (in Euro) minus lump sum fees per drug (see appendix, Section A.1)
Total remuneration	Total remuneration (in Euro) is determined by multiplying the AEP by the quantity of packages sold (refer to appendix, Section A.1, particularly Equation (A.4))
Average remuneration	Quantity weighted average remuneration per sale

Table 4: Description of the variables included in the event studies and TWFE models.

4 Estimation Strategy

This section describes the utilization of the VOASG introduction as a natural experiment to identify the impact of rebates on patients' choice of online or offline pharmacies (Section 4.1). In a subsequent step, it is described how the causal impact of VOASG is estimated using an event study design (Section 4.2) in combination with a two-way fixed effects (TWFE) DiD estimation (Section 4.3).

4.1 Identification

In this section, we outline our identification strategy, which leverages the differential impact of the VOASG on members compared to non-members of the statutory health insurance system. This natural experiment allows us to apply a DiD approach and conduct an event study to assess causal effects (Cunningham, 2021, Chapter 9). Prescriptions to members of the statutory health insurance, directly affected by the VOASG, form the treatment group, while prescriptions to privately insured individuals and self-pay patients, unaffected by the reform, serve as the control group. By comparing the differential changes in the dispensation of Rx drugs between these groups, we isolate the causal effect of the VOASG. To provide further clarity, we first offer a brief overview of the German insurance system, with a particular focus on the prescription drug dispensation scheme.

As described above, Rx drugs are prescribed by physicians and dispensed by both traditional and online pharmacies. Both the private and the statutory health insurance systems generally adhere to standardized reimbursement rates and Co-payments for prescribed medications. Irrespective of the specificities of each system, drug prices are the same in the offline and online channels irrespective of insurance. The same is true for self-pay patients. The only difference in the price dimension is that, after the VOASG came into effect on December 15, 2020, members of the statutory health insurance were no longer entitled to rebates in the form of vouchers for online purchases. However, these pharmacies are still permitted to provide rebates to privately insured consumers.[15]

Given that co-payments and potential rebates granted by online pharmacies are small compared to the fundamental differences between public and private health insurance (premium structures, reimbursement mechanisms, service quality, etc.), there is no reason to assume that the introduction of the VOASG had any impact on patients' choice regarding their insurance scheme. Moreover, there are notable barriers to switching between the two systems. Individuals usually can only switch when their employment status changes in a special way in terms of income and type of employment. The policy can thus be considered exogenous to the individuals' choice regarding insurance schemes.

The demand for prescription drugs is generally inelastic due to their nature (Gatwood et al., 2014; Yeung et al., 2018): a patient's need for medication is often diagnosed by a physician and is not easily deferred. Moreover, as the patient's insurance typically covers the majority of the cost, co-payments are of minor importance. This suggests that patients are unlikely to forego necessary medication solely due to the absence of rebates. While rebates

[15] More information are provided by the German Federal Ministry of Health, see `https://www.bundesgesundheitsministerium.de/apotheken.html`.

potentially influence a patient's choice of pharmacy (online or offline), their impact on overall drug consumption is likely minimal. Given the inelastic nature of demand, any shift in offline sales is expected to be accompanied by a similar shift in online sales. We thus interpret an increase in offline sales as a shift from the online to the offline channel.

We quantify the market impact of the VOASG by examining the number of packages dispensed. This metric is of primary importance to our analyses because pharmacy compensation is directly linked to it, and we will use the results of the DiD estimation to assess the additional profits of pharmacies with varying revenue levels.[16]

4.2 Event Study

The estimation equation for the event study reads as follows:

$$\ln(y_{pgt}) = \alpha_{pg} + \gamma_t + \sum_{\tau=2018}^{2020} \delta_\tau D_{pg\tau} + \beta_{2021} D_{pg2021} + \boldsymbol{W}_{pgt}\mu + \epsilon_{pgt}. \qquad (1)$$

Here, y denotes sales for pharmacies p and statutory health or private prescriptions g at time t (in years). The outcome variable y is measured in logs. Fixed effects α_{pg} and γ_t are included to capture cross-sectional heterogeneity for each combination of p and g, as well as time-varying effects. The term $\sum_{\tau=2018}^{2020} D_{pg\tau}$ represents indicator variables that take the value of one if prescription g is a statutory health prescription during the pre-treatment period spanning from 2018 to 2020. Similarly, D_{pgt} is an indicator variable that equals one if prescription g is a statutory health prescription at time $t = 2021$. The model thus includes 2018-2020 as leads and 2021 as a lag. As is standard in the literature (see Cunningham (2021, Chapter 9.4) or Freyaldenhoven et al. (2019)), the event study is normalized to the pre-intervention period (2020). The coefficient β_{2021} in Equation (1) refers to the treatment effect.[17] The coefficients $\delta_\tau \in \{2018, 2019, 2020\}$ capture the pre-treatment effects, which allow us to examine dynamics prior to the policy intervention.

The matrix $\boldsymbol{W}_{pgt}$ includes the following covariates: (i) the quantity-weighted average of doses per pharmacy p and group g at time t, and (ii)

[16] Robustness checks using doses instead of packages are reported in the Appendix, Section A.3.

[17] In particular, it can be interpreted in a similar way as the ATT of the TWFE estimation (see below), because there is only one post-treatment period.

the share of members of the statutory health insurance relative to total of insured individuals at the national level.

Covariate (i) is calculated based on Germany's N-classification system. As explained in Section 3.1, this system categorizes packages into three sizes: N1 (10 doses), N2 (30 doses), and N3 (100 doses). While not exact, this system provides a reasonable approximation of doses per package. To account for potential variations in package sizes that could influence our results, we calculate a weighted average of package sizes at the two-digit zip code or pharmacy level for each group. For instance, a combination of 15 N1 and 5 N2 packages would equate to approximately 300 doses, which corresponds to a weighted average of 20 doses. (The appendix (Section A.3) contains a robustness check, where package size instead of number of packages sold is used as the dependent variable.)

Covariate (ii) accounts for the relative share of individuals enrolled in statutory health insurance. This covariate is necessary to mitigate the potential confounding effects of shifts in insurance enrollment. Due to data constraints, this covariate is measured at the national level and varies annually, essentially functioning as an alternative to a simple time trend.

4.3 TWFE Estimation

The TWFE estimation equation reads

$$\ln(y_{pgt}) = \alpha_{pg} + \gamma_t + \beta D_{pgt} + \boldsymbol{W}_{pgt}\mu + \epsilon_{pgt}, \qquad (2)$$

where the notation is similar as in Equation (1). Similar to the event study, D_{pgt} is an indicator variable that equals one if g represents a statutory health prescription at time $t = 2021$. The DiD effect (ATT) is represented by β. Since the outcome variable is measured in logs, the coefficient β can be interpreted as a percentage change.[18]

4.4 Distributional Effects

As explained in Section 1, the VOASG was introduced to strengthen the comprehensive supply of pharmaceuticals to the general population during a period of a drastically shrinking number of brick-and-mortar pharmacies. To evaluate the distributional effects of the policy change, we extend the

[18] The exact ATT is computed by $e^{\beta} - 1$, although this transformation is negligible when the effect is close to zero, as it is in our case.

analysis by computing the additional revenues generated by the introduction of the VOASG on pharmacies with different revenues.

