Entry and price competition in the over-the-counter drug market after deregulation: evidence from Portugal *

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Abstract

In the last two decades, many European countries allowed the sale of Over-the-Counter (OTC) drugs outside pharmacies. This was expected to lower retail prices through increased competition. Evidence of such price reductions is scarce. We assess the impact of supermarket and outlet entry in the OTC drug market on OTC prices charged by incumbent pharmacies using a difference-in-differences strategy. We use price data on five popular OTC drugs for all retailers located in Lisbon for three distinct points in time (2006, 2010, and 2015). Our results suggest that competitive pressure in the market is mainly exerted by supermarkets, which charge, on average, 20% lower prices than pharmacies. The entry of a supermarket among the main competitors of an incumbent pharmacy is associated with an average 4 to 6% decrease in prices relative to the control group. These price reductions are long-lasting, but fairly localized. We find no evidence of price reductions following OTC outlet entry. Additional results from a reduced-form entry model and a propensity score matching difference-in-differences approach support the view that these effects are causal.

Keywords: over-the-counter drugs; pharmaceutical market; market liberalization; price competition.

JEL codes: I11, I18, L11.

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1 Introduction

Over-the-counter (OTC) drugs are pharmaceuticals whose purchase does not require a prescription. They are usually not reimbursed and their pricing is free, in contrast with the highly regulated prices of reimbursed and/or prescription-only pharmaceuticals.

During the last two decades, European countries have extensively reformed their community pharmacy sectors. An important element of these reforms is the liberalization of OTC medicine distribution (OECD, 2014). OTC market liberalization implies a move from a traditional pharmacy-centered model to a multi-channel distribution model in which OTC drugs are sold outside pharmacies, namely in supermarkets, petrol stations, and other non-pharmacy outlets. Throughout this paper, we refer to these as non-pharmacy retailers.

The rationale for OTC market liberalization was that the entry of non-pharmacy retailers, combined with free OTC pricing, would lower OTC drug prices via increased competition among retailers (Lluch and Kanavos, 2010; Stargardt et al., 2007; Morgall and Almarsdóttir, 1999). Existing literature posits that pharmacies are not used to price competition and do not place competitive constraints on each other (Pilorge, 2016; Stargardt et al., 2007).[1] The fact that, at least in urban areas, non-pharmacy retailers charge lower prices than traditional pharmacies (Anell, 2005; OFT, 2003) might mechanically lead to lower average prices, but provides no evidence of competitive forces. We examine whether facing increased competitive pressure following the entry of a non-pharmacy competitor, who is able to charge lower prices, triggers price decreases by incumbent pharmacies.

This is an important question that, to the best of our knowledge, has not yet been fully addressed in the literature. OTC drugs are one of the few product segments for which pharmacies can make their own pricing decisions. Because they are frequently used, we expect consumers to be aware of price differences between retailers (Sorensen, 2000). By shedding light on how competition takes place in this market, we contribute to inform policy-makers on the market dynamics they might expect upon liberalizing OTC medicine distribution.

The empirical analysis draws on the Portuguese experience. In Portugal, OTC market liberalization started in late 2005 and allowed OTC drugs to be sold outside pharmacies, namely in supermarkets and outlets.[2] OTC market liberalization reforms similar to the Portuguese one were implemented all over Europe during the last two decades: In 2000,

[1]This inability may be associated with either the development of close professional relationships among pharmacists or to their use to the non-competitive environment in place prior to market liberalization. Alternatively, pharmacies may not compete in prices but rather in quality, range of services, location, or opening times (Martins and Queirós, 2015; Lluch and Kanavos, 2010; Anell, 2005; Rudholm, 2008; Stargardt et al., 2007; Schaumans and Verboven, 2008).

[2]Patrício et al. (2005), CEGEA (2005), and Gomes (2007) used the classic frameworks of Hotelling (1929) and Waterson (1993) to make predictions of the expected price outcomes of the reform. These predictions pointed in very different directions and the real impact of the reform was never assessed.

Poland allowed for a limited range of OTC products to be sold outside pharmacies; Denmark, Norway, Italy, Hungary, Sweden, and France adopted similar policies in the following years; Germany and the United Kingdom had already done so during the 1990s.

We use price data for five popular OTC drugs across all retailer types (traditional pharmacies, supermarkets, and outlets) located in Lisbon. The dataset has a panel structure and each retailer is observed for at most three points in time, the years of 2006, 2010, and 2015. In our data, supermarkets and outlets charge, on average, 20% and 4% lower prices than traditional pharmacies, respectively.

Our empirical strategy is a difference-in-differences (DID) design, comparing the prices charged by pharmacies that experience entry of a supermarket or outlet among their main competitors and the prices charged by pharmacies that do not experience entry of a supermarket or outlet among their main competitors, before and after entry occurs. We use two alternative baseline measures to define the set of main competitors of a pharmacy. One measure takes as main competitors of a pharmacy its three nearest neighbors selling OTC drugs. The other measure takes as main competitors of a pharmacy all retailers located within a 400-meter radius distance. Identification comes from the different timing of exposure of incumbent pharmacies to different types of non-pharmacy entrants among their main competitors.

Our main results show that incumbent pharmacies lower their prices by about 6% after experiencing the entry of a supermarket among their three nearest neighbors. We do not find evidence that outlet entry leads to price reductions by pharmacies. We find a fair degree of heterogeneity in price responses across pharmacies operating in areas with different degrees of market concentration with our results being driven by the most isolated pharmacies, who likely enjoyed some degree of market power prior to experiencing entry. We obtain similar results when using a 400-meter radius to define the set of main competitors of a pharmacy. We interpret our findings in the context of a model based on Salop (1979) with non-pharmacy entrants differing from incumbent pharmacies in their marginal cost and, in particular, supermarkets being more efficient.

Our results do not seem to be driven by existing pre-treatment trends and survive a battery of robustness checks. When varying the number of nearest neighbors and the radius distance that define the set of main competitors of a pharmacy, we find that the statistical significance of our results falls quickly as we enlarge the set of main competitors of a pharmacy, suggesting competition is fairly localized. The causal interpretation of our findings, however, rests on the assumption that market structure is exogenous so that exposure to non-pharmacy entry is random. We address endogeneity concerns in two ways. First, we implement a propensity score matching DID approach, with propensity scores being a function of pre-entry levels of competitive pressure and demand faced by each pharmacy, and obtain results that are broadly in line with our main findings, although less statistically significant. Second, we estimate a reduced-form entry model in which the probability that a pharmacy faces non-pharmacy entry is a function of past prices. We find no evidence of an association between past prices and non-pharmacy entry.

Our findings contribute to the empirical literature on OTC drug pricing and the effects of OTC market liberalization in Europe. This literature is scarce, mostly descriptive, and often unable to confirm the expected downward trend in OTC prices (OECD, 2014; Vogler et al., 2014). We show that OTC liberalization reforms can lower prices via increased competition, though this crucially depends on the ability of entrants to exert competitive pressure on incumbent pharmacies.

Our study also contributes to a broader literature within industrial organization on the price effects following the entry of supermarkets and chain stores in general in a market previously composed of small, independent firms, as is the case of traditional pharmacies in Portugal.[3] Bennett and Yin (2019) study the entry of a retail pharmacy chain in India on the price of incumbent pharmacies. Basker (2005) studies the effect of Walmart entry on average city-level prices, and Basker and Noel (2009) estimate its effects on competitors' prices. We contribute to this literature by providing evidence for the OTC drug market.

The remainder of this paper is as follows. Section 2 provides institutional background on the Portuguese OTC market and the liberalization process. Section 3 describes the dataset and Section 4 presents the empirical strategy. Section 5 presents the results and Section 6 concludes.

2 Institutional background

Traditionally, community pharmacies enjoyed a monopoly for selling both prescription and OTC drugs. In Portugal, their monopoly for selling OTC drugs ended with Decree-Law n. 134/2005 (August 16, 2005), which allowed the sale of OTC drugs outside pharmacies.[4] Prescription drugs remain available only at traditional pharmacies.

The first non-pharmacy retailers entered the OTC market in October 2005. Non-pharmacy

[3] Traditional pharmacies in Portugal are independently owned due to existing ownership restrictions which limit the number of pharmacies that an agent can own. Ownership restrictions are common and seek to ensure a certain degree of market competition. Recently, organized groups of independently-owned pharmacies were created, but our data are prior to that.

[4] The Portuguese government announced the intention to liberalize the OTC market a few months before Decree-Law 134/2005 was passed. We cannot completely rule out that pharmacies adopted strategies other than pricing to prevent non-pharmacy entry. Nevertheless, the fact that non-pharmacy entry took off quickly after liberalization, combined with pharmacies not being used to operate in a competitive environment, leaves less scope for such strategic behavior.

retailers can be of two types: supermarkets and outlets (*parafarmácias*).
In supermarkets, by regulation, OTC drugs are not are freely accessible to customers. They are placed either in a closed shelf located behind the cashiers' check-out counter, or in a dedicated area together with other wellness products. Either way, customers wishing to purchase a given OTC drug must request it from the cashier or the employee attending to the dedicated area. Most supermarkets selling OTC drugs in Lisbon belong to either one of the two biggest supermarket chains in Portugal.
Non-pharmacy outlets are stores selling cosmetics, baby care products, vitamins and supplements, among others. OTC drugs represented a natural expansion of their product range. Outlets can be either independently owned or part of small chains of two or three stores.
Non-pharmacy retailers wishing to enter the Portuguese OTC market must apply for a license at the National Authority of Medicines and Health Products (Infarmed) and satisfy specific requirements related to drug storage, qualification of personnel, etc. Application by supermarket and outlet chains is done individually by each store belonging to the chain as opposed to one license application for all stores belonging to the chain.
The entry of supermarkets and outlets in the OTC market took place quickly following market liberalization.[5] In the first quarter of 2009 there were over 800 non-pharmacies in Portugal, and by the end of 2017 there were about 1,200. The volume share of OTC drugs in the total outpatient pharmaceutical market was 16.5% by the end of 2017. The corresponding value share was 11.7%. The non-pharmacy volume share of the OTC sector in Portugal has risen continuously since market liberalization, plateauing at 20% in 2014 (Infarmed, 2018).

3 Data

Our data consists of the prices of five popular OTC drugs charged by all pharmacies, supermarkets, and outlets located in the municipality of Lisbon for three different points in time, the years of 2006, 2010, and 2015.
The five OTC drugs are Aspirina 500mg (20 pills, Bayer), Cêgripe (20 pills, Jassen-Cilag Ltd.), Trifene200 (20 pills, Medinfar), Mebocaína Forte (20 tablets, Novartis), and Tantum Verde (mouthwash, Angelini). These drugs tackle simple conditions such as fever and headaches (Aspirina), colds (Cêgripe), menstrual pain (Trifene200), sore throat (Mebocaína Forte), and toothache and gum swelling (Tantum Verde). They are among the top-selling OTC drugs in Portugal. In 2009, these five drugs accounted for 10.8% of the volume sales of OTC drugs outside pharmacies. All of them featured in the top 15 best-selling drugs in volume and 3 of

[5]Throughout the paper, entry in the OTC market refers to the moment at which a retailer is granted a license to sell OTC drugs.

them featured in the top 10 (Infarmed, IP, 2010).[6] They are well-known brands to consumers and often advertised in the media. More importantly, they are available at all retailers.[7]

Price data for 2006 were kindly provided by Simões et al. (2006), who collected them between March and April. We then carried out two additional rounds of data collection, in 2010 and 2015. Infarmed keeps an on-line, updated list of all active retailers that are licensed to sell OTC drugs. We examined these lists before each data collection round and identified the active retailers and their exact locations. We collected price data for 2010 and 2015 between December 2010 and February 2011 and between February and April 2015, respectively.

Though Simões et al. (2006) visited every OTC retailer in 2006, some retailers were not willing to disclose price information, resulting in some missing price data for that year. When we carried out the data collection in 2010 and 2015, we purchased the drugs at retailers whose staff refused to disclose prices. In these two periods we observe prices for all retailers located in Lisbon.

We use the latitude and longitude coordinates of each retailer to identify its main competitors at each time period. We also construct indicators for retailer type (traditional pharmacy, supermarket or outlet) and the parish where each retailer is located.[8] Finally, we have data from the 2001 Portuguese census on the population living in the census block where each retailer is located.

We follow retailers over the three time periods for which we have data. Our dataset is unbalanced because there are retailers entering and exiting the market between each data collection round. Online Appendix S2 shows maps of the OTC market structure in Lisbon for the years 2006, 2010, and 2015. The number of supermarkets selling OTC drugs in our dataset increased over time, from 1 in 2006 to 25 in 2015. The number of outlets selling OTC drugs raised from 8 in 2006 to 25 in 2010 and then slightly declined to 21 in 2015. The number of traditional pharmacies has been declining over time, from 301 in 2006 to 259 in 2015.

We now highlight a few patterns present in our data. The average prices of the drugs under analysis increased over time, as did their variance. All supermarkets in our data belong to supermarket chains and each chain adopts a common pricing strategy, rather than store-specific prices that reflect the competitive environment faced by each store belonging to the chain. On average, supermarkets charge about 20% lower prices than traditional pharmacies for the sample of OTC drugs we analyze. This might be due to economies of scale in the distribution

[6] After 2009, Infarmed stopped releasing sales data by commercial designation, so we do not have more recent figures.

[7] Supermarkets and outlets typically carry a smaller selection of OTC drugs than pharmacies.

[8] Portuguese municipalities are composed of smaller areas called parishes. The number and geographic borders of the Lisbon parishes were revised in 2012. According to the revised version, which we use in our analysis, there are 24 parishes in Lisbon.

chain of supermarkets, more efficient practices regarding stock management and logistics, and stronger bargaining position when engaging in price negotiations with suppliers due to larger quantities purchased. All of these result, cumulatively, in lower marginal costs, leading to lower equilibrium prices for supermarkets. Outlet prices are, on average, 4% lower than those of traditional pharmacies. Outlets are either independent stores or part of very small chains, which might imply that they face wholesale prices similar to those faced by traditional pharmacies.

4 Methodology

4.1 Empirical Strategy

We use a DID strategy to assess the price effects following the entry of non-pharmacy retailers. Non-pharmacy entry started before our first round of data collection. However, non-pharmacy entry took place gradually, meaning that each pharmacy experiences entry of different types of non-pharmacies among its main competitors at different points in time. This is our source of identification.

We start by defining the set of main competitors of pharmacy i. One way to define the main competitors of a pharmacy is to consider its N nearest neighbors in terms of walking distance as main competitors.[9] Another way to define the main competitors of pharmacy i is to consider all retailers located within a radius R centered around i as main competitors. We use these two alternative definitions of main competitors throughout our analysis.

An incumbent pharmacy is "treated" if it experiences the entry of a non-pharmacy retailer among its main competitors. Prior to treatment, its set of main competitors consists only of traditional pharmacies. Because supermarkets and outlets charge different prices, they might exert different levels of competitive pressure on incumbent pharmacies and generate different price effects. We therefore distinguish two types of treatment, $SUPER_i$ and $OUTLET_i$, depending on whether the non-pharmacy entrant faced by pharmacy i is a supermarket or an outlet, respectively. Additionally, for each type of treatment we distinguish three treatment cohorts, c, according to treatment timing. Each of the two types of treatment can take place either before 2006 ($c = 1$, the first and earliest treatment cohort), between 2006 and 2010 ($c = 2$, the second treatment cohort), or between 2010 and 2015 ($c = 3$, the third and latest

[9] We use walking distances instead of straight-line distances to define the nearest competitors of each pharmacy. This accounts for physical barriers that might cause two nearby retailers not to be regarded as competitors by consumers, ie. a high-speed road. We measured walking distances between retailers after each data collection round because they can change over time due to urban development, ie. a new aerial bridge might be built allowing consumers to easily cross over a high-speed road.

treatment cohort). In total there are six treatment groups corresponding to two types of treatment and three treatment cohorts. The control group is composed of pharmacies who never face non-pharmacies among their main competitors.

We estimate the price differences between each treatment group and the control group at each of our sample years. The regression counterpart of these differences is as follows:

$$\begin{aligned} P_{ikt} = \theta_{ct}^{super} \times \delta_t SUPER_i^c + \theta_{ct}^{outlet} \times \delta_t OUTLET_i^c \\ + \delta_t + \gamma_k + \alpha_i + \varepsilon_{ikt}, \end{aligned} \tag{1}$$

$$\begin{aligned} \text{with } SUPER_i^c &= \{SUPER_i^1, SUPER_i^2, SUPER_i^3\} \\ \text{and } OUTLET_i^c &= \{OUTLET_i^1, OUTLET_i^2, OUTLET_i^3\} \end{aligned}$$

In equation (1), i indexes the pharmacy, t indexes time in years, k indexes the drug, and c indexes the treatment cohort. The dependent variable is the natural logarithm of the price charged by pharmacy i, for drug k in year t. $SUPER_i^c$ and $OUTLET_i^c$ are vectors of indicators for each of the three cohorts that experienced the entry of a supermarket and outlet, respectively, among their main competitors.[10] For example, $SUPER_i^2$ is a binary indicator taking value 1 in case pharmacy i experienced the entry of a supermarket among its main competitors between 2006 and 2010 (the second treatment cohort), and value 0 otherwise. Similarly, $OUTLET_i^3$ is a binary indicator taking value 1 if pharmacy i experienced the entry of an outlet among its main competitors between 2010 and 2015 (the third treatment cohort). δ_t is a vector containing fixed-effects for years 2010 and 2015. γ_k and α_i are drug and retailer fixed-effects, respectively. ε_{ikt} is an error term.