Economic theory predicts that, all else equal, pharmacies with lower revenues are more exposed to market exit (Jehle and Reny, 2011, Ch. 4). We therefore categorize pharmacies into deciles based on their revenue. The first decile includes the 10% of pharmacies with the lowest revenue, the second decile includes the next 10% with the second-lowest revenue, and so on.

To estimate how the effects of the VOASG differ between pharmacies with different revenues, Equation (2) is slightly modified.

$$ln(y_{pgt}) = \alpha_{pg} + \gamma_t + Deciles_{pgt} + Deciles_{pgt} \times D_{pgt} + \boldsymbol{W}_{pgt}\mu + \epsilon_{pgt}. \quad (3)$$

In Equation (3), the dummy $Deciles_{pgt}$ accounts for decile-specific heterogeneity.[19] The interaction between the DiD coefficient D_{gt} and the dummy variable $Deciles_{pgt}$ identifies the heterogeneous DiD effect for pharmacies within each revenue deciles. Additionally, a time trend is included in $\boldsymbol{W}_{pgt}$ to control for potentially diverging evolutions between the two insurance groups.

5 Results

This Section presents the results of our analyses. First, we derive the DiD effect using a combination of event study (Section 5.1) and TWFE estimation (Section 5.2). Second, based on the estimated DiD effect, we quantify the additional profits realized by pharmacies with varying revenue levels due to the introduction of the VOASG (Section 5.3).[20]

5.1 Event Study

Figure 2 presents the event study of the introduction of the VOASG (see Equation (1)).

[19] Note that $Deciles_{pgt}$ is not collinear with the fixed effect α_{pg} as pharmacies can shift between deciles over time.

[20] To ensure the robustness of our findings, we performed a simplified DiD analysis by directly comparing the pre- and post-VOASG mean sales between the treatment and control groups. The results of this analysis, which align with those presented in the main text, can be found in the Appendix (Section A.2).

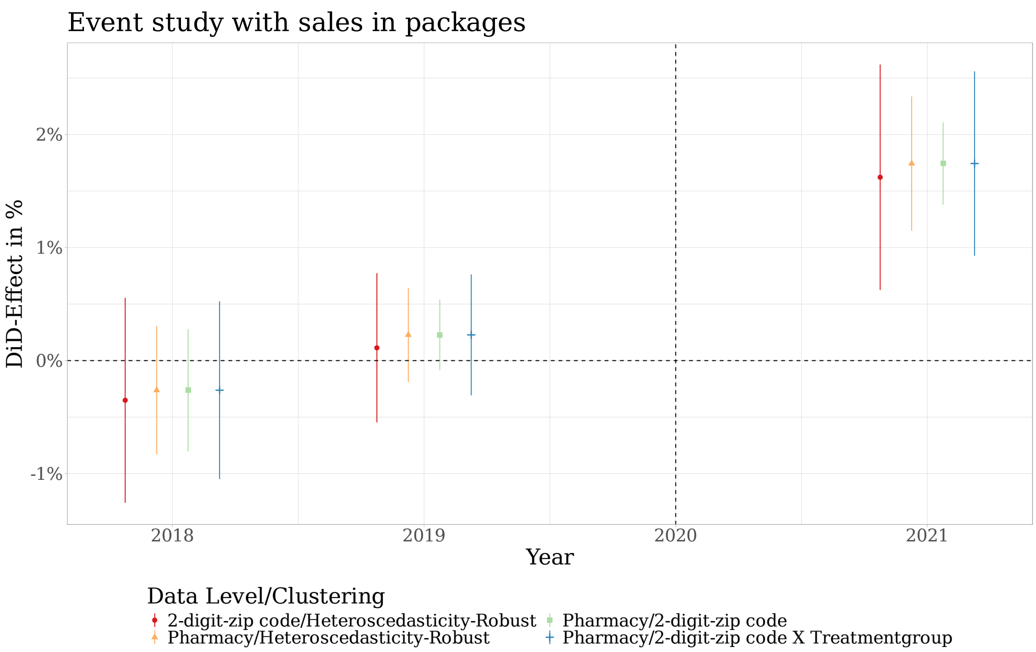

Figure 2: Event study results with 99 % confidence intervals.

Figure 2 contains an event study based on four different specifications. The first and second specifications (red and yellow) respectively contain a fixed effect on the zip code and pharmacy level, each one with robust standard errors. The third and fourth specifications contain a fixed effect at the pharmacy level, with standard errors clustered at the zip code level (gree) and at a combination of the zip code and treatment group level (blue), respectively.

The event study implies a DiD effect (ATT) between 0.0162 and 0.0174. Table 5 provides an overview of the estimated coefficients.

	(1)	(2)	(3)	(4)
Lead 2018 (δ_{2018})	-0.0035	-0.0026	-0.0026	-0.0026
	(0.0035)	(0.0022)	(0.0021)	(0.0030)
Lead 2019 (δ_{2019})	0.0011	0.0023	0.0023*	0.0023
	(0.0026)	(0.0016)	(0.0012)	(0.0021)
Lag 2021 (β_{2021})	0.0162***	0.0174***	0.0174***	0.0174***
	(0.0039)	(0.0023)	(0.0014)	(0.0031)
Weighted Average of Doses	0.0009	-0.0006	-0.0006	-0.0006
	(0.0031)	(0.0006)	(0.0009)	(0.0008)
Observations	760	43,896	43,896	43,896
Adj. R2	0.9997	0.9938	0.9938	0.9938
FE: Year	X	X	X	X
FE: 2 digit zip code & Treated	X			
FE: Pharmacy & Treated		X	X	X
Std. Errors	Robust	Robust	by: 2-digit-zip code	by: 2-digit-zip code & Treated

Note:

* p < 0.1, ** p < 0.05, *** p < 0.01

Table 5: Estimation results for Equation (1)).

Figure 2 and Table 5 highlight that pre-treatment coefficients δ_{2018} and δ_{2019} are statistically insignificant and close to zero. There is only one exception where, in Specification (3), the lead for 2019 is only mildly significant at the 10 %-level. Overall, this suggest that parallel trends are plausible, which, according to the literature (Roth et al., 2023, Sections 4.3–4.4), is the case when pre-treatment coefficients are statistically insignificant.

5.2 TWFE Estimation

Table 6 presents the results of the TWFE DiD model (see Equation (2)). We estimate two model specifications: a baseline model (A) and a model with a time-trend (B). For each specification, Column (1) presents results aggregated at the two-digit zip code level with robust standard errors. Columns (2) to (4) reports the results for an aggregation at pharmacy-level. Note that aggregating the data at the zip code level results in a lower number of observations than aggregation at the pharmacy level, as several pharmacies are located within the same zip code. Column (2) uses robust standard errors, while Columns (3) and (4) cluster standard errors at the two-digit zip code level, or at the two-digit zip code and insurance group level, respectively.