The main coefficients of interest are θ_{ct}^{super} and θ_{ct}^{outlet}, corresponding to interactions between the treatment groups and year fixed-effects. Their estimates convey the price impact of non-pharmacy entry on incumbent pharmacies and their dynamics over time. To be more precise, θ_{ct}^{super} conveys the price difference in year t between pharmacies that experience entry of a supermarket among their main competitors in treatment cohort c and pharmacies in the control group. An analogous interpretation applies to θ_{ct}^{outlet} for outlet entry.

Our empirical design is as flexible as possible, given that we only have data for three time points in time. Pharmacies experiencing supermarket and outlet entry after 2010 are observed twice prior to treatment, in 2006 and in 2010. The estimates of $\theta_{3,2010}^{super}$ and $\theta_{3,2010}^{outlet}$ correspond

[10]We use indicator variables for facing non-pharmacy entry, as opposed to measures of the general level of competitive pressure faced by a pharmacy. This is because we are specifically interested on the additional competitive pressure originating from the entry of different types of retailers, supermarkets and outlets. Our main interest is not on the general level of competitive pressure originating from a higher density of traditional pharmacies in an area, which has been assessed in previous literature (see, for example, Pilorge, 2016).

to price differences in 2010 between these pharmacies and the control group. Because these are price differences prior to treatment, the statistical significance of these estimates is informative about the plausibility of the parallel trend assumption.

Additionally, pharmacies experiencing supermarket and outlet entry between 2006 and 2010 are observed twice after treatment, in 2010 and in 2015. The estimates of $\theta_{2,2015}^{super}$ and $\theta_{2,2015}^{outlet}$ correspond to price differences in 2015 between these pharmacies and the control group. $\theta_{2,2010}^{super}$ and $\theta_{2,2010}^{outlet}$, in turn, convey a more immediate price impact of non-pharmacy entry on these pharmacies because they reflect price differences relative to the control group in 2010. Comparing these two pairs of estimates allows us to assess the persistence of the price effects induced by non-pharmacy entry.

When taking our model to the data, we select specific values of N and R. We set $N = 3$ for our baseline nearest neighbor specification. In this case, the treatments consist on the entry of a supermarket or outlet in the set of 3 nearest neighbors before 2006, between 2006 and 2010, or between 2010 and 2015. We set $R = 400$ meters for our baseline radius specification. Under this definition, the treatments consist on the entry of a supermarket or outlet within a 400-meter radius before 2006, between 2006 and 2010, or between 2010 and 2015. We vary our choices of N and R in robustness checks.

We estimate equation (1) using fixed-effects at the pharmacy level, thus differencing out all time-invariant, pharmacy-specific characteristics.[11] We cluster standard errors at the pharmacy level to account for serial correlation in pharmacy pricing decisions.[12]

Since our main interest is on the effects on the pricing of incumbent pharmacies, we estimate our baseline model among pharmacies only. Throughout most of our analysis, we focus on samples in which all treatment and control groups are mutually exclusive.[13] Thus, the number of pharmacies used in the estimation and the number of pharmacies in the treatment and control groups varies with the definition of main competitors. Table 1 shows the composition

[11]Our results are similar when using a random effects specification with parish and treatment group fixed-effects (online Appendix S3.1). From a statistical viewpoint, the random-effects model assumes the constant retailer-specific terms α_i to be independent drawings from an underlying population of retailers (see, for example, Heij et al. (2004)). Since our data contains the universe of retailers operating in Lisbon, this assumption seems less appropriate in our case. A Hausman test also favors the fixed-effects specification, so we use it throughout our analysis.

[12]This clustering option is common when defining markets around a focal retailer (see Hosken et al., 2008) because in such settings retailers are the relevant unit at which treatment assignment occurs. This is also in line with the recommendations of Abadie et al. (2017) to cluster standard errors at the level of treatment variation. We experimented with alternative ways of clustering the standard errors, namely two-way clustering by pharmacy and drug. This does not affect the significance of our results (Table S3.9 in the online Appendix).

[13]Pharmacies experiencing non-pharmacy entry at several points in time, or experiencing both supermarket and outlet entry are disregarded from most of our analysis. This avoids having many interaction terms in the model whose identification relies on very few pharmacies and it simplifies the construction of the propensity-score matched sample. Our results are unchanged if we include pharmacies that experienced multiple treatments (Table S3.6 in the online Appendix).

Table 1: Composition of control and treatment groups in the baseline sample

	Definition of main competitors					
	3 nearest neighbors			400-meter radius		
	2006	2010	2015	2006	2010	2015
Control group	152	220	197	136	206	186
Supermarket entry before 2006	2	2	2	0	0	0
Supermarket entry in 2006/10	6	6	6	5	5	5
Supermarket entry in 2010/15	13	13	13	6	6	6
Outlet entry before 2006	8	8	8	9	7	6
Outlet entry in 2006/10	10	10	10	14	14	12
Outlet entry in 2010/15	11	11	11	12	12	12
Total	202	270	247	182	250	227

NOTES: The table shows the number of pharmacies included in the baseline estimation samples per treatment group and year for our two alternative definitions of main competitors. In the first three columns the main competitors of a pharmacy are defined as its three nearest neighbors. In the last three columns, the main competitors of a pharmacy are defined as all retailers located within a 400-meter radius. The lower number of pharmacies in the control group in 2006 is a consequence of missing price data for that year, as discussed in Section 3. Within a definition of main competitors, we focus on a sample of pharmacies for which all the treatment groups and the control group are mutually exclusive.

of the treatment and control groups for our baseline choices of main competitors: the three nearest neighbors and the retailers located within a 400-meter radius.[14] In the specific case of the 400-meter radius measure, no pharmacies experienced entry of a supermarket before 2006 so that treatment group is empty. Each pharmacy belongs to the same group throughout all time periods in which it is observed. However, the number of pharmacies in each group can vary over time due to market entry and exit. For example, Table 1 conveys that some of the pharmacies that experienced entry of an outlet within a 400-meter radius exited the market. The increase in the number of pharmacies in the control group between 2006 and 2010 reflects the missing price data for 2006, as discussed in Section 3.

One concern is that pharmacies in the control group and those that eventually face non-pharmacy entry are already somewhat different prior to treatment. In Table 2 we compare the pre-treatment means of our main variables for pharmacies in the control group and those treated after 2006. We do this for our two alternative measures of main competitors. We

[14] Table S4.1 in the online Appendix shows the composition of control and treatment groups for different choices of N and R used in robustness checks.

Table 2: Testing for mean differences between groups of pharmacies at baseline (2006)

	Control group	Eventually treated	Difference	P-value
Main competitors: 3 nearest neighbors				
Price *Aspirina 500mg* (€)	3.033	2.996	0.026	0.378
Price *Cêgripe* (€)	4.312	4.195	0.118***	0.002
Price *Trifene200* (€)	3.348	3.255	0.093**	0.041
Price *Mebocaína Forte* (€)	4.676	4.613	0.062	0.238
Price *Tantum Verde* (€)	4.987	4.848	0.139**	0.047
Avg distance to 3 nearest neighbors (km)	0.241	0.274	-0.035	0.241
Avg walking time to 3 nearest neighbors (min)	5.161	5.800	-0.639	0.323
Population in census block (as of 2001)	589.024	723.286	-125.262***	0.002
Main competitors: 400-meter radius				
Price *Aspirina 500mg* (€)	3.026	3.004	0.022	0.554
Price *Cêgripe* (€)	4.323	4.240	0.083**	0.027
Price *Trifene200* (€)	3.340	3.285	0.055	0.149
Price *Mebocaína Forte* (€)	4.675	4.688	-0.013	0.213
Price *Tantum Verde* (€)	4.995	4.913	0.082	0.418
Number of retailers within radius	4.940	4.838	0.102	0.864
Population in census block (as of 2001)	590.694	646.255	-55.561	0.104

NOTES: The table shows the 2006 mean of several variables of interest across pharmacies in the control and treatment groups for our two alternative measures of main competitors. In the top panel, the main competitors of a pharmacy are its three nearest neighbors and in the bottom panel they are all retailers located within a 400-meter radius. For each panel, the first column reports averages across pharmacies belonging to the control group. The second column reports averages across pharmacies which were not yet treated in 2006, but will eventually face the entry of a non-pharmacy amongst their three nearest competitors, thus grouping together pharmacies facing the entry of a supermarket or an outlet either between 2006 and 2010, or between 2010 and 2015. Pharmacies already treated in 2006 are not accounted for in this table because they are not observed prior to treatment. The third column computes the difference of columns 1 and 2, and column 4 shows the corresponding two-sided p-value. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

exclude pharmacies who experienced non-pharmacy entry before 2006, as for these we have no pre-treatment observations. Pharmacies that eventually experience non-pharmacy entry charge lower prices for some of the drugs under analysis in 2006 and they tend to be located in areas with higher population. This motivates the estimation of equation (1) on a matched sample of pharmacies (Section 4.2).[15]

Entry is expected to have stronger effects in areas where market structure is more concentrated, i.e. closer to a monopoly. We assess this hypothesis by estimating equation (1) among the most and the least spatially isolated pharmacies, alternatively. We define the most spatially isolated pharmacies based on information for 2006. In the case of our nearest neighbors

[15]Table S4.2 in the online Appendix replicates this exercise for alternative treatment group definitions based on different choices of N and R used in robustness checks.

measure of main competitors, the most (least) spatially isolated pharmacies are those whose walking time in minutes to their third nearest competitor is above (below) the sample median in 2006. For our radius measure of competition, the most (least) spatially isolated pharmacies are those whose number of competitors within a 400-meter radius in 2006 is below (above) the sample median.

Our control group may be contaminated by second-order effects related to the entry of non-pharmacies. That is, if pharmacy A experiences the entry of non-pharmacy B among its main competitors, A might lower its price (first-order effect). That may cause C, who is in the control group and has A but not B among its main competitors, to change its price as a response to the price change of A (second-order effect). We mitigate this concern by restricting the control group to pharmacies whose main competitors are in the control group themselves. This robustness check is informative about whether our choice for the set of main competitors, and our definitions of control and treatment groups are adequate.

The maps of the market structure of the OTC market in Lisbon in online Appendix S2 show that some retailers exited the market during our study-period. Most of these were pharmacies. In robustness checks, we address pharmacy exit in several ways. First, we estimate equation (1) on a balanced panel of pharmacies. Second, we estimate equation (1) among pharmacies whose main competitors do not exit the market.[16] Third, we assess whether experiencing the entry of a non-pharmacy retailer makes pharmacies more likely to exit the market in the future. Specifically, we estimate a logit model whose dependent variable is a binary indicator taking value 1 in case pharmacy i exits the market before the next round of data collection, and value 0 otherwise. The independent variables are treatment group indicators, year fixed-effects, and parish fixed-effects. If the estimates corresponding to the treatment group indicators are not statistically different from zero, then experiencing entry of a supermarket or outlet does not systematically cause pharmacies to exit the market.

4.2 Endogeneity of market structure

Our estimates from equation (1) can only be interpreted as causal if entry and location decisions of non-pharmacies are exogenous. The decision to open a supermarket or outlet in a given location is plausibly unrelated to pharmacy market structure, as OTC drugs are a

[16]There can be variation in competition both from entry and from exit of OTC retailers that compose the set of main competitors of a pharmacy (ie, their three closest neighbors or the retailers within a 400-meter radius). We are interested in variation originating from entry of non-pharmacies, not exit of pharmacies. In order to isolate the former, we focus on a subsample of pharmacies whose main competitors do not exit the market. Therefore, any variation in competition comes from entry of a new retailer.

small subset of their product range.[17] However, it is more difficult to defend the exogeneity assumption when not all retailers belonging to a given chain apply for a license to sell OTC drugs.

One potential threat is the existence of retailer-specific unobservables that affect both prices charged by incumbent pharmacies and entry of non-pharmacies. To the extent that these are time-invariant, they are captured by the retailer fixed effects in our model. However, there can also be *time-varying*, retailer-specific unobservables if, for example, certain retailers experience demand shocks due to the natural course of urban development, gentrification of certain neighborhoods, etc. These shocks are difficult to measure at the small geographic level we are working with.

In an attempt to mitigate this concern, we combine propensity score matching with our DID design (Heckman et al., 1997; Smith and Todd, 2005). The underlying intuition is that by matching treated and untreated pharmacies on their propensity score, that is, on their probability of being treated, we make treated and control groups more similar in terms of the observables used in the estimation of the propensity score. Thus, treatment should be random, conditional on those observables. We estimate the propensity score as a function of the levels of competitive pressure and demand faced by each pharmacy prior to experiencing non-pharmacy entry.[18] We then use the estimated propensity scores to build a matched sample of pharmacies using single neighbor matching.[19] Finally, we estimate equation (1) in this matched sample.

Another potential threat is that, in addition to pharmacies adjusting their prices in the presence of a non-pharmacy, non-pharmacies make location decisions based on prices charged by existing pharmacies in the area. That is, non-pharmacy entrants select where to enter the market based on past prices in the area. For example, entrants might chose to enter

[17] In the particular case of supermarket chains, OTC drugs seem to correspond to a small share of total sales. For example, in 2014 the supermarket chain with the largest OTC sales value was Pingo Doce with M€8.3 nationwide (Infarmed, IP, 2015). Its total sales value was M€3,234 (Jerónimo Martins SGPS SA, 2015). At the time OTC drugs were available at 74 of a total of 380 stores existing Pingo Doce in Portugal. Assuming stores are symmetric, on average, OTC drugs amount to 1.3% of total sales value per store.

[18] Specifically, demand is measured as population living in the census block where the pharmacy is located, as of 2001. Competitive pressure is measured by the average walking time, in minutes, to the three closest competitors as of 2006 when defining the main competitors of a pharmacy as its three nearest neighbors. When considering all retailers located within a 400m radius, competitive pressure is measured by the total number of retailers located inside the 400m radius in 2006. Since both measures of demand and competitive pressure are continuous, we categorize them into quintiles and use the categorized variables for the matching. We disregard the groups that were treated already in 2006 in the matching, as for those we do not observe a pre-treatment period level of competitive pressure. In online Appendix S6 we provide additional technical details on the PSM procedure.

[19] As an alternative matching algorithm, we use local linear regression to build the matched sample. The results are shown in online Appendix S3.8 and are similar to those for the matched sample using single neighbor matching.

in areas where prices are higher as there they could potentially only slightly undercut the incumbents and make higher profits. We address this concern by assuming a sequential game in which in year $t-1$ supermarkets and outlets make joint entry and location decisions for year t, taking into account (functions of) $t-1$ prices charged by the pharmacies they would be competing with. Then in year t entry is realized and observed, and all players make their pricing decisions for that year taking entry as given. We have no information on retailers that did not enter the market. Thus, we use the fact that we observe entry in certain locations, but not in others. For this analysis, retailers are the relevant unit of observation and the prices of each of the five OTC drugs are aggregated to generate an OTC bundle price which is retailer-year specific, $P_{it} = \sum_{k=1}^{5} P_{ikt}$.[20] The equation taken to the data is as follows:

$$entry^*_{it} = \beta_0 + \beta_1 \zeta(P_{i,t-1}) + \delta_t + \lambda_j + \varepsilon_{it}, \qquad \varepsilon_{it} \sim iid\ logistic \tag{2}$$
$$entry_{it} = \begin{cases} 1 & \text{if } entry^*_{it} > 0, \\ 0 & \text{if } entry^*_{it} \leq 0 \end{cases}$$

where $entry^*_{it}$ is a latent variable representing the probability that pharmacy i experiences the entry of a non-pharmacy among its main competitors in year t. Although we do not observe this probability, we observe whether a pharmacy experienced non-pharmacy entry at a given point in time, $entry_{it}$. Thus, $entry_{it}$ is a binary indicator taking value 1 in case pharmacy i experienced the entry of a supermarket or outlet among its main competitors in year t, and value 0 otherwise. $\zeta(P_{t-1})$ is a functional form through which past prices affect entry and location decisions by supermarkets or outlets. ζ is, alternatively, the $t-1$ price charged by pharmacy i (P_{it-1}), and the ratio between P_{it-1} and the average $t-1$ price among all retailers operating in Lisbon. The remaining terms are time and parish fixed effects, δ_t and λ_j, respectively. ε_{it} is a logistically-distributed error term. Since we take lags of price, the model is estimated using the years 2010 and 2015 only and the lags are taken with respect to the previous period for which we have data. We estimate separate models for the probability of experiencing entry of a supermarket or an outlet, and for our two definitions of main competitors. If the estimates of β_1 are not statistically different from zero in these models, then entry and location decisions of supermarkets and outlets are not driven by past prices charged by pharmacies operating in that location for the five drugs under analysis.