Table 6 shows a DiD effect that ranges from 0.0136 to 0.0165. All results are statistically significant at the 1 % level. These effects represent the

	(1)	(2)	(3)	(4)
Specification A: Sales in Packages				
DiD-Coefficient	0.0155***	0.0165***	0.0165***	0.0165***
	(0.0039)	(0.0023)	(0.0015)	(0.0032)
Share of Statutory Health Insured Members	1.5718	1.1123	1.1123	1.1123
	(1.8638)	(1.2091)	(1.1569)	(1.7127)
Weighted Average of Doses	0.0013	-0.0006	-0.0006	-0.0006
	(0.0030)	(0.0006)	(0.0009)	(0.0008)
Observations	760	43,896	43,896	43,896
Adj. R2	0.9997	0.9938	0.9938	0.9938
FE: Year	X	X	X	X
FE: 2 digit zip code & Treated	X			
FE: Pharmacy & Treated		X	X	X
Std. Errors	Robust	Robust	by: 2-digit-zip code	by: 2-digit-zip code & Treated
Specification B: Sales in Packages with Trends				
DiD-Coefficient	0.0136***	0.0149***	0.0149***	0.0149***
	(0.0048)	(0.0029)	(0.0018)	(0.0036)
Weighted Average of Doses	0.0012	-0.0006	-0.0006	-0.0006
	(0.0030)	(0.0006)	(0.0009)	(0.0008)
Time Trend of Treatment-Group	0.0017	0.0013	0.0013	0.0013
	(0.0017)	(0.0011)	(0.0010)	(0.0015)
Observations	760	43,896	43,896	43,896
Adj. R2	0.9997	0.9938	0.9938	0.9938
FE: Year	X	X	X	X
FE: 2 digit zip code & Treated	X			
FE: Pharmacy & Treated		X	X	X
Std. Errors	Robust	Robust	by: 2-digit-zip code	by: 2-digit-zip code & Treated

Note:

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Results of the DiD-estimation.

average treatment effect on the treated (ATT) and can be interpreted as percentage changes. Therefore, due to the introduction of the VOASG, sales increased by approximately 1.36 % to 1.65 %, depending on the level of aggregation, compared to a counterfactual scenario without the policy. This suggests that a notable portion of patients switch to that sales channel where Rx drugs are offered more cheaply.[21]

[21] Industry data indicate a 21.5% reduction in reimbursements from statutory health insurance providers to foreign mail-order pharmacies (Korf, 2023, p. 19). Considering the estimated small market share of these pharmacies in the prescription drug market (approximately 1% as reported by Albrecht et al. (2020), depending on the basket of pharmaceuticals considered), the estimated ATT appears plausible.

5.3 Distributional Effects

Table 7 presents an estimation of the additional profits that pharmacies with different revenues realized due to the introduction of the VOASG (see Section 4, especially Equation (3)).

The panels presented in Table 7 are defined in Section 5. The coefficients for "DiD for Decile x" capture the interaction between the DiD effect and the respective decile. These coefficients should be interpreted in the same manner as the DiD coefficient in Table 6, but are specific to each decile. For instance, a coefficient value of 0.0128 for "DiD for Decile 1" indicates that, on average, sales of brick-and-mortar pharmacies in the lowest revenue decile (treatment group) increased by 1.28 %, holding all else constant.

The results reveal a notable asymmetry in the magnitude of the effects across different revenue deciles. Specifically, the increase in Rx sales for deciles one to seven ranges from approximately 0.92 % to 1.46 % across all panels in Table 7. In contrast, the effect for the highest three deciles is one point five to two times larger, ranging from 1.82 % to 2.16 %. In other words, pharmacies with higher revenues seem to have benefited more from the partial ban on rebates than those with lower revenues. This disparity is further accentuated by the fact that the results in Table 7 are expressed in relative terms. Given that higher-revenue pharmacies typically have larger absolute sales, the impact in absolute terms is even more pronounced. This can be visualized in Figure 3, which illustrates the absolute increase in remuneration for each decile, calculated based on the results in Table 7.[22]

Figure 3 illustrates the distribution of the absolute impact of the partial ban on rebates across pharmacies with varying revenue levels. This figure was constructed by multiplying each pharmacy's remuneration for dispensing Rx drugs by its corresponding DiD effect (see Table 7). For instance, the Rx remuneration of the pharmacy in the lowest revenue decile is multiplied by the "DiD for Decile 1", while the remuneration of the highest-revenue pharmacy is multiplied by the "DiD for Decile 10". (For a more detailed explanation of how remuneration is computed, see Appendix A.1.)

The dotted lines in Figure 3 represent the average increase in profits for each decile. As previously discussed, the first seven deciles exhibit significantly lower gains compared to the highest three. Our findings suggest that, on average, the rebate ban generated additional annual profits for pharmacies in the first decile of around €1,360. In contrast, the corresponding gain

[22] Detailed descriptive statistics on the distribution of remuneration across deciles and further explanations on calculations are presented in the appendix, Section A.4.

	(1)	(2)	(3)
Weighted Average of Doses	-0.0017***	-0.0017**	-0.0017**
	(0.0005)	(0.0007)	(0.0007)
Time Trend of Treatment-Group	0.0016*	0.0016	0.0016
	(0.0009)	(0.0010)	(0.0013)
DiD for Decile 1	0.0128***	0.0128**	0.0128**
	(0.0047)	(0.0053)	(0.0056)
DiD for Decile 2	0.0111***	0.0111***	0.0111**
	(0.0043)	(0.0038)	(0.0046)
DiD for Decile 3	0.0107***	0.0107**	0.0107**
	(0.0040)	(0.0041)	(0.0043)
DiD for Decile 4	0.0146***	0.0146***	0.0146***
	(0.0042)	(0.0041)	(0.0044)
DiD for Decile 5	0.0127***	0.0127***	0.0127***
	(0.0040)	(0.0034)	(0.0044)
DiD for Decile 6	0.0092**	0.0092**	0.0092**
	(0.0037)	(0.0036)	(0.0040)
DiD for Decile 7	0.0131***	0.0131***	0.0131***
	(0.0037)	(0.0030)	(0.0036)
DiD for Decile 8	0.0182***	0.0182***	0.0182***
	(0.0038)	(0.0030)	(0.0039)
DiD for Decile 9	0.0208***	0.0208***	0.0208***
	(0.0037)	(0.0031)	(0.0037)
DiD for Decile 10	0.0190***	0.0190***	0.0190***
	(0.0040)	(0.0039)	(0.0047)
Observations	43,896	43,896	43,896
Adj. R2	0.9959	0.9959	0.9959
FE: Year	X	X	X
FE: Pharmacy & Treated	X	X	X
FE: Deciles	X	X	X
Std. Errors	Robust	by: 2-digit-zip code	by: 2-digit-zip code & Treated