[20] We acknowledge that this is a relatively coarse measure of prices in a geographical area, because we are only considering five OTC drugs and these five particular OTC drugs might poorly represent the prices of all goods sold by the pharmacies in that area. But this is the best measure we have given the available information.

5 Results

Table 3 shows our main results. In the first column we consider the main competitors of a pharmacy to be its three nearest neighbors and in column 2 we consider its main competitors to be the retailers located within a 400-meter radius. The results are broadly similar across the two definitions of main competitors. Overall, the entry of a supermarket among the main competitors of a pharmacy is associated with long-lasting price reductions. In 2010, pharmacies who faced the entry of a supermarket amongst their main competitors between 2006 and 2010 charged 6-7% lower prices than those in the control group. In 2015, this very same group of pharmacies was still charging, on average, 4-6% lower prices than pharmacies in the control group.[21] The effects are insignificant for pharmacies experiencing entry of a supermarket between 2010 and 2015. While pharmacies experiencing supermarket entry before 2006 charge 2-3% lower prices than those in the control group both in 2010 and 2015, we do not know how their prices compared to the control group pre-entry and thus do not put too much emphasis on this result.

The entry of an outlet among the main competitors of a pharmacy is not associated with price reductions. The finding that incumbent pharmacies react differently to supermarket and outlet entry is consistent with a model in the spirit of Salop (1979), where competition is localized and non-pharmacy entrants can have a cost-advantage or cost-disadvantage relative to traditional pharmacies. We outline such a model in online Appendix S1. In our model, the extent to which pharmacies lower prices after experiencing non-pharmacy entry depends on two distinct forces. On the one hand, there is now a closer competitor which creates downward pressure on incumbent prices. On the other hand, due to the localized nature of competition, incumbents may face a softer or tougher rival at the margin. In case of a more efficient entrant, both these forces go in the direction of lowering pharmacy prices (closer and more efficient rival). In case of a less efficient entrant, the two forces work in opposite directions and the total impact on pharmacy prices is ambiguous. In our setting, entry by large supermarket chains is likely to be approximated by the low-cost entrant, reflecting their cost advantage in logistics, management and, eventually, bargaining power with wholesalers. The entry of outlets, in turn, might be better approximated by the higher-cost entrant.

In the last two rows of Table 3, we compare the prices charged in 2010 by pharmacies that experience non-pharmacy entry only after 2010 with those charged by pharmacies in the control group. The lack of statistical significance of these estimates supports the plausibility

[21] To put these effects into perspective, the entry of a pharmacy chain in India is associated with a 2% price decline among incumbents (Bennett and Yin, 2019), and the entry of Walmart, which charged on average 10% lower prices, is associated with a 1-1.2% price decrease by its competitors (Basker and Noel, 2009) and a short-run average city-level price decrease in the range of 1.5-3% (Basker, 2005).

Table 3: Estimates of θ from equation (1), baseline and matched samples

	No matching		Single neighbor matching	
	3 nearest neighbors	400m radius	3 nearest neighbors	400m radius
	(1)	(2)	(3)	(4)
DiD estimates:				
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)	-0.027***			
	(0.008)			
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)	-0.038***			
	(0.013)			
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.064***	-0.076***	-0.055*	-0.053**
	(0.019)	(0.015)	(0.033)	(0.026)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.064***	-0.038*	-0.080**	-0.010
	(0.022)	(0.023)	(0.035)	(0.031)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.015	-0.025	-0.030	0.009
	(0.016)	(0.017)	(0.027)	(0.025)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	0.013	-0.031		
	(0.020)	(0.022)		
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	-0.005	-0.033*		
	(0.010)	(0.019)		
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	0.009	-0.006	0.019	0.010
	(0.023)	(0.017)	(0.022)	(0.023)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.015	-0.015	-0.001	-0.024
	(0.021)	(0.020)	(0.025)	(0.026)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	-0.001	0.035*	-0.016	0.060**
	(0.034)	(0.021)	(0.035)	(0.025)
Pre-treatment trends:				
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.009	-0.041	0.000	0.020
	(0.027)	(0.033)	(0.024)	(0.024)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.007	0.011	0.003	0.040*
	(0.018)	(0.015)	(0.023)	(0.022)
N	3,429	3,280	970	960
R^2	0.912	0.913	0.913	0.903

NOTES: Estimates of θ^{super} and θ^{outlet} based on the estimation of equation (1) among traditional pharmacies. In columns 1 and 3 the main competitors of pharmacy i are its 3 nearest neighbors. In columns 2 and 4 the main competitors of pharmacy i are the retailers located with a 400-meter radius. The first two columns estimate the model in the original sample. The last two columns estimate the model on a matched sample of treated and control pharmacies (matching was done using single neighbor matching on propensity scores). We disregard the groups that were treated already in 2006 in the matching, as for those we do not observe a pre-treatment period. All specifications include year, drug, and pharmacy fixed-effects. Standard errors are shown in parenthesis. In columns 1 and 2 standard errors are clustered at the pharmacy level. In columns 3 and 4 standard errors are bootstrapped using 30 repetitions drawn cross-sectionally at the pharmacy level in the original sample. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

of the common trend assumption, but their magnitude is sometimes not too different from our main effects. Figure S5.5 in the online Appendix plots raw prices for the two groups of pharmacies treated after 2010 and the control group. These plots do not suggest different trends across groups, though we would need a longer panel to make a stronger claim regarding this matter.

In the last two columns of Table 3 we report the results from estimating equation (1) on a matched sample of treated and control pharmacies, with matching done using single neighbor matching on propensity scores. The size of the matched sample is considerably smaller than the size of the baseline sample. While the results obtained with the matched sample go in the same direction as the ones obtained with the baseline sample, some statistical significance is lost.

Table S3.2 in the online Appendix shows that our results are driven by the most spatially isolated pharmacies as of 2006, who enjoyed some degree of market power before experiencing entry. Our baseline results are robust to estimating the model on a balanced panel of pharmacies, including all retailer types, including pharmacies that are in multiple treatment groups, restricting the sample to pharmacies whose main competitors are in the control group themselves, and restricting the sample to pharmacies whose main competitors do not exit the market (Tables S3.5, S3.3, S3.6, S3.4, and S3.7 in the online Appendix, respectively).

We vary the values of N and R for the definitions of main competitors in online Appendix S4. The findings from that exercise convey the fact that competition in the OTC market is very localized. For example, increasing N from 3 to 5 shows very few statistically significant price effects following non-pharmacy entry. Similarly, when enlarging the radius within which main competitors are located from 400 to 600 or 800 meters most of the price effects vanish (see Table S4.3 in online Appendix S4 for the baseline results and the following tables for robustness checks).

Experiencing the entry of a non-pharmacy retailer does not seem to cause pharmacies to exit the market before the next round of data collection (Table S3.10 in the online Appendix).[22]

Finally, Table 4 shows the results of the reduced-form entry model. These do not support the claim that non-pharmacies make entry decisions based on the prices charged by pharmacies already operating in that area because the estimate of β_1 in equation (2) is never statistically significant. Because our reduced-form entry model has a very specific functional form, we

[22]Exit of traditional pharmacies cannot be directly linked to the liberalization of the OTC market, as the share of OTC drugs on total pharmacy revenue is probably too small to produce such an impact. Instead, it is more likely a consequence of the overall economic environment and the squeezing of pharmacy margins on prescription drugs (Barros, 2012). This is consistent with the figures in Table 1, showing that the vast majority of the pharmacies who exited the market were in the control group. In Table S7.1 in the Online Appendix we provide a brief overview of the main regulations affecting pharmacy profitability that were passed between 2005 and 2015.

Table 4: Results from the estimation of the reduced-form entry model

Main Competitors	$\zeta(P_{t-1})$ specification	Supermarket	Outlet
3 Nearest neighbors	P_{it-1}	-0.771	-7.079
		(1.533)	(1.027)
	P_{it-1} relatively to average market price	-0.999	-1.289
		(4.293)	(1.262)
400m radius	P_{it-1}	-0.865	0.665
		(2.226)	(0.836)
400m radius	P_{it-1} relatively to average market price	-1.432	0.548
		(7.868)	(0.820)

NOTES: Marginal effects of β_1 from RE logit estimation of equation (6), with dependent variable being an indicator for facing the entry of a supermarket (column 1) and an outlet (column 2). There are two panels. The top panel takes the main competitors of pharmacy i as its three nearest neighbors. The bottom panel takes the main competitors of pharmacy i as the retailers located within a 400-meter radius. In each of the panels, the first row tests whether pharmacy i facing the entry of a supermarket/outlet among its main competitors depends on the prices it charged in the previous period, $\zeta(P_{t-1}) = P_{it-1}$. The corresponding figures can be interpreted as the percentage-point change in the probability of facing entry associated with a 1% higher OTC bundle price in the previous period. The second row tests whether it depends on the lagged prices of pharmacy i relatively to the average bundle price in the city of Lisbon. The corresponding figures can be interpreted as the percentage-point change associated with a 1-unit increase in the independent variable. Recall that our estimation sample differs according to how we define the set of main competitors of pharmacy i, so that a different number of observations is used to obtain each estimate shown on the table. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

create bar charts of the share of pharmacies in each of the deciles of current and past prices for the bundle of drugs we analyze. We do this separately by year and by type of non-pharmacy entrant. If entry is in any way related to current or past prices, then these plots should convey a non-random relationship. In particular, if entry occurred in locations which were potentially more profitable because they had higher prices, then pharmacies in the highest price deciles would experience the largest shares of entry by non-pharmacies. We find no such pattern (Figures S5.1 and S5.3 in the online Appendix). A similar analysis using deciles of resident population instead of price deciles yields again no clear pattern (Figures S5.2 and S5.4 in the online Appendix).

6 Concluding remarks

We use unique OTC price data at the retailer level for the city of Lisbon to examine the effects of non-pharmacy entry on the prices of incumbent pharmacies. We show that non-pharmacy entry can be successful at fostering competition and lowering prices charged by pharmacies. However, the extent to which this occurs depends crucially on the type non-pharmacy entrant and, particularly, on their ability to exert competitive pressure on incumbent pharmacies. Supermarkets in our sample charge about 20% lower prices than pharmacies, whereas outlets charge 4% lower prices than pharmacies. This means that supermarkets have a greater ability to exert competitive pressure on pharmacies than outlets.

Our baseline results reflect those differences. While incumbent pharmacies charge 4-6% lower prices than the control group after experiencing the entry of a supermarket among their main competitors, they do not seem to react to the entry of an outlet. Furthermore, while incumbent pharmacies lower their prices as a response to supermarket entry, they do not lower prices enough so as to match the prices charged by supermarkets. This findings are in line with predictions from a model in the Salop tradition with non-pharmacy entrants differing from incumbents in their marginal cost.

Our results are specific to retailers operating in the municipality of Lisbon and to the set of drugs and time periods we analyze. They might not generalize to other settings. In particular, price reductions may not occur in rural areas, where entry of supermarkets takes place on a smaller scale. Nevertheless, our study contributes to a deeper understanding of how competition takes place in retail pharmaceutical OTC markets.

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Online Appendix

S1 Theoretical framework

We highlight the economic effects associated with OTC liberalization using a stylized model of entry and competition in the OTC market. We consider a model in the tradition of Salop (1979), with entry of competitors with marginal cost differences relative to incumbents. This reflects the possibility that different types of non-pharmacy entrants may have a cost-advantage or disadvantage relative to community pharmacies. Entry is exogenously given, to focus on the price effects from entry.

The equilibrium price effects of entry into the OTC market will result from extra competition due to more players in the market and from how hard marginal competition has become. In the Salop model, competition is localized, so entry by a low cost rival creates a downward pressure on prices from both a closer rival and a lower marginal cost, more aggressive, competitor. On the other hand, entry by a higher cost competitor brings a balance between a closer rival and a "softer" (higher marginal cost) competitor. The former drives down equilibrium prices while the latter exerts pressure for increasing equilibrium prices.

We consider exogenous entry instead of the free entry equilibrium as in Salop (1979). The existence of entry fixed costs will limit entry in a trivial way and will not add any particular insight. Our interest lies in the price implications of entry of OTC non-pharmacy retailers with different marginal costs, to generate testable implications.

In our setting, entry by large supermarket chains is likely to be approximated by the low-cost entrant, reflecting their cost advantage in logistics, management and, eventually, bargaining power with wholesalers. In areas where supermarkets enter the OTC market, we expect prices to decrease in pharmacies. The entry of other small OTC retailers, outlets, on the other hand may induce a richer set of effects. If they have marginal costs lower than those of pharmacies, but higher than those of supermarkets, the same qualitative effects described for supermarkets apply, though with lower intensity. More interesting is that, in the presence of higher cost entrants, we cannot rule out that equilibrium prices increase. The competition effect works in the direction of lower prices but the strategic interaction effect due to localized competition works in the direction of higher prices whenever the entrant has higher marginal costs. Thus the empirical prediction on the effect of entry of small OTC retailers on equilibrium prices is ambiguous (in the absence of a strong presumption that such outlets have a marginal cost advantage relative to pharmacies).

The model uses the simplest layout to support the above claims.[23] In the pre-entry equilibrium

[23]Importantly, we deviate from the traditional Salop (1979) model in that we do not we do not have fixed costs in our model. We do not explicitly model fixed costs because we want to focus on the price changes after

we consider two pharmacies symmetrically located on the Salop circumference of length one. Density of consumers (patients) is 1 and uniformly distributed along the circumference. Each consumer has a linear cost t of "travelling" to an OTC retailer. A distance x implies a total travel cost of tx. We use x to index a patient location on the circle relative to the nearest left-side OTC retailer. The distance to the nearest right-side retailer is denoted by $d - x$, and the associated travel cost is $t(d - x)$. The value of d is determined by the location of OTC retailers. With n sellers, $d = 1/n$. Consumers of OTC products are assumed to have no insurance coverage (either public or private) for this type of product.[24]

Traditional pharmacies are assumed to be profit maximizing in their decisions regarding the price of OTC products. Pharmacies have a constant marginal cost, c, of selling an OTC product. Supermarkets and outlets have constant marginal cost given by $c + \Delta^S$ and $c + \Delta^O$, respectively. We assume $\Delta^S < 0$, $\Delta^S < \Delta^O$, and Δ^O can be greater or smaller than 0.

To keep the model as tractable as possible without losing any essential element, we assume that entry occurs in pairs (either two supermarkets or two outlets) and that all locations are symmetrically placed on the Salop circumference. These assumptions can be easily relaxed without changing the qualitative nature of the result. Symmetry allows for far more tractable expressions, from which economic intuition can be obtained.

We first characterize the market equilibrium for two symmetrically located community pharmacies. Demand directed to each pharmacy results from patients located both to its left and right-hand sides. A pharmacy located at point i on the Salop circumference faces demand

$$D_i = \left(\frac{1}{2n} - \frac{p_i - p_{i-1}}{2t}\right) + \left(\frac{1}{2n} - \frac{p_i - p_{i+1}}{2t}\right), \tag{3}$$

where $i - 1$ and $i + 1$ denote the locations of rivals. Note that with two pharmacies only, $p_{i-1} = p_{i+1}$, as the other pharmacy is both the left-side and the right-side competitor.

Profit of each pharmacy is

$$\Pi_i = (p_i - c)\left(\frac{1}{n} - \frac{p_i - p_{i-1}}{t}\right). \tag{4}$$

the entry fo non-pharmacy retailers only to obtain testable implications in reduced form equations, and we do not characterize the equilibrium with free entry and relocation of firms within the circle. This modeling option stems from specific features of the OTC market and our setting that may render the free-entry version do the model unsuitable. First, relocation is costly and we do not see firms relocating in the data. Second, pharmacy entry is regulated and non-pharmacy entry also requires approval by the regulator (Infarmed). Third, some supermarket entrants will have fixed location as well in the sense that they were already operating before OTC market liberalization and simply added OTC drugs to their product range. Finally, while we do observe pharmacy exit in the data, that is likely driven by developments in the prescription drug market rather than the OTC market. In our theoretical framework, we are only modeling the OTC segment.

[24] Although some OTC products are covered by the National Health Service in Portugal, most are not.

Maximizing each firms' profit with respect to price and solving for the symmetric price equilibrium, we obtain the standard result of $p^* = (t/2) + c$.