Note:

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Results of the DiD-estimation for revenue deciles.

for pharmacies in the tenth decile is more than five times greater, reaching

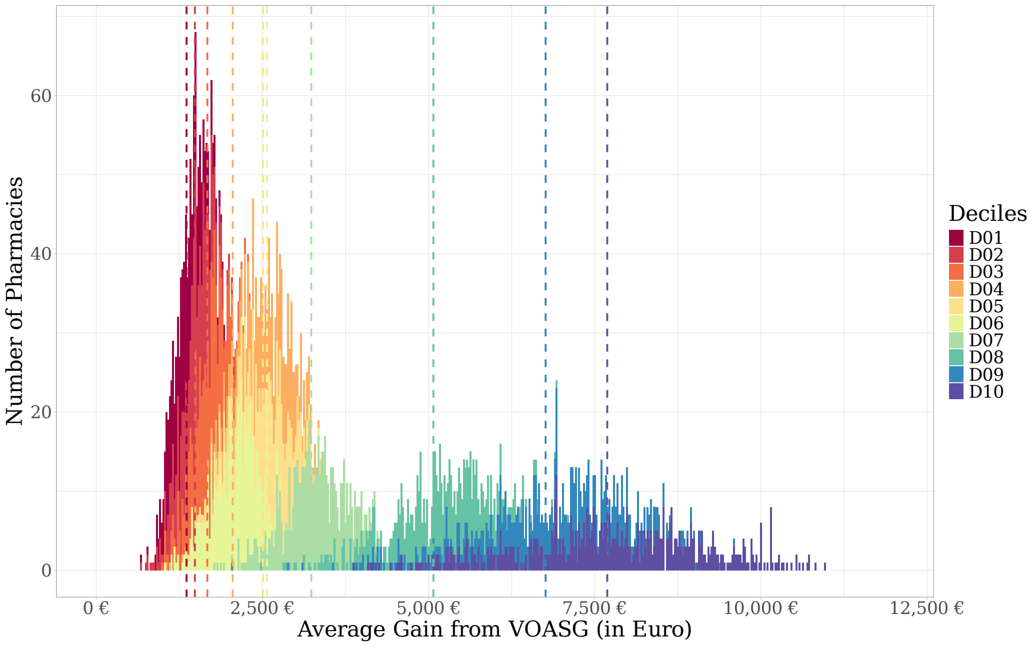

Figure 3: DiD effect for each decile (see Table 7). $Average\ Gain\ from\ VOASG = Sales \times \frac{\beta_{Decile}}{1+\beta_{Decile}} \times$ $Average\ Remuneration\ Per\ Sale$.

€7,690. Figure 3 also indicates that 50 % of the pharmacies experienced an increase in profits of less than €3,246 (median). In contrast, the average gain across all pharmacies is at 3,500. These results show that the gains from the introduction of VOASG were unevenly distributed across pharmacies, with *larger* pharmacies actually benefiting more strongly.

These results can be further contextualized. As discussed previously, pharmacies exit the market when opportunity costs exceed revenues. The question, therefore, is whether the additional profits are meaningful enough to sustain pharmacies in the market. To evaluate this, consider that the average *monthly* income of a German employee in 2021 was €4,100 (Destatis, `https://t.ly/N2dJq`). In contrast, the *annual* gain for pharmacies in the first decile approximates one-third of this amount. The majority of pharmacies experienced an increase equivalent to 50-60% of this figure. In other words, pharmacy owners' yearly gains were substantially less than the average monthly wage of an employee. Given that these owners are highly skilled professionals, the impact of the VOASG on their revenues can be considered relatively low.

Against the backdrop of these findings, the continued decline in the number of brick-and-mortar pharmacies after 2020 is unsurprising. By the end of 2023, the total number had decreased to 17,571, reflecting a 6.3 % reduction compared to 2020. While external factors, such as the war in Ukraine and the pandemic, influenced the market, the policy change appears to have failed to address the underlying causes of pharmacy closures.

The additional profits of brick-and-mortar pharmacies following VOASG's partial ban of vouchers basically correspond to an increase in expenditure of those patients who, without the policy change, would have purchased online. However, as already explained in Section 2.3, it is debatable whether declaring this redistribution a loss in consumer surplus is appropriate, as it would be in standard markets. It is eventually a policy question whether this effect of vouchers is actually desired. If it is, the question would be why brick-and-mortar pharmacies should not be allowed to grant rebates. This discussion goes beyond the scope of this paper and is left for future research.

6 Limitations

Our study is subject to certain limitations. While it relies on the most comprehensive and detailed dataset available on the German pharmacy market (to our knowledge), the data is limited to the two-digit zip code level. Consequently, we are unable to further specify the precise location of a given pharmacy. If the data were more granular, we could have conditioned the effects on specific socio-geographic factors, such as rural versus urban areas and the specific competitive landscape of offline pharmacies.

A comparable dataset encompassing online sales is currently unavailable. Our interpretation, which posits that e-commerce experiences losses equivalent to the gains of the offline channel, is thus contingent on the assumption of inelastic demand.

It is essential to consider these limitations when interpreting our findings. However, these caveats do not affect the validity of our identification strategy.

7 Conclusion

We find that the partial ban on rebates led to an increase in offline sales of around 1.36 to 1.65 % for an average brick-and-mortar pharmacy compared to a counterfactual scenario in which rebates would not have been banned. Given that the demand for Rx drugs can be considered price inelastic, any increase in offline sales should correspond to a decrease in online sales by the same amount.

Our findings reveal that a substantial portion of consumers respond to price differences and rebates for Rx drugs by selecting the more affordable retail channel. This insight is particularly relevant in light of the 2016 European Court of Justice ruling (Case No.: C-148/15) mentioned above, which legalized rebates offered by foreign online pharmacies. In this ruling, the judges claimed that the German government had failed to show that RPM was an effective tool to achieve the alleged goal of securing the comprehensive supply of pharmaceuticals to the general population. Our research provides empirical evidence that consumers are price-sensitive, suggesting that online rebates could potentially erode offline sales and profitability.

However, the policy appears to have had an asymmetric effect on pharmacies. We estimated that annual additional profits ranged from €1,360 - €7,690. Notably, the *additional annual profit* for the lowest decile equates to around one third of the average *monthly* income of an employee in Germany in 2021.[23] The findings also indicate that the majority of pharmacies experienced only a mild increase in profits, with a median increase in profits of €3,246. Pharmacies in the top three revenue deciles experienced a sales increase that was one point five to two times stronger than the increase in lower deciles. This suggests that larger pharmacies benefited disproportionately from the rebate ban compared to smaller pharmacies.

These findings indicate that the law, against its stated goal, did not significantly support pharmacies at risk of market exit. This is corroborated by the developments in 2021-2023, when another 6.3% of pharmacies closed. This suggests that further reforms are necessary to reverse the trend of declining pharmacy numbers. Such reforms can, for instance, specifically target pharmacy remuneration for dispensing Rx drugs.