The next step is the characterization of the post-entry equilibrium. We assume that two non-pharmacy OTC retailers enter the market and locate symmetrically on the circle in relation to pharmacies' location. Moreover, pharmacies do not relocate in response to entry.[25] Our assumption of symmetric entrants also implies that entrants have the same marginal cost (different from pharmacies marginal cost).

Demand directed at retailer i now has to accommodate the existence of more competitors, $d = 1/4$. The profit of a retailer located at i is given by

$$\Pi_i = (p_i - c - \Delta)\left(\frac{1}{4} - \frac{p_i - p_{i-1}}{2t} - \frac{p_i - p_{i+1}}{2t}\right) \tag{5}$$

with $\Delta = 0$ for traditional pharmacies.

Pharmacies face a symmetric situation in their decisions and so do supermarkets (or outlets). Thus, we only need to characterize two equilibrium values of prices, one for each type of retailer. Each pharmacy faces competition by two supermarkets/outlets and each supermarket/outlet faces competition of two pharmacies. The resulting equilibrium prices for incumbent pharmacies (I) and non-pharmacy entrants (E) are:

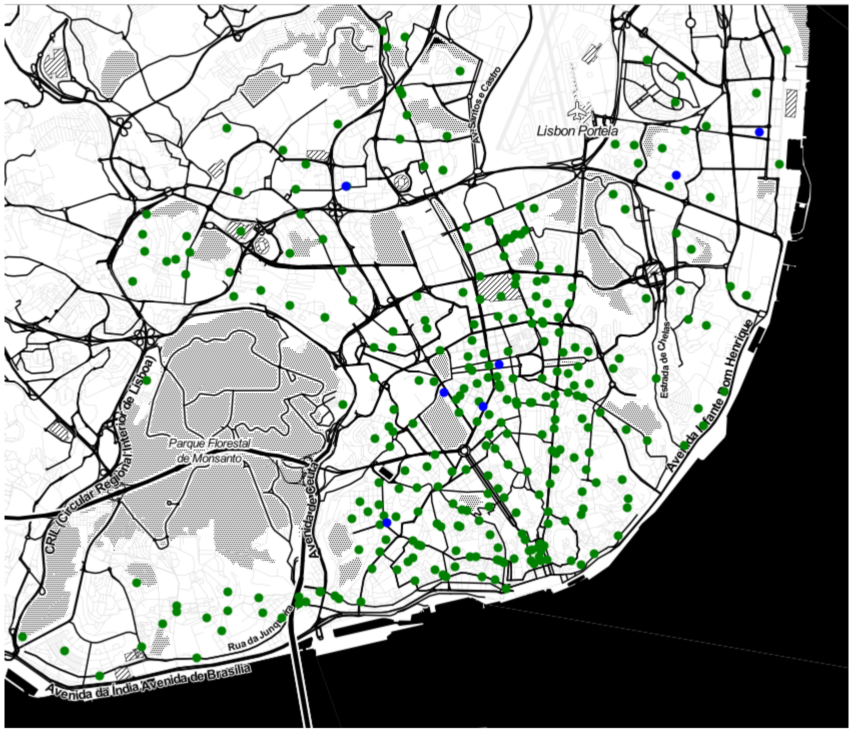
$$p^I = c + \frac{t}{4} + \frac{\Delta^E}{3}, \qquad p^E = c + \frac{t}{4} + \frac{2\Delta^E}{3} \tag{6}$$

From these equilibrium prices it follows that for $\Delta^E < 0$ (more efficient entrants), $p^E < p^I < p^*$. The direct competition effect of more retailers is captured by the difference $(t - t/4)$ when comparing p^I and p^*. The strategic interaction effect from competition is associated with the term Δ^E. With $\Delta^E > 0$ different possibilities exist. Equilibrium price of pharmacies increases if $\Delta^E > 9/4t$ (and pharmacies have lower price than entrants in this case).

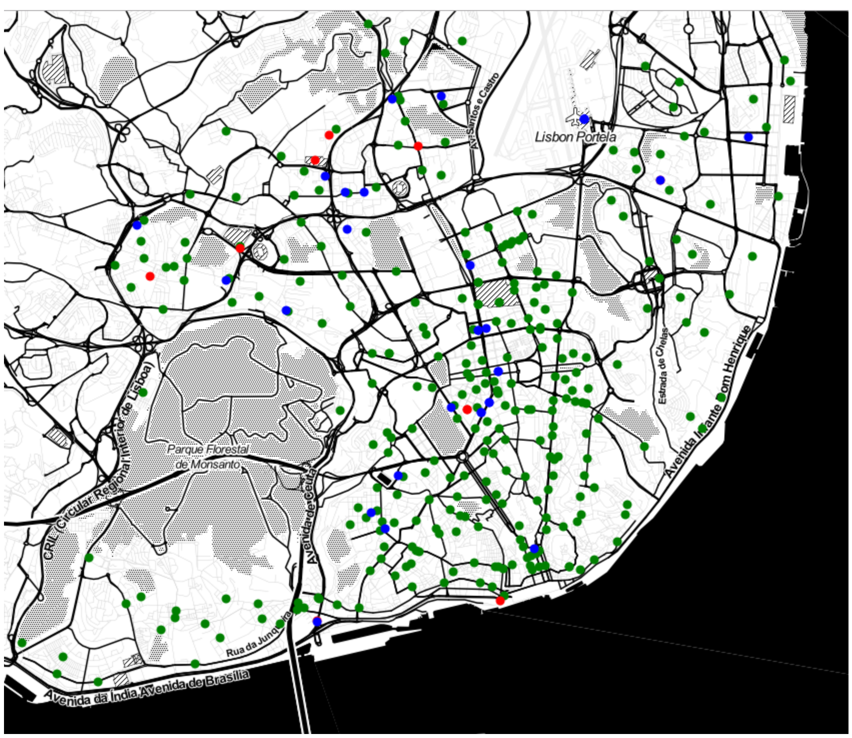
These results provide the conceptual background to guide the interpretation of our empirical findings.

[25] Given our assumption of two entrants, the forces for maximum product differentiation and symmetric locations is compatible with the assumption made. Moreover, it is unlikely that pharmacies will relocate geographically as OTC are a relevant but not the main source of their revenues (and relocation may take place in other dimensions relevant to patients other than geographic distance).

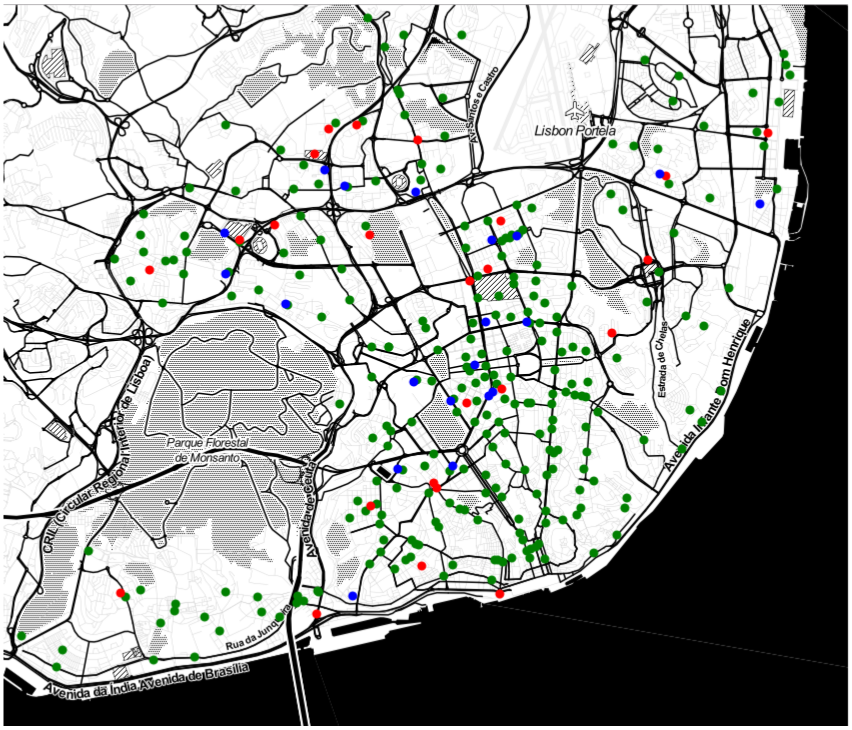
S2 OTC Market Structure in Lisbon



(a) 2006



(b) 2010



(c) 2015

Figure S2.1: Evolution of OTC market structure in Lisbon

NOTES: Panels (a), (b) and (c) convey the location and type of each OTC retailer active in the Lisbon market as of 2006, 2010, and 2015, respectively. Traditional pharmacies are marked in green, supermarkets are marked in red and outlets are marked in blue. Because some retailers are located very nearby each other, the markers might overlap. In total, there were 301 pharmacies, 1 supermarket, and 8 outlets in 2006; 283 pharmacies, 10 supermarkets, and 25 outlets in 2010; and 259 pharmacies, 25 supermarkets, and 21 outlets in 2015.

S3 Additional tables of results for baseline definitions of main competitors

Remark: The use of a random effects model does not change our basic insights

Table S3.1: Results from estimating equation (1) using random effects

	3 nearest neighbors	400-meter radius
	(1)	(2)
DID estimates:		
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)	-0.026***	
	(0.008)	
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)	-0.037***	
	(0.013)	
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.063***	-0.075***
	(0.019)	(0.015)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.063***	-0.038
	(0.022)	(0.023)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.013	-0.024
	(0.016)	(0.017)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	0.015	0.023
	(0.020)	(0.022)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	-0.004	0.022
	(0.009)	(0.020)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	0.011	-0.005
	(0.023)	(0.017)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.017	0.014
	(0.021)	(0.019)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	0.001	0.036*
	(0.034)	(0.021)
Pre-treatment trends:		
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.008	-0.039
	(0.027)	(0.033)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.005	0.012
	(0.018)	(0.014)
Observations	3,429	3,280
R^2	0.912	0.913

NOTES: Estimates of θ based on the estimation of equation (1) among pharmacies using random effects. Columns 1 takes the main competitors of pharmacy i as its 3 nearest neighbors and column 2 considers all retailers within a 400-meter radius as main competitors. All models include year, drug, parish, and treatment group fixed-effects. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Remark: Our results are driven by the most spatially isolated pharmacies

Table S3.2: Results from estimating equation (1) among the most and least spatially isolated pharmacies in 2006

	Most spatially isolated		Least spatially isolated	
	3 nearest neighbors	400-meter radius	3 nearest neighbors	400-meter radius
	(1)	(2)	(3)	(4)
DID estimates:				
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)	-0.026**			
	(0.010)			
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)	-0.033**			
	(0.015)			
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.071***	-0.099***	-0.058*	-0.030***
	(0.022)	(0.018)	(0.030)	(0.010)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.078***	-0.074***	-0.036*	-0.013
	(0.018)	(0.024)	(0.019)	(0.009)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.033**	-0.047	-0.007	-0.010
	(0.016)	(0.036)	(0.025)	(0.019)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	0.008	-0.026	0.013	0.076***
	(0.025)	(0.021)	(0.021)	(0.019)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	-0.003	-0.015	-0.010	0.067***
	(0.013)	(0.015)	(0.010)	(0.021)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	-0.014	-0.054***	0.030	0.032
	(0.026)	(0.017)	(0.030)	(0.021)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.006	-0.018	0.003	0.045**
	(0.025)	(0.031)	(0.033)	(0.021)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	0.067	0.076*	-0.005	0.026
	(0.052)	(0.039)	(0.034)	(0.023)
Pre-treatment trends:				
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.041	-0.008	0.017	-0.053
	(0.032)	(0.020)	(0.025)	(0.046)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.016	-0.005	-0.007	0.020
	(0.037)	(0.039)	(0.019)	(0.015)
Observations	1,257	924	1,752	1,287
R^2	0.921	0.922	0.918	0.919

NOTES: Estimates of θ based on the estimation of equation (1) among pharmacies located in areas where market structure is the most and the lest concentrated. Columns 1 and 3 take the main competitors of pharmacy i as its 3 nearest neighbors and columns 2 and 4 consider all retailers within a 400-meter radius as main competitors. In columns 1 and 3 the sample was restricted to pharmacies whose walking time (in minutes) to their 3rd nearest competitor is above and the sample median in 2006, respectively. In columns 2 and 4 the sample was restricted to pharmacies whose number of competitors within a 400-meter radius in 2006 is below and above the sample median, respectively. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Remark: Our results are robust to including all retailer types in the estimation

Table S3.3: Results from estimating equation (1) among all retailer types

	3 nearest neighbors	400-meter radius
	(1)	(2)
DID estimates:		
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)	-0.029***	
	(0.008)	
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)	-0.034**	
	(0.013)	
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.066***	-0.076***
	(0.019)	(0.015)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.060***	-0.038*
	(0.022)	(0.023)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.011	-0.025
	(0.016)	(0.017)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	-0.008	0.031
	(0.027)	(0.022)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	0.000	0.033*
	(0.019)	(0.019)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	0.008	-0.006
	(0.023)	(0.017)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.019	0.015
	(0.021)	(0.020)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	0.003	0.035*
	(0.034)	(0.021)
Pre-treatment trends:		
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.011	-0.040
	(0.027)	(0.033)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.008	0.011
	(0.018)	(0.015)
Observations	3,851	3,280
R^2	0.905	0.913

NOTES: Estimates of θ based on the estimation of equation (1) among all retailer types: traditional pharmacies, supermarkets and outlets. Column 1 takes the main competitors of retailer i as its 3 nearest neighbors. Column 2 considers as main competitors of retailer i all retailers located within a 400-meter radius. All models include year, drug, and retailer fixed-effects. Standard errors shown in parenthesis are clustered at the retailer level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Remark: Our results are robust to restricting the estimation to pharmacies whose competitors are all in the control group

Table S3.4: Results from estimating equation (1) among pharmacies whose competitors are all in the control group

	3 nearest neighbors	400-meter radius
	(1)	(2)
DID estimates:		
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)	-0.026***	
	(0.009)	
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)	-0.038***	
	(0.014)	
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.049**	-0.073***
	(0.020)	(0.015)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.058***	-0.037
	(0.020)	(0.023)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.015	-0.024
	(0.017)	(0.018)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	-0.006	0.034
	(0.025)	(0.022)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	0.000	0.034*
	(0.022)	(0.019)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	0.011	-0.003
	(0.023)	(0.017)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.015	0.017
	(0.021)	(0.020)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	-0.001	0.0.37*
	(0.028)	(0.021)
Pre-treatment trends:		
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.022	0.014
	(0.023)	(0.015)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.000	0.010
	(0.017)	(0.015)
Observations	2,455	2,764
R^2	0.915	0.915

NOTES: Estimates of θ based on the estimation of equation (1) among pharmacies whose competitors are all in the control group. Column 1 takes the main competitors of pharmacy i as its 3 nearest neighbors. Column 2 considers as main competitors of pharmacy i all retailers located within a 400-meter radius. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Remark: Our results are robust to restricting the estimation to a balanced panel of pharmacies

Table S3.5: Results from estimating equation (1) in a balanced panel of pharmacies

	3 nearest neighbors	400-meter radius
	(1)	(2)
DID estimates:		
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)	-0.022***	
	(0.008)	
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)	-0.037***	
	(0.013)	
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.046**	-0.071***
	(0.020)	(0.015)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.057***	-0.035
	(0.020)	(0.023)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.011	-0.021
	(0.017)	(0.019)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	-0.005	0.039
	(0.025)	(0.025)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	0.000	0.038*
	(0.021)	(0.021)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	0.014	-0.011
	(0.023)	(0.018)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.016	0.014
	(0.021)	(0.020)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	-0.000	0.038*
	(0.028)	(0.021)
Pre-treatment trends:		
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.016	-0.037
	(0.023)	(0.034)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	0.002	0.015
	(0.017)	(0.015)
Observations	2,265	2,043
R^2	0.923	0.923

NOTES: Estimates of θ based on the estimation of equation (1) among pharmacies who are observed at all time periods (2006, 2010, and 2015). Column 1 takes the main competitors of pharmacy i as its 3 nearest neighbors. Column 2 considers as main competitors of pharmacy i all retailers located within a 400-meter radius. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Remark: Our results are robust to including pharmacies experiencing multiple treatments in the estimation

Table S3.6: Results from estimating equation (1) with non-mutually exclusive treatments

	3 nearest neighbors	400-meter radius
	(1)	(2)
DID estimates:		
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)	-0.027***	
	(0.008)	
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)	-0.038***	
	(0.013)	
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.064***	-0.077***
	(0.019)	(0.015)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.064***	-0.040*
	(0.022)	(0.023)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.018	-0.061***
	(0.015)	(0.021)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	0.013	0.030
	(0.020)	(0.022)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	-0.005	0.031
	(0.010)	(0.019)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	0.009	-0.007
	(0.023)	(0.017)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.015	0.014
	(0.021)	(0.020)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	-0.004	0.017
	(0.031)	(0.019)
Pre-treatment trends:		
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.012	-0.053**
	(0.024)	(0.021)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.010	0.004
	(0.017)	(0.014)
Observations	3,769	3,679
R^2	0.909	0.909

NOTES: Estimates of θ based on the estimation of equation (1) among pharmacies, without imposing mutually exclusivity of treatment groups. Column 1 takes the main competitors of pharmacy i as its 3 nearest neighbors. Column 2 considers as main competitors of pharmacy i all retailers located within a 400-meter radius. All models include year, drug, and pharmacy fixed-effects as well as interactions between different treatment groups. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Remark: Our results are robust to restricting the estimation to pharmacies whose main competitors do not exit the market

Table S3.7: Results from estimating equation (1) among pharmacies whose main competitors do not exit

	3 nearest neighbors	400-meter radius
	(1)	(2)
DID estimates:		
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)	-0.023**	
	(0.009)	
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)	-0.039***	
	(0.014)	
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.125***	-0.091***
	(0.007)	(0.015)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.056***	-0.046
	(0.008)	(0.028)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.031**	0.007
	(0.015)	(0.021)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	0.055***	0.042**
	(0.007)	(0.018)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	-0.013*	0.037*
	(0.008)	(0.021)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	-0.020	-0.011
	(0.036)	(0.018)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.013	0.011
	(0.029)	(0.021)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	-0.059	0.024
	(0.046)	(0.021)
Pre-treatment trends:		
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.068	-0.027
	(0.050)	(0.030)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.012	0.002
	(0.016)	(0.016)
Observations	1,975	2,631
R^2	0.912	0.914

NOTES: Estimates of θ based on the estimation of equation (1) among pharmacies whose main competitors do not exit the market during the time horizon under analysis. Column 1 takes the main competitors of pharmacy i as its 3 nearest neighbors. Column 2 considers as main competitors of pharmacy i all retailers located within a 400-meter radius. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Remark: Statistical significance is often lost when estimating our model in a PS-matched sample using local linear regression

Table S3.8: Results from estimating equation (1) in a PS-matched sample using local linear regression

	3 nearest neighbors	400-meter radius
	(1)	(2)
DID estimates:		
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.055	-0.053**
	(0.056)	(0.026)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.080*	-0.010
	(0.048)	(0.031)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.030	0.008
	(0.044)	(0.030)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	0.019	0.011
	(0.028)	(0.024)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	-0.001	0.024
	(0.050)	(0.027)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	-0.016	0.060**
	(0.066)	(0.024)
Pre-treatment trends:		
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	0.000	0.021
	(0.045)	(0.025)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	0.002	0.040*
	(0.065)	(0.021)
Observations	970	1,180
R^2	0.913	0.904

NOTES: Estimates of θ based on the estimation of equation (1) in a matched sample of pharmacies in the treated groups and pharmacies in the control group. Matching was done on propensity scores using local linear regression. Column 1 takes the main competitors of pharmacy i as its 3 nearest neighbors. Column 2 considers as main competitors of pharmacy i all retailers located within a 400-meter radius. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are bootstrapped using 30 repetitions, drawn cross-sectionally at the pharmacy level in the original sample. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Remark: The statistical significance of ou results is robust to using two-way clustering by drug and pharmacy

Table S3.9: Results from estimating equation (1) with 2-way clustering of standard errors

	3 nearest neighbors	400m radius
	(1)	(2)
DiD estimates:		
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)	-0.027	
	(0.023)	
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)	-0.038**	
	(0.015)	
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.064***	-0.076**
	(0.012)	(0.019)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.064***	-0.038**
	(0.012)	(0.013)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.015	-0.025
	(0.010)	(0.013)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	0.013	0.031
	(0.009)	(0.018)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	-0.005	0.033**
	(0.005)	(0.011)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	0.009	-0.006
	(0.022)	(0.013)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.015	0.015
	(0.015)	(0.016)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	-0.001	0.035
	(0.030)	(0.019)
Pre-treatment trends:		
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.009	-0.040
	(0.024)	(0.031)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.007	0.011
	(0.021)	(0.016)
Observations	3,429	3,280
R^2	0.912	0.919

NOTES: Estimates of θ based on the estimation of equation (1) among traditional pharmacies. In column 1 the main competitors of pharmacy i are its 3 nearest neighbors. In column 2 the main competitors of pharmacy i are the retailers located with a 400-meter radius. All specifications include year, drug, and pharmacy fixed-effects. Standard errors are shown in parenthesis are clustered at the pharmacy and drug level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Remark: We find no evidence that experiencing non-pharmacy entry makes pharmacies more likely to exit the market before the next data collection round

Table S3.10: Does experiencing non-pharmacy entry make pharmacies more likely to exit next period?

	Number of nearest neighbors (N)		Radius (R)		
	4	5	400m	600m	800m
	(1)	(2)	(3)	(4)	(5)
Supermarket entry before 2006					
Supermarket entry in 2006/10				-0.132	-0.033
				(0.0123)	(0.101)
Outlet entry before 2006	-0.137	0.071	0.006	0.095	0.042
	(0.135)	(0.130)	(0.099)	(0.073)	(0.096)
Outlet entry in 2006/10	-0.143	-0.109	-0.128	-0.121	-0.145*
	(0.111)	(0.091)	(0.086)	(0.085)	(0.086)
Observations	380	356	368	328	265

NOTES: Marginal effects from a logit regression of a binary variable equaling 1 for pharmacies that exited the market before the next round of data collection and 0 otherwise, on treatment group indicators, parish fixed-effects, and year fixed-effects. Columns 1 and 2 take the main competitors of pharmacy i as its N nearest neighbors, with N=4 and N=5, respectively. For N=1,2,3 there is not enough variation to estimate the model because none of pharmacies experiencing non-pharmacy entry among 1,2, and 3 nearest competitors exits the market. Columns 3, 4, and 5 take all retailers located within a 400, 600, and 800-meter radius as main competitors of pharmacy i. Regardless of the definition of main competitors used, no pharmacies experiencing supermarket entry among their main competitors before 2006 exited the market so the corresponding coefficients cannot be estimated. Similarly, when using $N = 4$, $N = 5$, and $R = 400$, none of the pharmacies that experienced entry of a supermarket among their main competitors between 2006 and 2010 exited the market so these coefficients cannot be estimated either. All models include year and parish fixed-effects. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

S4 Results for other definitions of main competitors

Remark: Enlarging the set of main competitors of a pharmacy (by including a larger number of nearest neighbors or increasing the radius distance) yields few statistically significant price effects, suggesting competition in the OTC market is fairly localized.

Table S4.1: Sample composition for alternative definitions of main competitors

Main competitors	Group	2006	2010	2015
Nearest neighbor	Control Group	190	258	234
	Supermarket entry before 2006	0	0	0
	Supermarket entry in 2006/10	4	4	4
	Supermarket entry in 2010/15	4	4	4
	Outlet entry before 2006	8	8	8
	Outlet entry in 2006/10	10	10	10
	Outlet entry in 2010/15	15	15	15
	Total	231	299	275
2 nearest neighbors	Control Group	167	235	212
	Supermarket entry before 2006	1	1	1
	Supermarket entry in 2006/10	3	3	3
	Supermarket entry in 2010/15	8	8	8
	Outlet entry before 2006	9	9	9
	Outlet entry in 2006/10	8	8	8
	Outlet entry in 2010/15	9	9	9
	Total pharmacies	205	273	250
4 nearest neighbors	Control Group	138	207	185
	Supermarket entry before 2006	3	3	3
	Supermarket entry in 2006/10	5	5	5
	Supermarket entry in 2010/15	19	19	19
	Outlet entry before 2006	13	12	12
	Outlet entry in 2006/10	10	10	9
	Outlet entry in 2010/15	18	18	18
	Total pharmacies	206	274	251

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Table S4.1 – *Continued from previous page*

Main competitors	Group	2006	2010	2015
	Control Group	109	179	159
	Supermarket entry before 2006	0	0	0
5 nearest neighbors	Supermarket entry in 2006/10	5	5	5
	Supermarket entry in 2010/15	18	18	18
	Outlet entry before 2006	10	8	7
	Outlet entry in 2006/10	14	14	12
	Outlet entry in 2010/15	18	18	18
	Total pharmacies	174	242	219
	Control Group	94	166	150
	Supermarket entry before 2006	1	1	1
600m radius	Supermarket entry in 2006/10	9	9	8
	Supermarket entry in 2010/15	12	12	12
	Outlet entry before 2006	13	9	7
	Outlet entry in 2006/10	17	17	14
	Outlet entry in 2010/15	12	12	12
	Total pharmacies	158	226	204
	Control Group	68	141	129
	Supermarket entry before 2006	0	0	0
800m radius	Supermarket entry in 2006/10	9	9	7
	Supermarket entry in 2010/15	8	8	8
	Outlet entry before 2006	12	7	6
	Outlet entry in 2006/10	21	21	18
	Outlet entry in 2010/15	10	10	10
	Total pharmacies	128	196	178

NOTES: The table shows the number of pharmacies included in the estimation sample, for alternative definitions of main competitors of a pharmacy: the N nearest neighbors with N=1,2,4,5 in the top four panels, and the retailers located within a radius R of 600 and 800 meters in the two bottom panels. The lower number of pharmacies in the control group in 2006 is a consequence of missing price data for that year, as discussed in Section 3. In addition, the number of pharmacies used in the estimation sample changes with the definition of main competitors because we are focusing on samples of pharmacies for which each treatment is mutually exclusive. Thus, a longer radius (or more nearest neighbors) means higher chances that a pharmacy falls into more than one treatment group and is excluded from the analysis.

Table S4.2: Testing for differences at baseline for alternative definitions of main competitors

Variable	Control	Eventually Treated	Difference	P-value
Main competitors: nearest neighbor				
Price *Aspirina 500mg* (€)	3.041	2.873	0.167*	0.018
Price *Cêgripe* (€)	4.292	4.273	0.019	0.745
Price *Trifene200* (€)	3.326	3.271	0.055	0.428
Price *Mebocaína Forte* (€)	4.664	4.582	0.082	0.295
Price *Tantum Verde* (€)	4.970	4.864	0.107	0.309
Avg distance to nearest neighbor (km)	0.309	0.434	-0.125*	0.059
Avg time to nearest neighbor (min)	3.729	5.077	-1.348	0.120
Population in census block (as of 2001)	609.516	698.308	-88.792	0.124
Main competitors: 2 nearest neighbors				
Price *Aspirina 500mg* (€)	3.030	3.045	-0.015	0.772
Price *Cêgripe* (€)	4.302	4.273	0.019	0.745
Price *Trifene200* (€)	3.336	3.268	0.069	0.167
Price *Mebocaína Forte* (€)	4.663	4.635	0.028*	0.062
Price *Tantum Verde* (€)	4.972	4.899	0.073	0.037
Avg distance to 2 nearest neighbors (km)	0.154	0.188	-0.034	0.142
Avg time to 2 nearest neighbors (min)	4.406	5.357	-0.951	0.128
Population in census block (as of 2001)	598.024	723.286	-125.262***	0.002
Main competitors: 4 nearest neighbors				
Price *Aspirina 500mg* (€)	3.036	2.997	0.040	0.321
Price *Cêgripe* (€)	4.314	4.224	0.089**	0.013
Price *Trifene200* (€)	3.415	3.307	0.035	0.411
Price *Mebocaína Forte* (€)	4.671	4.667	0.004	0.931
Price *Tantum Verde* (€)	4.979	4.918	0.061	0.356
Avg distance to 4 nearest neighbors (km)	0.311	0.323	-0.012	0.717
Avg time to 4 nearest neighbors (min)	5.796	5.860	-0.064	0.920
Population in census block (as of 2001)	591.058	662.233	-71.175**	0.040

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Table S4.2 – *Continued from previous page*

Variable	Control	Eventually Treated	Difference	P-value
Main competitors: 5 nearest neighbors				
Price *Aspirina 500mg* (€)	3.033	3.013	0.020	0.588
Price *Cêgripe* (€)	4.325	4.260	0.065*	0.063
Price *Trifene200* (€)	3.340	3.326	0.014	0.732
Price *Mebocaína Forte* (€)	4.681	4.697	-0.015	0.725
Price *Tantum Verde* (€)	4.993	4.940	0.053	0.418
Avg distance to 5 nearest neighbors (km)	0.510	0.512	-0.002	0.966
Avg time to 5 nearest neighbors (min)	6.385	6.249	0.136	0.836
Population in census block (as of 2001)	588.156	618.763	-30.608	0.340
Main competitors: 600-meter radius				
Price *Aspirina 500mg* (€)	3.022	3.019	0.002	0.958
Price *Cêgripe* (€)	4.321	4.238	0.084*	0.052
Price *Trifene200* (€)	3.337	3.299	0.039	0.382
Price *Mebocaína Forte* (€)	4.666	4.678	-0.012	0.811
Price *Tantum Verde* (€)	4.987	4.915	0.072	0.308
Number of retailers within radius	10.376	7.108	3.268***	0.002
Population in Census section (as of 2001)	594.101	651.243	-57.142	0.142
Main competitors: 800-meter radius				
Price *Aspirina 500mg* (€)	3.008	3.027	0.019	0.688
Price *Cêgripe* (€)	4.310	4.253	0.057	0.224
Price *Trifene200* (€)	3.324	3.306	0.018	0.697
Price *Mebocaína Forte* (€)	4.657	4.673	-0.016	0.761
Price *Tantum Verde* (€)	4.977	4.884	0.093	0.244
Number of retailers within radius	14.153	10.448	3.705**	0.010
Population in Census section (as of 2001)	588.329	653.103	-64.774	0.151

NOTES: The table conveys the mean of several variables of interest in 2006 for several alternative definitions of main competitors. In the top four panels, the main competitors of a pharmacy are its N nearest neighbors, with N=1,2,4,5, respectively. In the two bottom panels, the main competitors of a pharmacy are all retailers located inside a 600 and 800-meter radius, respectively. For each panel, the first column reports averages across pharmacies belonging to the control group. The second column reports averages across pharmacies which were not yet treated in 2006, but will eventually face the entry of a non-pharmacy amongst their main competitors, thus grouping together pharmacies facing the entry of a supermarket or an outlet either between 2006 and 2010, or between 2010 and 2015. Pharmacies already treated in 2006 is not accounted for in this table because they are not observed prior to treatment. Column 3 computes the difference of columns 1 and 2, and column 4 shows the corresponding two-sided p-value.