[23]Destatis, `https://t.ly/N2dJq`.

References

ABDA, 2021. Zahlen, daten, fakten 2021. https://www.pharma4u.de/fileadmin/user_upload/pdf/ABDA-Leitlinien/ABDA_ZDF_2021_Broschuere.pdf.

ABDA, 2024. Zahlen, daten, fakten 2024. https://www.abda.de/fileadmin/user_upload/assets/ZDF/Zahlen-Daten-Fakten-24/ABDA_ZDF_2024_Broschuere.pdf.

Agomo, C.O., 2012. The role of community pharmacists in public health: a scoping review of the literature. Journal of Pharmaceutical Health Services Research 3, 25–33.

Albrecht, M., Baake, P., an der Heiden, I., Brenck, A., Ochmann, R., Schiffhorst, G., 2020. Ökonomisches Gutachten zum Apothekenmarkt. Technical Report. IGES Institut und Deutsches Institut.

An, B.Y., Chung, J., 2023. Who bears the brunt of disruptive innovation? the effect of grocery e-commerce on local retail competitors. Journal of Regional Science .

Atella, V., Belotti, F., Depalo, D., 2017. Drug therapy adherence and health outcomes in the presence of physician and patient unobserved heterogeneity. Health Economics 26, 106–126.

Austvoll-Dahlgren, A., Aaserud, M., Vist, G., Ramsay, C., Oxman, A.D., Sturm, H., Kösters, J., Vernby, A., 2008. Pharmaceutical policies: effects of cap and co-payment on rational drug use. The Cochrane database of systematic reviews , CD007017–CD007017.

Brown, J.R., Goolsbee, A., 2002. Does the internet make markets more competitive? evidence from the life insurance industry. Journal of political economy 110, 481–507.

Brynjolfsson, E., Smith, M.D., 2000. Frictionless commerce? a comparison of internet and conventional retailers. Management science 46, 563–585.

Catalano, G., Khan, M.M.M., Chatzipanagiotou, O.P., Pawlik, T.M., 2024. Pharmacy accessibility and social vulnerability. JAMA Network Open 7, e2429755–e2429755.

Cavallo, A., 2017. Are online and offline prices similar? evidence from large multi-channel retailers. American Economic Review 107, 283–303.

Chava, S., Oettl, A., Singh, M., Zeng, L., 2024. Creative destruction? impact of e-commerce on the retail sector. Management Science 70, 2168–2187.

Coenen, M., Haucap, J., Herr, A., Kuchinke, B., 2011. Wettbewerbspotenziale im deutschen Apothekenmarkt. Technical Report. DICE - Ordnungspolitische Perspektiven Nr. 17.

Costa, S., Cary, M., Helling, D.K., Pereira, J., Mateus, C., 2019. An overview of systematic reviews of economic evaluations of pharmacy-based public health interventions: addressing methodological challenges. Systematic reviews 8, 1–20.

Couture, V., Faber, B., Gu, Y., Liu, L., 2021. Connecting the countryside via e-commerce: evidence from china. American Economic Review: Insights 3, 35–50.

Cunningham, S., 2021. Causal inference: The mixtape. Yale university press.

Di Novi, C., Leporatti, L., Montefiori, M., 2020. Older patients and geographic barriers to pharmacy access: When nonadherence translates to an increased use of other components of health care. Health economics 29, 97–109.

Duminy, L., Ress, V., Wild, E.M., 2022. Complex community health and social care interventions–which features lead to reductions in hospitalizations for ambulatory care sensitive conditions? a systematic literature review. Health Policy 126, 1206–1225.

Farbmacher, H., Winter, J., 2013. Per-period co-payments and the demand for health care: evidence from survey and claims data. Health economics 22, 1111–1123.

Freyaldenhoven, S., Hansen, C., Shapiro, J.M., 2019. Pre-event trends in the panel event-study design. American Economic Review 109, 3307–38.

Gatwood, J., Gibson, T.B., Chernew, M.E., Farr, A.M., Vogtmann, E., Fendrick, A.M., 2014. Price elasticity and medication use: cost sharing across multiple clinical conditions. Journal of Managed Care Pharmacy 20, 1102–1107.

Goldmanis, M., Hortaçsu, A., Syverson, C., Emre, Ö., 2010. E-commerce and the market structure of retail industries. The Economic Journal 120, 651–682.

Haschka, R.E., Schley, K., Herwartz, H., 2020. Provision of health care services and regional diversity in germany: Insights from a bayesian health frontier analysis with spatial dependencies. The European Journal of Health Economics 21, 55–71.

an der Heiden, I., Meyrahn, F., 2017. Ermittlung der Erforderlichkeit und des Ausmaßes der in der Arzneimittelpreisverordnung (AMPreisV) geregelten Preise. Technical Report. 2HM & Associates GmbH. URL: https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/ermittlung-der-erforderlichkeit-und-des-ausmasses-von-aenderungen-der-in-der-arzneimittelpreisverordnung.pdf?__blob=publicationFile&v=12.

Heinsohn, J.G., Flessa, S., 2013. Competition in the german pharmacy market: an empirical analysis. BMC health services research 13, 1–12.

Herr, A., Suppliet, M., 2017. Tiered co-payments, pricing, and demand in reference price markets for pharmaceuticals. Journal of Health Economics 56, 19–29.

Herwartz, H., Schley, K., 2018. Improving health care service provision by adapting to regional diversity: an efficiency analysis for the case of germany. Health Policy 122, 293–300.

Inoue, Y., Takikawa, M., Morita, Y., Takao, K., Kanamoto, I., Sugibayashi, K., 2016. A comparison of pharmacists' role functions across various nations: the importance of screening. Research in Social and Administrative Pharmacy 12, 347–354.

Iyamu, I., Gómez-Ramírez, O., Xu, A.X., Chang, H.J., Watt, S., Mckee, G., Gilbert, M., 2022. Challenges in the development of digital public health interventions and mapped solutions: findings from a scoping review. Digital health 8, 20552076221102255.

Jehle, G., Reny, P., 2011. Advanced microeconomic theory, 3rd edition. Pearson Education Limited.

Jin, G.Z., Kato, A., 2007. Dividing online and offline: A case study. The review of economic studies 74, 981–1004.

Korf, C., 2023. Presentation at dav wirtschaftsforum 2023. https://www.abda.de/fileadmin/user_upload/assets/Pressetermine/2023/DAV-WiFo-2023/Apothekenwirtschaftsbericht_2023_DAV_Wirtschaftsforum.pdf.

Li, L., Liu, Z., 2021. Research on efficiency measurement and spatiotemporal disparity of rural public health services in china. PLoS One 16, e0252871.

Long, C.S., Kumaran, H., Goh, K.W., Bakrin, F.S., Ming, L.C., Rehman, I.U., Dhaliwal, J.S., Hadi, M.A., Sim, Y.W., Tan, C.S., 2022. Online pharmacies selling prescription drugs: systematic review. Pharmacy 10, 42.