Table S4.3: Results from estimating equation (1) with alternative definitions of main competitors

	Number of nearest neighbors				Radius	
	1	2	4	5	600m	800m
	(1)	(2)	(3)	(4)	(5)	(6)
DID estimates:						
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)		-0.038***	-0.037***		-0.036***	
		(0.005)	(0.006)		(0.007)	
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)		-0.023***	-0.023***		-0.020***	
		(0.005)	(0.006)		(0.008)	
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.063**	-0.094***	-0.082***	-0.049	-0.022	-0.037
	(0.027)	(0.016)	(0.023)	(0.031)	(0.026)	(0.032)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.062**	-0.095***	-0.050*	-0.044*	-0.038*	-0.030
	(0.028)	(0.017)	(0.028)	(0.032)	(0.020)	(0.023)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.035*	-0.037***	0.029	-0.028**	-0.010	-0.045*
	(0.020)	(0.012)	(0.018)	(0.015)	(0.021)	(0.023)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	0.007	-0.016	0.044**	0.046***	0.014	-0.024
	(0.016)	(0.024)	(0.018)	(0.014)	(0.021)	(0.022)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	0.001	-0.025	0.008	0.016	0.030	0.029
	(0.019)	(0.023)	(0.021)	(0.020)	(0.021)	(0.036)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	-0.017**	-0.034	-0.015	-0.005	-0.002	0.007
	(0.007)	(0.023)	(0.029)	(0.025)	(0.018)	(0.016)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.031***	-0.027	-0.001	0.028	0.012	0.009
	(0.005)	(0.020)	(0.024)	(0.020)	(0.018)	(0.015)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	0.003	-0.014	-0.018	-0.004	0.005	-0.007
	(0.053)	(0.033)	(0.024)	(0.019)	(0.022)	(0.022)
Pre-treatment trends:						
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.022	-0.026	-0.027	-0.027	0.002	-0.038
	(0.022)	(0.026)	(0.023)	(0.019)	(0.029)	(0.033)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.053***	-0.017	-0.003	-0.000	-0.000	-0.012
	(0.020)	(0.018)	(0.012)	(0.011)	(0.017)	(0.016)
Observations	3,709	3,624	3,309	3,160	2,925	2,497
R^2	0.910	0.911	0.912	0.913	0.911	0.914

NOTES: Estimates of θ based on the estimation of equation (1) using alternative measures of main competitors. Columns 1 to 4 take the main competitors of pharmacy i as its N nearest neighbors, with $N = 1, 2, 4, 5$, respectively. Columns 5 and 6 consider all retailers located within a radius of 600 and 800 meters, respectively, as main competitors. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Table S4.4: Results from estimating equation (1) among the most spatially isolated pharmacies in 2006

	Number of nearest neighbors				Radius	
	1	2	4	5	600m	800m
	(1)	(2)	(3)	(4)	(5)	(6)
DID estimates:						
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)		-0.032***	-0.034***		-0.042***	
		(0.008)	(0.009)		(0.009)	
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)		-0.025***	-0.020*		-0.027**	
		(0.008)	(0.010)		(0.011)	
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)		-0.070***	-0.102***		-0.059**	-0.058**
		(0.009)	(0.020)		(0.027)	(0.027)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.058**	-0.116***	-0.077***	-0.55*	-0.049**	-0.043**
	(0.028)	(0.010)	(0.021)	(0.032)	(0.022)	(0.019)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.061**	-0.045***	-0.029*	-0.056**	-0.038	0.040*
	(0.029)	(0.016)	(0.016)	(0.025)	(0.034)	(0.023)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	-0.029	0.035***	0.028**	-0.055**	-0.006	0.030*
	(0.027)	(0.013)	(0.014)	(0.025)	(0.030)	(0.018)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	0.037**	0.019	-0.012	0.031**	-0.027**	0.096
	(0.016)	(0.031)	(0.016)	(0.013)	(0.013)	(0.062)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	0.032	-0.025	-0.023	-0.005	-0.050**	0.001
	(0.040)	(0.026)	(0.028)	(0.034)	(0.023)	(0.028)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	-0.012	-0.015	-0.006	0.023	-0.017	0.028
	(0.009)	(0.024)	(0.027)	(0.031)	(0.025)	(0.022)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	0.131***	0.059	-0.093***	-0.067*	0.020	-0.070
	(0.009)	(0.052)	(0.026)	(0.035)	(0.077)	(0.047)
Pre-treatment trends:						
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.040***	-0.035	-0.040	-0.050	-0.050	-0.033
	(0.012)	(0.037)	(0.028)	(0.047)	(0.064)	(0.042)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.091***	-0.014	-0.010	-0.032	-0.034	-0.035***
	(0.008)	(0.037)	(0.009)	(0.032)	(0.056)	(0.012)
Observations	1,288	1,292	1,137	903	933	733
R^2	0.916	0.919	0.921	0.921	0.914	0.922

NOTES: Estimates of θ based on the estimation of equation (1) among pharmacies located in areas where market structure is the most concentrated (ie. closest to a monopoly). Columns 1 to 4 take the main competitors of pharmacy i as its N nearest neighbors, with $N = 1, 2, 4, 5$, respectively. Columns 5 and 6 consider all retailers located within a radius of 600 and 800 meters, respectively, as main competitors. In columns 1 to 4 the samples were restricted to pharmacies whose walking time (in minutes) to their Nth nearest neighbor is above the sample mean in 2006. In columns 5 and 6 the samples were restricted to pharmacies whose number of competitors within the relevant radius in 2006 is below the sample median for the relevant radius distance. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Table S4.5: Results from estimating equation (1) among the least spatially isolated pharmacies in 2006

	Number of nearest neighbors				Radius	
	1	2	4	5	600m	800m
	(1)	(2)	(3)	(4)	(5)	(6)
DID estimates:						
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)						
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)						
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)			-0.086**		0.040	0.008
			(0.034)		(0.036)	(0.074)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)			-0.028		-0.044	0.015
			(0.025)		(0.038)	(0.038)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.048***	-0.031	-0.032	-0.019	-0.025	-0.056
	(0.009)	(0.023)	(0.022)	(0.022)	(0.031)	(0.050)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	-0.036*	-0.041	0.047**	0.065***	0.025	-0.023
	(0.018)	(0.032)	(0.020)	(0.021)	(0.033)	(0.023)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	-0.004	-0.053**	0.013	0.050*	0.062***	0.019
	(0.009)	(0.021)	(0.023)	(0.026)	(0.019)	(0.038)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)		-0.057	-0.011	0.018	0.042*	0.009
		(0.036)	(0.042)	(0.031)	(0.024)	(0.021)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)		-0.078***	-0.018	0.043*	0.037	-0.014
		(0.019)	(0.035)	(0.024)	(0.026)	(0.022)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	-0.072***	-0.054	-0.023	0.001	0.001	0.008
	(0.009)	(0.034)	(0.024)	(0.023)	(0.024)	(0.024)
Pre-treatment trends:						
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	0.053***	0.026*	-0.021	0.018	0.003	-0.042
	(0.009)	(0.013)	(0.021)	(0.025)	(0.040)	(0.055)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.013	-0.018	-0.005	0.006	0.008	0.012
	(0.009)	(0.020)	(0.012)	(0.015)	(0.020)	(0.020)
Observations	1,102	1,497	1,856	1,099	924	760
R^2	0.908	0.915	0.919	0.919	0.925	0.926

NOTES: Estimates of θ based on the estimation of equation (1) among pharmacies located in areas where market structure is the least concentrated (ie. furthest from a monopoly). Columns 1 to 4 take the main competitors of pharmacy i as its N nearest neighbors, with $N = 1, 2, 4, 5$, respectively. Columns 5 and 6 consider all retailers located within a radius of 600 and 800 meters, respectively, as main competitors. In columns 1 to 4 the samples were restricted to pharmacies whose walking time (in minutes) to their Nth nearest neighbor is below the sample mean in 2006. In columns 5 and 6 the samples were restricted to pharmacies whose number of competitors within the relevant radius in 2006 is above the sample median for the relevant radius distance. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Table S4.6: Results from estimating equation (1) among all retailer types

	Number of nearest neighbors				Radius	
	1	2	4	5	600m	800m
	(1)	(2)	(3)	(4)	(5)	(6)
DID estimates:						
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)		-0.039***	-0.041***		-0.036***	
		(0.006)	(0.006)		(0.007)	
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)		-0.020***	-0.022***		-0.020***	
		(0.006)	(0.006)		(0.008)	
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.064**	-0.096***	-0.123***	-0.053*	-0.022	-0.037
	(0.027)	(0.016)	(0.037)	(0.031)	(0.026)	(0.032)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.058**	-0.092***	-0.107*	-0.042*	-0.038*	-0.030
	(0.028)	(0.017)	(0.056)	(0.023)	(0.020)	(0.023)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.032	-0.034***	-0.027	-0.026*	-0.010	-0.045*
	(0.021)	(0.012)	(0.018)	(0.015)	(0.021)	(0.023)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	0.006	-0.025	0.012	0.043***	0.014	-0.024
	(0.016)	(0.024)	(0.030)	(0.014)	(0.021)	(0.022)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	0.004	-0.018	-0.004	0.018	0.030	0.029
	(0.019)	(0.023)	(0.024)	(0.020)	(0.021)	(0.036)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	-0.003	-0.029	-0.019	-0.004	-0.002	0.007
	(0.014)	(0.021)	(0.029)	(0.024)	(0.018)	(0.016)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.041***	-0.020	0.001	0.032*	0.012	0.009
	(0.009)	(0.020)	(0.024)	(0.019)	(0.018)	(0.015)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	0.006	-0.010	-0.016	-0.002	0.005	-0.007
	(0.053)	(0.033)	(0.024)	(0.020)	(0.022)	(0.022)
Pre-treatment trends:						
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.023	-0.027	-0.031	-0.030	-0.000	-0.038
	(0.022)	(0.026)	(0.023)	(0.019)	(0.017)	(0.033)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.054***	-0.018	-0.006	-0.004	0.008	-0.012
	(0.020)	(0.018)	(0.012)	(0.012)	(0.020)	(0.016)
Observations	4,141	4,056	3,716	3,542	2,925	2,497
R^2	0.904	0.904	0.905	0.906	0.911	0.914

NOTES: Estimates of θ based on the estimation of equation (1) among all retailer types: traditional pharmacies, supermarkets and outlets. Columns 1 to 4 take the main competitors of pharmacy i as its N nearest neighbors, with $N = 1, 2, 4, 5$, respectively. Columns 5 and 6 consider all retailers located within a radius of 600 and 800 meters, respectively, as main competitors. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are clustered at the retailer level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Table S4.7: Results from estimating equation (1) among pharmacies whose competitors are all in the control group

	Number of nearest neighbors				Radius	
	1	2	4	5	600m	800m
	(1)	(2)	(3)	(4)	(5)	(6)
DID estimates:						
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)		-0.036***	-0.054***		-0.030***	
		(0.006)	(0.019)		(0.009)	
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)		-0.022***	-0.033*		-0.022**	
		(0.006)	(0.018)		(0.010)	
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.064**	-0.093***	-0.059***	-0.048	-0.017	-0.038
	(0.027)	(0.017)	(0.022)	(0.032)	(0.026)	(0.034)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.063**	-0.094***	-0.057**	-0.048**	-0.040*	-0.034
	(0.028)	(0.018)	(0.025)	(0.024)	(0.021)	(0.026)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.037*	-0.036***	-0.005	-0.031**	-0.012	-0.049*
	(0.021)	(0.013)	(0.020)	(0.016)	(0.022)	(0.026)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	0.006	-0.015	0.024	0.047***	0.020	-0.025
	(0.016)	(0.024)	(0.021)	(0.016)	(0.021)	(0.024)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	-0.001	-0.024	0.010	0.013	0.028	0.025
	(0.019)	(0.023)	(0.021)	(0.021)	(0.022)	(0.038)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	-0.018**	-0.033	-0.012	-0.004	0.004	0.006
	(0.007)	(0.023)	(0.030)	(0.025)	(0.019)	(0.020)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.029***	-0.025	0.003	0.024	0.010	0.005
	(0.006)	(0.021)	(0.024)	(0.025)	(0.018)	(0.020)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	0.001	-0.013	0.001	-0.008	0.003	-0.013
	(0.053)	(0.034)	(0.020)	(0.020)	(0.022)	(0.020)
Pre-treatment trends:						
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.023	-0.025	-0.025	-0.025	0.008	-0.039
	(0.022)	(0.026)	(0.015)	(0.015)	(0.029)	(0.035)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.053***	-0.015	0.001	0.001	0.006	0.005
	(0.020)	(0.018)	(0.013)	(0.013)	(0.018)	(0.020)
Observations	3,246	2,849	1,858	1,712	1,875	1,486
R^2	0.911	0.910	0.912	0.918	0.913	0.909

NOTES: Estimates of θ based on the estimation of equation (1) among pharmacies whose competitors are all in the control group. Columns 1 to 4 take the main competitors of pharmacy i as its N nearest neighbors, with $N = 1, 2, 4, 5$, respectively. Columns 5 and 6 consider all retailers located within a radius of 600 and 800 meters, respectively, as main competitors. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Table S4.8: Results from estimating equation (1) in a balanced panel of pharmacies

	Number of nearest neighbors				Radius	
	1	2	4	5	600m	800m
	(1)	(2)	(3)	(4)	(5)	(6)
DID estimates:						
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)		-0.034***	-0.052***		-0.031***	
		(0.005)	(0.019)		(0.007)	
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)		-0.023***	0.033*		-0.019**	
		(0.006)	(0.018)		(0.009)	
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.060**	-0.090***	-0.057***	-0.041	-0.035	-0.033
	(0.027)	(0.016)	(0.021)	(0.031)	(0.022)	(0.029)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.060**	-0.095***	-0.057**	-0.041*	-0.045**	-0.029
	(0.028)	(0.018)	(0.024)	(0.024)	(0.018)	(0.021)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.034*	-0.034***	-0.004	-0.023	-0.017	-0.044*
	(0.021)	(0.012)	(0.019)	(0.015)	(0.021)	(0.023)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	0.010	-0.013	0.025	0.054***	0.032	-0.008
	(0.016)	(0.024)	(0.021)	(0.016)	(0.022)	(0.023)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	0.002	-0.024	0.008	0.019	0.037*	0.035
	(0.019)	(0.023)	(0.021)	(0.021)	(0.037)	
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	-0.014*	-0.031	0.010	0.027	-0.012	-0.000
	(0.007)	(0.023)	(0.025)	(0.021)	(0.019)	(0.016)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.032***	-0.026	0.013	0.043**	0.006	0.003
	(0.006)	(0.021)	(0.023)	(0.019)	(0.018)	(0.015)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	0.005	-0.013	0.001	-0.001	0.006	-0.006
	(0.053)	(0.033)	(0.022)	(0.020)	(0.022)	(0.022)
Pre-treatment trends:						
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.019	-0.018	-0.030	-0.017	0.000	-0.031
	(0.022)	(0.026)	(0.019)	(0.020)	(0.028)	(0.034)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.049**	-0.013	0.009	0.009	0.005	-0.005
	(0.020)	(0.018)	(0.012)	(0.012)	(0.017)	(0.016)
Observations	2,460	2,385	2,235	1,923	1,698	1,314
R^2	0.912	0.920	0.921	0.924	0.922	0.928

NOTES: Estimates of θ based on the estimation of equation (1) among pharmacies who are observed at all time periods (2006, 2010, 2015). Columns 1 to 4 take the main competitors of pharmacy i as its N nearest neighbors, with $N = 1, 2, 4, 5$, respectively. Columns 5 and 6 consider all retailers located within a radius of 600 and 800 meters, respectively, as main competitors. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Table S4.9: Results from estimating equation (1) among pharmacies whose main competitors did not exit

	Number of nearest neighbors				Radius	
	1	2	4	5	600m	800m
	(1)	(2)	(3)	(4)	(5)	(6)
DID estimates:						
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)		-0.035***	-0.032***			
		(0.006)	(0.008)			
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)		-0.024***	-0.024***			
		(0.006)	(0.007)			
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.060*	-0.103***	-0.126***	-0.040	-0.023	-0.039
	(0.036)	(0.019)	(0.008)	(0.038)	(0.026)	(0.032)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.041	-0.082***	-0.057***	-0.027	-0.039*	-0.031
	(0.030)	(0.019)	(0.007)	(0.024)	(0.020)	(0.023)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.034*	-0.040***	-0.050*	-0.049*	-0.017	-0.060**
	(0.021)	(0.014)	(0.027)	(0.026)	(0.022)	(0.023)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	0.011	0.046***			0.027	-0.025
	(0.031)	(0.014)			(0.021)	(0.022)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	-0.028	-0.045**			0.043**	0.028
	(0.017)	(0.023)			(0.020)	(0.036)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	-0.016**	-0.055*	-0.022	0.028	-0.003	0.005
	(0.007)	(0.031)	(0.036)	(0.030)	(0.018)	(0.016)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.032***	-0.010	0.012	0.055***	0.010	0.008
	(0.006)	(0.029)	(0.029)	(0.021)	(0.018)	(0.015)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	0.004	-0.022	-0.005	0.017	-0.008	-0.022
	(0.053)	(0.047)	(0.036)	(0.031)	(0.021)	(0.019)
Pre-treatment trends:						
2010×Treated with supermarket in 201015	-0.021	-0.042	-0.070**	-0.081***	-0.006	-0.053
	(0.022)	(0.046)	(0.029)	(0.029)	(0.030)	(0.033)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.052***	-0.025	-0.010	0.001	-0.005	-0.018
	(0.020)	(0.020)	(0.013)	(0.016)	(0.018)	(0.017)
Observations	3,099	2,448	1,532	1,242	2,675	2,412
R^2	0.910	0.911	0.917	0.918	0.910	0.915

NOTES: Estimates of θ based on the estimation of equation (1) among pharmacies whose main competitors do not exit the market during the time horizon under analysis. Columns 1 to 4 take the main competitors of pharmacy i as its N nearest neighbors, with $N = 1, 2, 4, 5$, respectively. Columns 5 and 6 consider all retailers located within a radius of 600 and 800 meters, respectively, as main competitors. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Table S4.10: Results from estimating equation (1) with non-mutually exclusive treatments