Lostakova, H., Curdova, M., Janouch, V., 2012. Purchace behavior of online pharmacies clients. Economics and management 17, 1098–1107.

Mays, G.P., Smith, S.A., Ingram, R.C., Racster, L.J., Lamberth, C.D., Lovely, E.S., 2009. Public health delivery systems: evidence, uncertainty, and emerging research needs. American Journal of Preventive Medicine 36, 256–265.

Perraudin, C., Bugnon, O., Pelletier-Fleury, N., 2016. Expanding professional pharmacy services in european community setting: is it cost-effective? a systematic review for health policy considerations. Health policy 120, 1350–1362.

Raza, M.A., Aziz, S., Noreen, M., Anjum, I., Raza, S.M., 2022. A portrait of the pharmacy profession globally: pharmacist universal professional identity and establishment of global pharmacy council. INNOVATIONS in pharmacy 13.

Roth, J., Sant'Anna, P.H., Bilinski, A., Poe, J., 2023. What's trending in difference-in-differences? a synthesis of the recent econometrics literature. Journal of Econometrics 235, 2218–2244.

Sinai, T., Waldfogel, J., 2004. Geography and the internet: Is the internet a substitute or a complement for cities? Journal of Urban Economics 56, 1–24.

Smith, F., 2009. Private local pharmacies in low-and middle-income countries: a review of interventions to enhance their role in public health. Tropical Medicine & International Health 14, 362–372.

Statista, 2024. Absatzanteile des arzneimittelversandhandels am deutschen otc-markt nach produktkategorie in den jahren 2008 bis 2019. `https://de.statista.com/statistik/daten/studie/280477/umfrage/absatzanteile-am-otc-versandapothekenmarkt/`.

WHO Collaborating Centre for Drug Statistics Methodology, 2024. Guidelines for ATC Classification and DDD Assignment. Oslo. URL: `https://atcddd.fhi.no/atc_ddd_index_and_guidelines/guidelines/`. last updated: 2024-03-01.

Wong, B.L.H., Maaß, L., Vodden, A., van Kessel, R., Sorbello, S., Buttigieg, S., Odone, A., 2022. The dawn of digital public health in europe: Implications for public health policy and practice. The Lancet Regional Health–Europe 14.

Yeung, K., Basu, A., Hansen, R.N., Sullivan, S.D., 2018. Price elasticities of pharmaceuticals in a value based-formulary setting. Health economics 27, 1788–1804.

Yurkovich, J.T., Evans, S.J., Rappaport, N., Boore, J.L., Lovejoy, J.C., Price, N.D., Hood, L.E., 2024. The transition from genomics to phenomics in personalized population health. Nature Reviews Genetics 25, 286–302.

A Appendix

A.1 Remuneration in Detail

When dispensing an Rx drug, pharmacists receive a fixed fee of € 8.35 per package and a variable fee of 3 % of the wholesale price AEP (§ 3 AMPreisV). For prescriptions covered by statutory health insurance, this remuneration is reduced by a gross lump-sum fee of € 1.77 (net € 1.49; see § 130 (1) SGB V) paid to the insurance company, provided that remuneration is paid within 10 days.

The remuneration of pharmacies for dispensing Rx drugs is regulated and can be computed based on the retail list price AVP:

$$(Gross)\ AVP = (1 + \text{VAT}) \cdot (Net)\ AVP \tag{A.1}$$

$$(Net)\ AVP = r_f + r_v + pDL + nDZ + AEP. \tag{A.2}$$

As shown in Equation (A.1), gross AVP is calculated by multiplying net AVP by the value-added tax rate, which is 19% in Germany (16% for the first two quarters of 2020). Net AVP, Equation (A.2), consists of a fixed rate, $r_f = € \ 8.35$, in addition to a variable component, $r_v = 0.03 \cdot AEP$. Recall that AEP refers to the wholesale price. Moreover, AVP includes two lump-sum fees per prescription drug in net terms: a fee for so-called pharmaceutical services (*pharmazeutische Dienstleistung* (pDL)) of $pDL = € \ 0.20$, and a fee for emergency pharmacy services (*Notdienstzuschlag* (nDZ)) of $nDZ = € \ 0.20$.[A1] Rearranging Equation (A.2) gives the wholesale list price AEP as a function of the AVP and the other components of a pharmacy's remuneration:

$$AEP = \frac{(Net)\ AVP - (r_f + pDL + nDZ)}{1.03}. \tag{A.3}$$

Based on AEP, we can compute the compensation per Rx-drug dispensed:

$$\begin{aligned} R(AEP) &= \underbrace{(Net)\ AVP - pDL - nDZ - STHF}_{(Net)\ AVP \text{ w.o. lump sum fees}} - AEP \\ &= r_f + r_v - STHF \\ &= € \ 8.35 + 0.03 \cdot AEP - € \ 1.49. \end{aligned} \tag{A.4}$$

[A1] A detailed description can be found on the homepage of the Federal Union of German Associations of Pharmacists (ABDA): `https://www.abda.de/apotheke-in-deutschland/preise-und-honorare/beispielrechnung/`; only available in German language.

Here, $STHF =$ € 1.49 denotes the additional net lump-sum fee per statutory health insurance prescription drug (with $STHF = 0$ for private prescriptions). For example, an Rx-drug prescribed under statutory health insurance with $AEP =$ € 50 results in a remuneration of $R(50) =$ € 8.36.

Regarding the technical implementation, during the aggregation process, we ascertain net revenue excluding elements pDL, nDZ, and $STHF$, denoted $(Net)\ AVP\ w.o.\ lump\ sum\ fees$. We also determine the total costs by summing over AEP and further differentiate these figures to derive the total remuneration for each two-digit zip code or pharmacy p, group g, and year t (see Tables 1 and 2). The results of the respective calculations for deciles 1 to 10 are summarized in Table A.1.

	Deciles	Mean	SD	Min	P25	Median	P75	Max
Gross Revenue (in Euro) from Statutory Health Prescriptions by Pharmacy in 2021	D01	694,825	107,027	365,910	619,466	707,555	780,411	918,617
	D02	898,429	105,612	375,124	836,078	907,012	978,202	1,118,446
	D03	1,069,323	105,645	695,538	1,008,279	1,082,769	1,144,722	1,304,631
	D04	1,217,061	116,976	519,110	1,153,307	1,229,121	1,298,209	1,447,576
	D05	1,377,001	133,080	790,864	1,307,640	1,397,290	1,462,790	1,642,521
	D06	1,559,251	142,510	834,556	1,487,207	1,578,656	1,659,385	1,849,085
	D07	1,763,678	147,199	732,421	1,676,696	1,771,491	1,856,267	2,074,630
	D08	2,011,384	175,497	1,323,046	1,914,402	2,025,218	2,133,129	2,416,269
	D09	2,381,734	233,485	1,006,973	2,243,196	2,399,030	2,541,571	2,945,108
	D10	3,249,097	627,266	2,012,603	2,854,133	3,098,203	3,482,232	6,869,854
Net Revenue (in Euro) from Statutory Health Prescriptions by Pharmacy in 2021	D01	583,871	89,935	307,466	520,558	594,562	655,778	771,945
	D02	754,962	88,741	315,225	702,584	762,193	821,996	939,868
	D03	898,569	88,772	584,445	847,291	909,839	961,945	1,096,164
	D04	1,022,717	98,294	436,225	969,085	1,032,873	1,090,928	1,216,397
	D05	1,157,115	111,837	664,572	1,098,846	1,174,192	1,229,234	1,380,185
	D06	1,310,257	119,747	701,306	1,249,705	1,326,587	1,394,440	1,553,846
	D07	1,482,054	123,684	615,481	1,408,982	1,488,629	1,559,907	1,743,322
	D08	1,690,203	147,481	1,111,802	1,608,663	1,701,839	1,792,340	2,030,473
	D09	$2e+06$	196,206	846,196	1,885,031	2,015,969	2,135,773	2,474,939
	D10	2,730,298	527,110	1,691,216	2,398,426	2,603,527	2,926,157	5,772,980
Net Revenue w.o. lump sum fees (in Euro) from Statutory Health Prescriptions by Pharmacy in 2021	D01	560,415	87,060	295,819	498,801	568,880	628,475	740,249
	D02	725,822	85,601	301,853	677,522	732,485	789,090	906,640
	D03	864,615	85,838	556,555	814,771	875,090	926,494	1,060,352
	D04	984,163	95,004	420,673	932,825	992,887	1,051,264	1,175,963
	D05	1,114,338	108,121	646,402	1,056,123	1,130,154	1,183,478	1,347,118
	D06	1,262,126	115,626	677,613	1,202,639	1,277,625	1,339,810	1,504,633
	D07	1,428,648	120,700	597,998	1,357,673	1,435,713	1,507,907	1,689,007
	D08	1,629,473	142,867	1,070,758	1,547,803	1,643,388	1,729,281	1,966,905
	D09	1,930,876	189,985	826,700	1,817,743	1,944,083	2,058,881	2,393,400
	D10	2,644,192	520,429	1,630,590	2,316,601	2,516,686	2,841,886	5,664,327
Total Remuneration (in Euro) from Statutory Health Prescriptions by Pharmacy in 2021	D01	107,788	17,536	54,039	95,022	107,500	120,585	153,070
	D02	134,769	22,370	60,962	120,310	135,985	150,501	187,565
	D03	157,586	23,512	93,360	141,666	160,836	174,790	217,194
	D04	179,000	26,270	72,882	162,217	180,972	199,126	233,019
	D05	199,269	31,633	89,633	178,379	204,688	221,627	270,290
	D06	224,442	35,606	112,155	201,281	229,664	250,671	303,367
	D07	249,862	36,033	85,547	229,440	250,915	274,787	329,040
	D08	284,276	43,145	139,039	258,801	288,453	314,700	397,559
	D09	331,314	55,485	$1e+05$	298,599	335,423	372,308	470,201
	D10	412,801	75,463	207,936	367,546	412,764	465,584	588,611
Total Net Revenue (in Euro) per Pharmacy from Rx in 2021	D01	693,373	84,438	436,844	631,480	713,541	763,667	805,599
	D02	893,718	48,541	805,975	851,774	898,746	934,183	973,616
	D03	1,051,556	44,295	974,228	1,013,446	1,053,345	1,092,117	1,123,415
	D04	1,193,845	42,963	1,123,768	1,154,162	1,193,204	1,230,982	1,271,731
	D05	1,351,620	44,027	1,272,385	1,313,041	1,350,629	1,390,098	1,427,260
	D06	1,512,879	48,487	1,427,668	1,470,210	1,514,149	1,556,733	1,594,732
	D07	1,703,807	61,527	1,595,295	1,652,130	1,702,838	1,759,689	1,808,252
	D08	1,938,898	80,837	1,808,417	1,869,584	1,934,012	2,009,602	2,088,366
	D09	2,306,836	132,220	2,088,832	2,197,524	2,297,658	2,419,661	2,556,098
	D10	3,108,563	538,309	2,556,484	2,729,172	2,939,959	3,332,300	6,242,840
Sales (in Packages) of Statutory Health Prescriptions per Pharmacy in 2021	D01	13,733	2,350	6,820	11,952	13,624	15,402	19,821
	D02	17,060	3,132	7,833	14,927	17,239	19,288	24,610
	D03	19,879	3,330	10,348	17,666	20,220	22,196	28,623
	D04	22,572	3,723	9,103	20,151	22,780	25,439	30,227
	D05	25,046	4,516	10,631	21,999	25,777	28,296	35,292
	D06	28,179	5,102	13,402	24,852	28,706	31,961	39,949
	D07	31,267	5,227	10,229	28,200	31,482	34,974	42,797
	D08	35,556	6,199	15,360	31,834	36,198	39,817	52,179
	D09	41,300	7,939	11,428	36,436	41,830	46,890	61,203
	D10	50,415	10,298	23,148	43,717	51,290	57,808	73,556
Average Remuneration per Sale (in Euro) from Statutory Health Prescriptions by Pharmacy in 2021	D01	7.86	0.157	7.52	7.75	7.84	7.96	8.42
	D02	7.93	0.217	7.54	7.78	7.88	8.04	8.74
	D03	7.96	0.215	7.57	7.82	7.93	8.06	9.07
	D04	7.96	0.209	7.57	7.82	7.92	8.05	8.97
	D05	7.99	0.257	7.61	7.84	7.93	8.11	9.32
	D06	8	0.258	7.55	7.84	7.95	8.1	9.68
	D07	8.03	0.273	7.61	7.86	7.97	8.12	9.65
	D08	8.03	0.271	7.62	7.86	7.97	8.11	9.35
	D09	8.07	0.307	7.61	7.88	7.99	8.17	9.53
	D10	8.24	0.391	7.66	7.96	8.11	8.42	9.84

Table A.1: Summary statistics for the presented calculations by deciles 1 to 10.

A.2 Mean DiD Effect

A simplified DiD effect can be computed by comparing mean sales of the treatment and control groups before and after the introduction of the VOASG are compared. Figure A.1 depicts annual sales categorized by prescriptions to members of the statutory health insurance system and private prescriptions. The top subfigure depicts absolute values and the bottom one displays sales normalized to 2020.