	Number of nearest neighbors				Radius	
	1	2	4	5	600m	800m
	(1)	(2)	(3)	(4)	(5)	(6)
DID estimates:						
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)		-0.038***	-0.036***	-0.032	-0.037***	-0.052***
		(0.005)	(0.006)	(0.024)	(0.007)	(0.014)
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)		-0.023***	-0.021***	-0.049***	-0.021***	-0.038***
		(0.005)	(0.006)	(0.019)	(0.008)	(0.013)
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.063**	-0.094***	-0.081***	-0.048	-0.023	-0.037
	(0.027)	(0.016)	(0.023)	(0.031)	(0.026)	(0.032)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.062**	-0.095***	-0.048*	-0.041*	-0.038*	-0.029
	(0.028)	(0.017)	(0.028)	(0.023)	(0.020)	(0.023)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.035*	-0.037***	-0.008	0.010	-0.013	-0.040*
	(0.020)	(0.012)	(0.020)	(0.015)	(0.018)	(0.022)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	0.007	-0.016	0.044**	0.048***	0.013	-0.023
	(0.016)	(0.024)	(0.018)	(0.014)	(0.021)	(0.022)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	0.001	-0.025	0.010	0.019	0.029	0.030
	(0.019)	(0.023)	(0.021)	(0.020)	(0.021)	(0.036)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	-0.017**	-0.034	-0.015	-0.004	-0.003	0.007
	(0.007)	(0.023)	(0.029)	(0.025)	(0.018)	(0.016)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.031***	-0.027	0.001	0.031	0.012	0.010
	(0.005)	(0.020)	(0.024)	(0.020)	(0.017)	(0.015)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	0.003	-0.014	0.001	0.014	0.002	-0.003
	(0.053)	(0.033)	(0.023)	(0.018)	(0.019)	(0.020)
Pre-treatment trends:						
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.022	-0.026	-0.027	-0.022	-0.007	-0.034
	(0.022)	(0.026)	(0.020)	(0.017)	(0.021)	(0.023)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.053***	-0.014	-0.003	0.004	-0.009	-0.008
	(0.020)	(0.033)	(0.012)	(0.012)	(0.016)	(0.017)
Observations	3,769	3,769	3,769	3,769	3,769	3,769
R^2	0.908	0.909	0.909	0.909	0.909	0.909

NOTES: Estimates of θ based on the estimation of equation (1) among pharmacies, without imposing mutually exclusivity of treatment groups. Columns 1 to 4 take the main competitors of pharmacy i as its N nearest neighbors, with $N = 1, 2, 4, 5$, respectively. Columns 5 and 6 consider all retailers located within a radius of 600 and 800 meters, respectively, as main competitors. All models include year, drug, and pharmacy fixed-effects as well as interactions between different treatment groups. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Table S4.11: Results from estimating equation (1) with 2-way clustering of standard errors by drug and pharmacy

	Number of nearest neighbors (N)				Radius	
	1	2	4	5	600m	800m
DiD estimates:						
2010×Supermarket entry before 2006 ($\theta^{super}_{1,2010}$)		-0.038**	-0.037**		-0.036**	
		(0.010)	(0.011)		(0.010)	
2015×Supermarket entry before 2006 ($\theta^{super}_{1,2015}$)		-0.023	-0.023		-0.020	
		(0.027)	(0.028)		(0.030)	
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.063**	-0.094***	-0.082***	-0.049	-0.022	-0.037
	(0.017)	(0.015)	(0.018)	(0.027)	(0.026)	(0.029)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.062**	-0.095***	-0.050	-0.044**	-0.038**	-0.030*
	(0.016)	(0.007)	(0.024)	(0.011)	(0.009)	(0.013)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.035	-0.037***	-0.029**	-0.028*	-0.010	-0.045**
	(0.040)	(0.008)	(0.009)	(0.010)	(0.016)	(0.016)
2010×Outlet entry before 2006 ($\theta^{outlet}_{1,2010}$)	0.007	-0.016	0.044**	0.046**	0.014	-0.024
	(0.012)	(0.021)	(0.011)	(0.016)	(0.021)	(0.016)
2015×Outlet entry before 2006 ($\theta^{outlet}_{1,2015}$)	0.001	-0.025	0.008	0.016	0.030	0.029
	(0.011)	(0.018)	(0.012)	(0.015)	(0.022)	(0.033)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	-0.017**	-0.034	-0.015	-0.005	-0.002	0.007
	(0.009)	(0.022)	(0.029)	(0.028)	(0.014)	(0.018)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.031*	-0.027**	-0.001	0.028	0.012	0.009
	(0.014)	(0.009)	(0.020)	(0.017)	(0.012)	(0.008)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	0.003	-0.014	-0.018	-0.004	0.005	-0.007
	(0.054)	(0.031)	(0.022)	(0.017)	(0.017)	(0.021)
Pre-treatment trends:						
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.022	-0.026	-0.027	-0.027	0.002	-0.038
	(0.020)	(0.022)	(0.020)	(0.017)	(0.026)	(0.030)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.053*	-0.017	-0.003	-0.000	-0.000	-0.012
	(0.024)	(0.021)	(0.009)	(0.008)	(0.014)	(0.006)
Observations	3,709	3,624	3,309	3,160	2,925	2,497
R^2	0.910	0.911	0.912	0.913	0.918	0.921

NOTES: Estimates of θ based on the estimation of equation (1) among traditional pharmacies. Columns 1 to 4 take the main competitors of pharmacy i are its N nearest neighbors, with $N = 1, 2, 4, 5$, respectively. Columns 5 and 6 consider all retailers located within a radius of 600 and 800 meters, respectively, as main competitors. All specifications include year, drug, and pharmacy fixed-effects. Standard errors are shown in parenthesis are clustered at the pharmacy and drug level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table S4.12: Results from estimating equation (1) in PS-matched samples of pharmacies using single neighbor matching

	Number of nearest neighbors (N)				Radius (R)	
	1	2	4	5	600m	800m
	(1)	(2)	(3)	(4)	(5)	(6)
DID estimates:						
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$)	-0.060***	-0.079***	-0.037*	-0.048	-0.007	-0.045
	(0.022)	(0.025)	(0.020)	(0.041)	(0.029)	(0.030)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.055***	-0.094***	-0.038	-0.048***	-0.027	-0.036
	(0.020)	(0.027)	(0.025)	(0.018)	(0.024)	(0.024)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.029*	-0.036***	-0.017	-0.032	-0.001	-0.039
	(0.015)	(0.008)	(0.015)	(0.020)	(0.029)	(0.028)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	-0.015**	-0.020	0.029	-0.004	0.017	-0.003
	(0.007)	(0.021)	(0.021)	(0.027)	(0.023)	(0.022)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.037**	-0.025	0.011	0.025	0.025	0.016
	(0.018)	(0.020)	(0.020)	(0.022)	(0.022)	(0.024)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	0.009	-0.012	-0.012	-0.005	0.004	-0.015
	(0.062)	(0.025)	(0.022)	(0.021)	(0.025)	(0.025)
Pre-treatment trends:						
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.020	-0.011	0.017	-0.025	0.013	-0.051*
	(0.018)	(0.025)	(0.020)	(0.023)	(0.030)	(0.028)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.050**	-0.002	0.039***	0.001	0.012	-0.029
	(0.023)	(0.014)	(0.007)	(0.021)	(0.027)	(0.021)
Observations	390	830	1,090	1,600	1,400	1,310
R^2	0.916	0.905	0.903	0.913	0.905	0.933

NOTES: Estimates of θ based on the estimation of equation (1) on a matched sample of pharmacies, with matching done on propensity scores using single nearest-neighbor matching. Columns 1 to 4 take the main competitors of pharmacy i as its N nearest neighbors, with $N = 1, 2, 4, 5$, respectively. Columns 5 and 6 consider all retailers located within a radius of 600 and 800 meters, respectively, as main competitors. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are bootstrapped using 30 repetitions, drawn cross-sectionally at the pharmacy level in the original sample. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Table S4.13: Results from estimating equation (1) in PS-matched samples of pharmacies using local linear regression

	Number of nearest neighbors (N)				Radius (R)	
	1	2	4	5	600m	800m
	(1)	(2)	(3)	(4)	(5)	(6)
DID estimates:						
2010×Supermarket entry in 2006/10 ($\theta^{super}_{2,2010}$) -0.060	-0.074**	-0.039	-0.034	-0.014	-0.047	
	(0.056)	(0.037)	(0.034)	(0.041)	(0.030)	(0.031)
2015×Supermarket entry in 2006/10 ($\theta^{super}_{2,2015}$)	-0.055	-0.092	-0.032	-0.040**	-0.027	-0.044*
	(0.067)	(0.057)	(0.037)	(0.019)	(0.025)	(0.026)
2015×Supermarket entry in 2010/15 ($\theta^{super}_{3,2015}$)	-0.029	-0.034	0.004	-0.024	-0.001	-0.047*
	(0.065)	(0.043)	(0.033)	(0.018)	(0.026)	(0.028)
2010×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2010}$)	-0.015	-0.014	0.015	0.003	0.026	-0.006
	(0.050)	(0.053)	(0.058)	(0.026)	(0.024)	(0.023)
2015×Outlet entry in 2006/10 ($\theta^{outlet}_{2,2015}$)	0.037	-0.024	0.012	0.034	0.030	0.009
	(0.051)	(0.041)	(0.039)	(0.021)	(0.022)	(0.024)
2015×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2015}$)	0.009	-0.010	-0.017	0.002	0.004	-0.022
	(0.062)	(0.051)	(0.027)	(0.021)	(0.025)	(0.025)
Pre-treatment trends:						
2010×Supermarket entry in 2010/15 ($\theta^{super}_{3,2010}$)	-0.020	-0.006	0.026	-0.011	0.013	-0.054*
	(0.052)	(0.046)	(0.037)	(0.024)	(0.030)	(0.028)
2010×Outlet entry in 2010/15 ($\theta^{outlet}_{3,2010}$)	-0.050	0.003	0.033	0.015	-0.012	-0.032
	(0.052)	(0.044)	(0.029)	(0.021)	(0.028)	(0.022)
Observations	390	830	1,030	1,560	1,390	1,580
R^2	0.916	0.905	0.904	0.915	0.905	0.930

NOTES: Estimates of θ based on the estimation of equation (1) on a matched sample of pharmacies, with matching done on propensity scores using local linear regression. Columns 1 to 4 take the main competitors of pharmacy i as its N nearest neighbors, with $N = 1, 2, 4, 5$, respectively. Columns 5 and 5 consider all retailers located within a radius of 600 and 800 meters, respectively, as main competitors. All models include year, drug, and pharmacy fixed-effects. Standard errors shown in parenthesis are bootstrapped using 30 repetitions, drawn cross-sectionally at the pharmacy level in the original sample. $*p < 0.10, **p < 0.05, ***p < 0.01$.

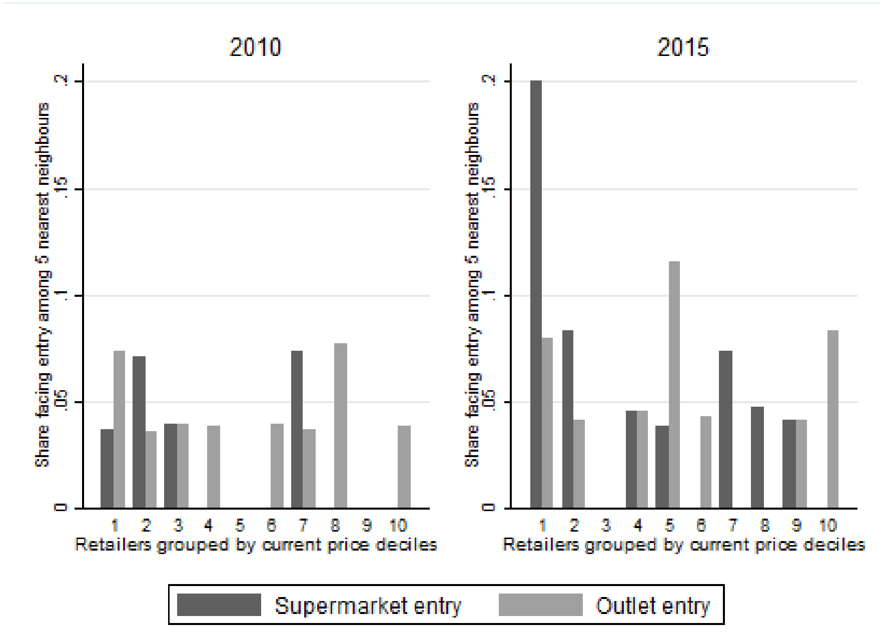
Table S4.14: Results from the estimation of the reduced-form entry model

Main Competitors	$\zeta(P_{t-1})$ specification	Supermarket	Outlet
Nearest neighbor	P_{it-1}	-0.716	-1.937*
		(1.647)	(1.033)
	P_{it-1} relatively to average market price	-0.744	-2.075**
		(1.525)	(1.042)
2 Nearest neighbors	P_{it-1}	-0.885	-0.154
		(5.882)	(0.649)
	P_{it-1} relatively to average market price	-0.802	-0.307
		(3.204)	(0.720)
4 Nearest neighbors	P_{it-1}	-0.912**	-0.593
		(0.448)	(0.917)
	P_{it-1} relatively to average market price	-1.200***	-0.793
		(0.421)	(1.537)
5 Nearest neighbors	P_{it-1}	-0.724	-0.082
		(0.615)	(0.681)
	P_{it-1} relatively to average market price	-0.903	-0.194
		(0.579)	(0.686)
600m radius	P_{it-1}	0.027	0.214
		(0.912)	(0.749)
	P_{it-1} relatively to average market price	-0.511	0.140
		(0.803)	(0.736)
800m radius	P_{it-1}	-0.490	-1.167
		(1.178)	(1.057)
	P_{it-1} relatively to average market price	-0.626	-1.242
		(1.068)	(1.034)

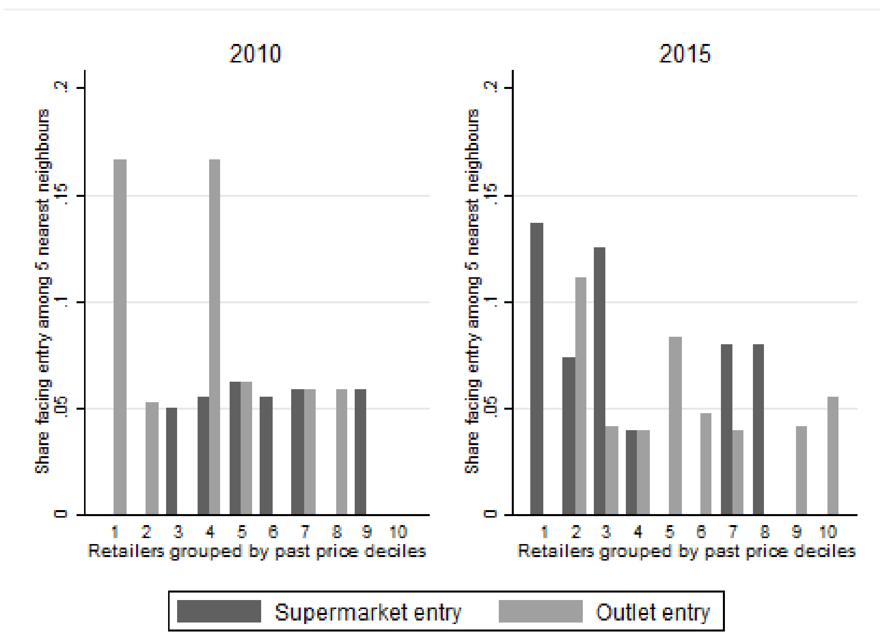
NOTES: Marginal effects of β_1 from RE logit estimation of equation (2), with dependent variable being an indicator for facing the entry of a supermarket (column 1) and an outlet (column 2). There are six panels, each corresponding to an alternative definition of main competitors of pharmacy i. In the top four panels, the main competitors of a pharmacy are its N nearest neighbors, with N=1,2,4,5, respectively. In the two bottom panels, the main competitors of a pharmacy are the retailers located within a radius of 600 and 800 meters, respectively. In each of the panels, the first row tests whether pharmacy i facing the entry of a supermarket/outlet among its main competitors depends on the prices it charged in the previous period, $\zeta(P_{t-1}) = P_{it-1}$. The corresponding figures can be interpreted as the percentage-point change in the probability of facing entry associated with a 1% higher OTC bundle price in the previous period. The second row tests whether it depends on the lagged prices of pharmacy i relatively to the average bundle price in the city of Lisbon. The corresponding figures can be interpreted as the percentage-point change associated with a 1-unit increase in the independent variable. Recall that our estimation sample differs according to how we define the set of main competitors of pharmacy i, so that a different number of observations is used to obtain each marginal effect shown on the table. Standard errors shown in parenthesis are clustered at the pharmacy level. $*p < 0.10, **p < 0.05, ***p < 0.01$.

S5 Additional Plots

Remark: In general, the plots do not suggest that supermarket or outlet entry systematically took place near pharmacies in the highest price deciles or the highest population deciles.



(a) By current price deciles



(b) By past price deciles

Figure S5.1: Share of pharmacies facing non-pharmacy entry among their 3 nearest neighbors, by price deciles

NOTES: In the top panel, pharmacies are grouped into deciles of their current price for the bundle of five OTC drugs considered in our analysis. In the bottom panel, pharmacies are grouped into deciles of their past price for the bundle of five OTC drugs considered in our analysis. In all the four plots the vertical axis indicates the share of pharmacies in each decile who faced the entry of a supermarket or outlet among their three nearest neighbors. We see that entry of supermarkets and outlets took place along all current and past price deciles in both 2010 and 2015, with no clear pattern.