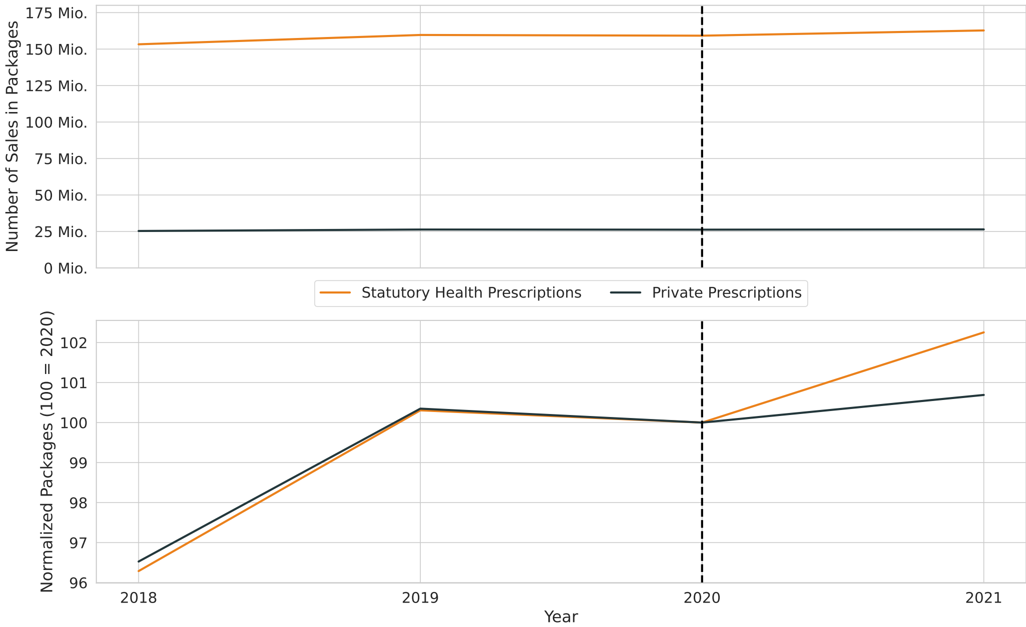

Figure A.1: Evolution of sales in packages by statutory health and private prescriptions. The top figure denote sales in absolute values, while the bottom figure depict sales normalized to the year 2020.

Figure A.1 shows that Post-VOASG, prescription drug sales in the treatment group increased relative to the control group.[A2] In particular, calculating the DiD effect by simply comparing the mean values before and after the treatment (without considering any covariates), we find a DiD effect of roughly 0.0163, i.e., sales of brick-and-mortar pharmacies increased by roughly 1.63 % compared to a counterfactual of a state without VOASG. This result should be viewed as a first indication.

[A2]The figure also shows that prescriptions issued to members of the statutory health insurance are six times higher than those issued to privately insured and self-pay patients. This discrepancy is explained by the fact that most Germans are covered by statutory health insurance, as already explained in Section 1.

A.3 Package Size as Dependent Variable

As a robustness check, we use doses as the dependent variable in equation (2) instead of incorporating them as a covariate. Recall that information on doses were obtained from the German N-classification system, see Section 3.1. Table A.2 displays the results of this alternative estimation.

	(1)	(2)	(3)	(4)
Specification A: Sales in NDD				
DiD-Coefficient	0.0139***	0.0150***	0.0150***	0.0150***
	(0.0038)	(0.0023)	(0.0015)	(0.0031)
Fraction of Members in Insurance	-1.9188	-2.1932*	-2.1932*	-2.1932
	(1.8371)	(1.2062)	(1.1068)	(1.6978)
Weighted Average of Doses	0.0172***	0.0156***	0.0156***	0.0156***
	(0.0029)	(0.0006)	(0.0008)	(0.0008)
Observations	760	43,896	43,896	43,896
Adj. R2	0.9998	0.9945	0.9945	0.9945
FE: Year	X	X	X	X
FE: 2 digit zip code & Treated	X			
FE: Pharmacy & Treated		X	X	X
Std. Errors	Robust	Robust	by: 2-digit-zip code	by: 2-digit-zip code & Treated
Specification B: Sales in NDD with Trends				
DiD-Coefficient	0.0145***	0.0158***	0.0158***	0.0158***
	(0.0047)	(0.0028)	(0.0018)	(0.0036)
Weighted Average of Doses	0.0171***	0.0156***	0.0156***	0.0156***
	(0.0030)	(0.0006)	(0.0008)	(0.0008)
Time Trend of Treatment-Group	-0.0013	-0.0015	-0.0015	-0.0015
	(0.0017)	(0.0011)	(0.0010)	(0.0015)
Observations	760	43,896	43,896	43,896
Adj. R2	0.9998	0.9945	0.9945	0.9945
FE: Year	X	X	X	X
FE: 2 digit zip code & Treated	X			
FE: Pharmacy & Treated		X	X	X
Std. Errors	Robust	Robust	by: 2-digit-zip code	by: 2-digit-zip code & Treated

Note:
* p < 0.1, ** p < 0.05, *** p < 0.01

Table A.2: TWFE DiD estimation with NDD as dependent variable.

The table's interpretation and structure mirror those of Table 6. The ATT reported in Table A.2 are comparable to those in the main text, ranging from 0.0139 to 0.0158.

A.4 Distributional Effects

In Section 5.3, particularly in Figure 3, we provided a histogram visualizing the "Average Gain from VOASG" for each pharmacy. This measure is derived from the DiD coefficient *for each decile* (see Table 7), the volume of sales from statutory health prescriptions per pharmacy, and the average remuneration per sale across pharmacies for the year 2021 (see Table A.1). The average remuneration per sale is calculated by dividing the total remuneration by the sales expressed in packages, thereby yielding a quantity-weighted average remuneration per package for each pharmacy p, group g, and year t.

For example, consider a pharmacy that processed 25,000 statutory health prescriptions in 2021, and earned an average of 8 Euro per prescription. If it fell within the fifth decile, the VOASG would have resulted in earnings of $24,000 \times \frac{0.0127}{1+0.0127} \times 8$ Euro $= 2,408$ Euro ($Average\ Gain\ from\ VOASG = Sales \times \frac{\beta_{Decile}}{1+\beta_{Decile}} \times Average\ Remuneration\ Per\ Sale.$).

Table A.3 displays summary statistics for the *Average gain from VOASG* by decile.

	Deciles	Mean	SD	Min	P25	Median	P75	Max
Average Gain from VOASG (in Euro) by $\beta_{Deciles}$	D01	1,359	221	681	1,198	1,355	1,520	1,929
	D02	1,484	246	671	1,325	1,498	1,657	2,066
	D03	1,671	249	990	1,502	1,706	1,854	2,303
	D04	2,569	377	1,046	2,328	2,598	2,858	3,345
	D05	2,508	398	1,128	2,245	2,576	2,789	3,401
	D06	2,053	326	1,026	1,841	2,101	2,293	2,775
	D07	3,236	467	1,108	2,971	3,249	3,558	4,261
	D08	5,072	770	2,481	4,618	5,147	5,615	7,094
	D09	6,761	1,132	2,045	6,093	6,845	7,597	9,595
	D10	7,688	1,405	3,872	6,845	7,687	8,671	10,962

Table A.3: Summary statistics for the *Average gain from VOASG* by decile.