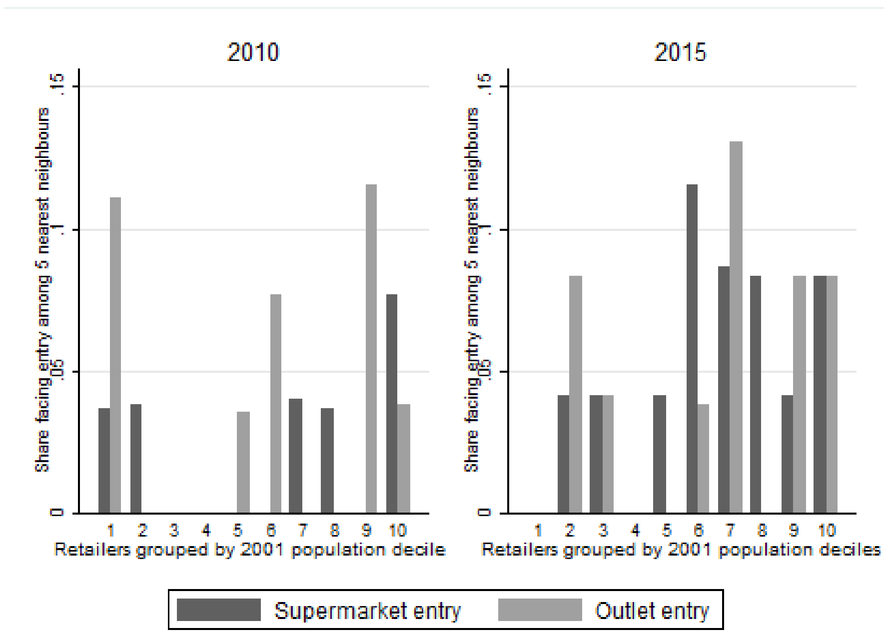
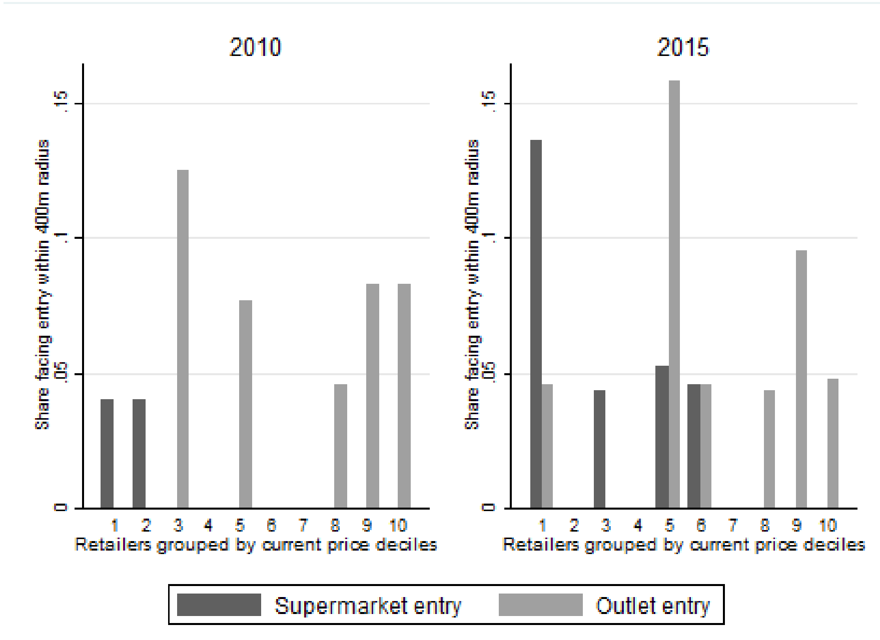
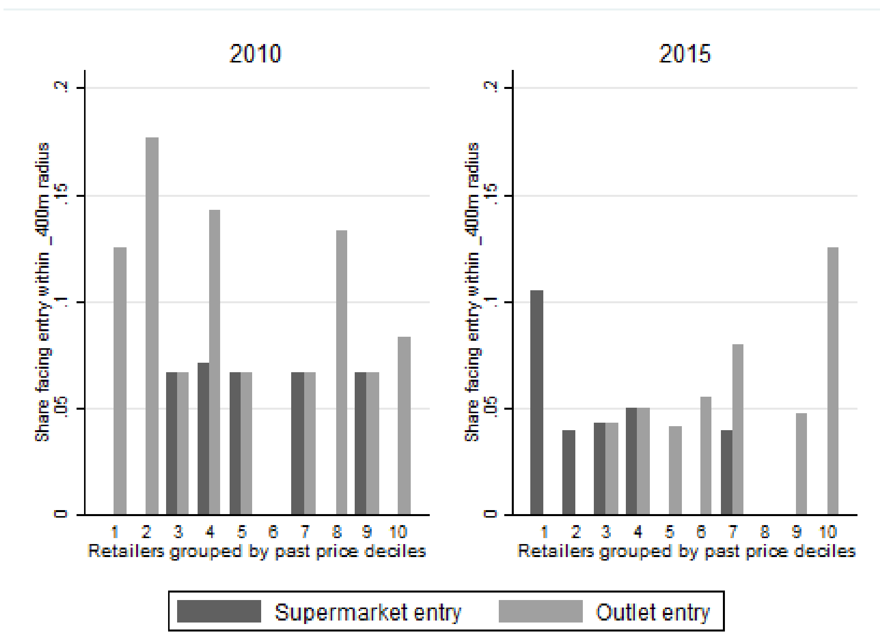


Figure S5.2: Share of pharmacies facing entry of non-pharmacies among the 3 nearest neighbors, by population deciles

NOTES: In order to create this figure, pharmacies are grouped into deciles of their 2001 level of demand, as measured by the resident population in the Census tract where they are located. In all the four plots the vertical axis indicates the share of pharmacies in each decile who faced the entry of a supermarket or outlet among their three nearest neighbors. We again see that entry of supermarkets and outlets took place along all population deciles in both 2010 and 2015, with no clear pattern.



(a) By current price deciles



(b) By past price deciles

Figure S5.3: Share of pharmacies facing non-pharmacy entry within a 400-meter radius, by price deciles

NOTES: In the top panel, pharmacies are grouped into deciles of their current price for the bundle of five OTC drugs considered in our analysis. In the bottom panel, pharmacies are grouped into deciles of their past price for the bundle of five OTC drugs considered in our analysis. In all the four plots the vertical axis indicates the share of pharmacies in each decile who faced the entry of a supermarket or outlet within a 400-meter radius. We see that entry of supermarkets and outlets took place along all current and past price deciles in both 2010 and 2015, with no clear pattern.

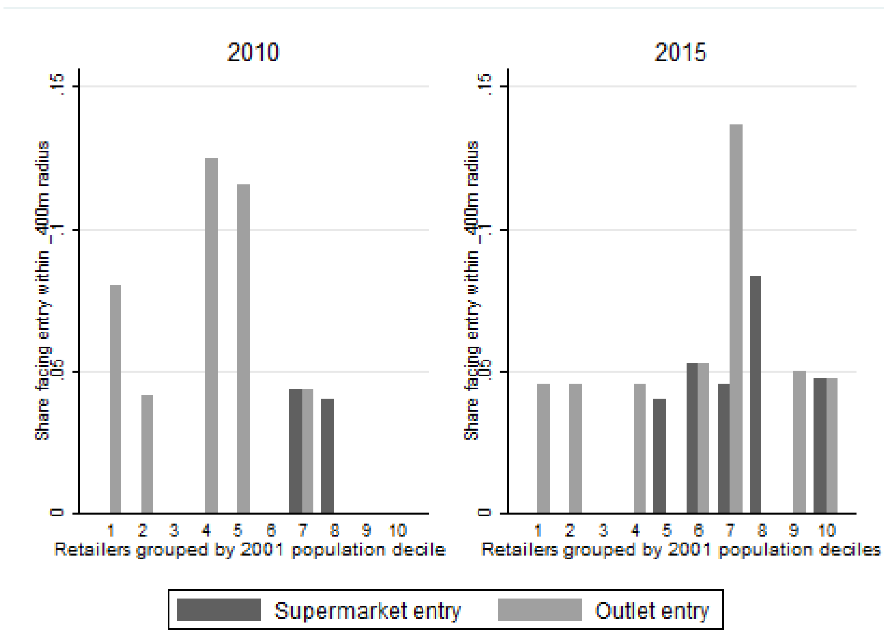
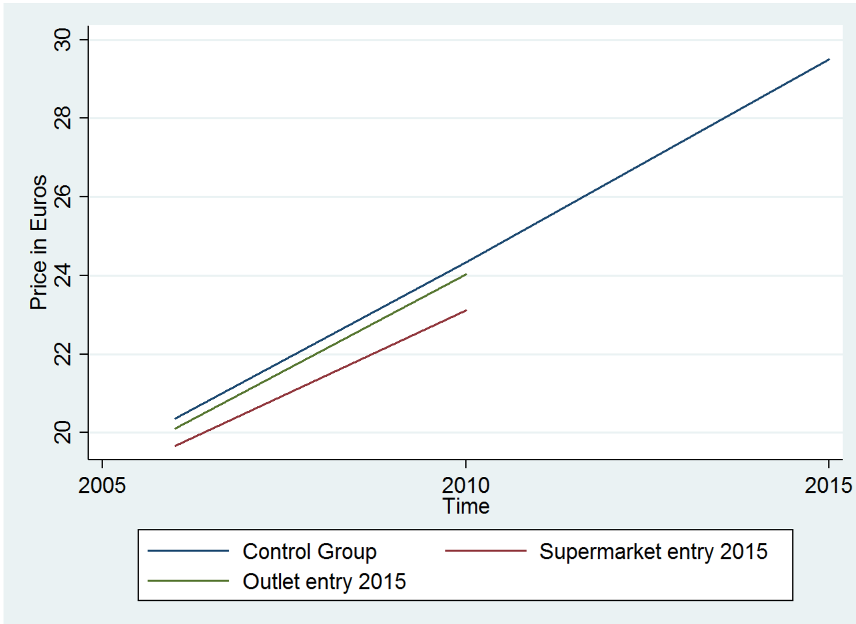
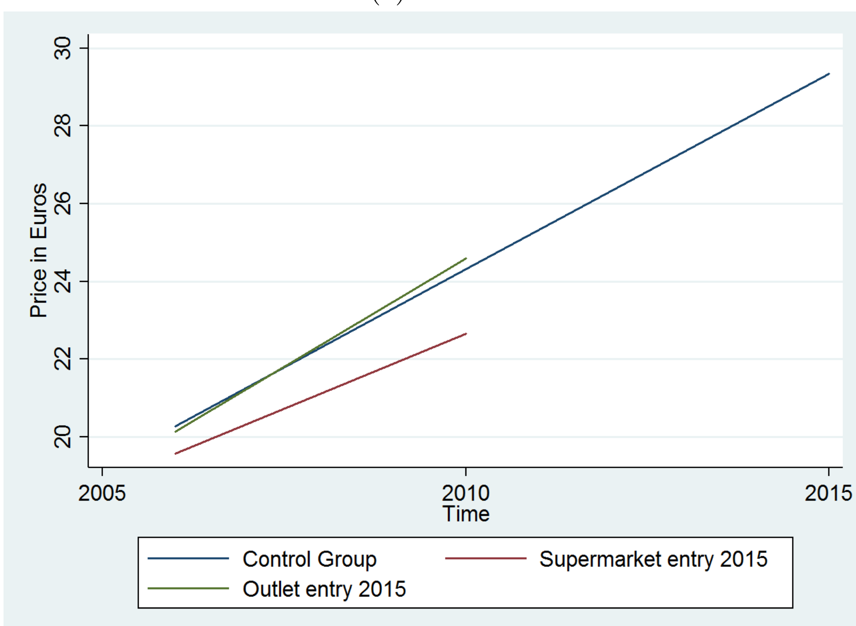


Figure S5.4: Share of pharmacies facing entry of non-pharmacies within a 400-meter radius, by population deciles

NOTES: In order to create this figure, pharmacies are grouped into deciles of their 2001 level of demand, as measured by the resident population in the Census tract where they are located. In all the four plots the vertical axis indicates the share of pharmacies in each decile who faced the entry of a supermarket or outlet within a 400-meter radius. We again see that entry of supermarkets and outlets took place along all population deciles in both 2010 and 2015, with no clear pattern.



(a) $N = 3$



(b) 400-meter radius

Figure S5.5: Plot assessing the plausibility of the common trend assumption

NOTES: The figures compare the evolution of the price of the bundle of 5 drugs in our analysis for three distinct groups: the control group and the two groups of pharmacies who experienced entry of a supermarket or outlet among their main competitors after 2010. In panel (a) main competitors are the 3 nearest neighbors and in panel (b) they are all retailers located within a 400-meter radius. For groups treated after 2010 we observe prices for two pre-treatment periods and can compare their evolution with the control group. Overall, the plots do not suggest distinct price trends across the three groups between 2006 and 2010.

S6 Details on the PSM-DID procedure

We use a propensity score matching difference-in-differences approach to address the possible endogeneity of market structure (Heckman et al., 1997; Smith and Todd, 2005). The underlying intuition for this approach is that by matching treated and untreated pharmacies on their propensity score, that is, their probability of being treated, we make the groups more similar in terms of the observables used in the estimation of the propensity score. Thus, treatment should be random, conditional on the observables used to estimate the propensity score. The crucial assumption we are making with the use of PSM-DID is that, by achieving balancing on observables between the treated and control groups in the matched sample, it makes it more likely that such balancing also extends to unobservables, particularly time-variant unobservables (as time-invariant ones are in any case differenced out by the DID).

Below, we detail the more technical aspects regarding our implementation of PSM-DID.

Just like simple DID, PSM-DID yields estimates of the average treatment effect on the treated. PSM is, however, a data-demanding method. Typical applications of PSM control for a large set of observables in the estimation of the propensity score. While Heckman et al. (1997) shows that models using a richer set of covariates to estimate the propensity scores tend to be less biased, including more covariates also makes is more difficult to define the region of common support (Gibson-Davis and Foster, 2006). There is little guidance on how to balance this trade-off. As noted by Lechner (2010), one should include neither pre-treatment values of the outcome variable nor post-treatment values of independent variables in the estimation of the propensity score. With this in mind, and given that we do not have many variables available to estimate propensity scores, we opted for matching on few variables.

Specifically, we match pharmacies on two measures. These measures are the level of competitive pressure and the level of demand faced prior to experiencing non-pharmacy entry. Pre-entry levels of competitive pressure are measured as of 2006, our first data period. In the specifications using the N nearest neighbors as main competitors, pre-entry levels of competitive pressure are captured by the average walking time (in minutes) to the N nearest retailers in 2006. In the specifications using a radius distance to define the set of main competitors of a pharmacy, the pre-entry level of competitive pressure is given by the number of retailers within that radius in 2006. As for information of pre-entry levels of demand faced by each pharmacy, we complement our dataset with information from Statistics Portugal on the resident population in the Census tract where each pharmacy is located. This information was collected in the 2001 Census of the population.

We categorize the two variables used to estimate the propensity score into quintiles and we used the categorized variables for the matching. Given our unusual setting, featuring multiple time periods and multiple treatments, we proceed as follows. Using a logit model, we estimate the propensity scores separately for each of the four treatment groups and for each year of our data. Therefore, for each model specification, a total of 12(=4 treatments ×3 time periods) PSM procedures were carried out in order to obtain the matched sample of pharmacies. Given the estimated propensity scores, we match each treated pharmacy to its closest untreated PSM-neighbor at each time period (thus allowing us to easily accommodate some exit that we see in the data). We use two alternative methods for matching treated and untreated pharmacies. The first method is single nearest-neighbor within caliper matching with replacement, setting the caliper at 0.02. The second method consists of non-parametric local linear matching, with a bandwidth of 0.8.[26] Finally, we run our model specifications in this matched sample.

While asymptotically the estimates obtained should be independent of the matching method, this is not the case in small samples. In particular, nearest neighbor estimates may be the least biased, but are also less precise. Non-parametric methods, such as local linear regression, in turn, may be more biased, but have higher precision (Gibson-Davis and Foster, 2006). Therefore, if these two matched samples lead to similar price effects following the entry of supermarkets and outlets in the OTC market, then we have more confidence that these effects do not depend on the matching estimators used.

The standard errors of the estimates need to account for the propensity score estimation, the imputation of the common support, the fact that we are matching with replacement, and possibly also the order in which treated pharmacies are matched. A popular approach in this setting is to use bootstrapping methods. We bootstrap the entire procedure, meaning that we bootstrap pharmacies in the original sample, then carry out the estimation of the propensity scores and the matching procedure for each treatment and for each year, and finally estimate equation (1) in the matched sample for each of our bootstrapped samples.

We check covariate balancing between treatment and control groups in the original and matched samples. For the sake of brevity, and since 12 PSM procedures are carried out for each of the models we estimate, we do not show the results of covariate balancing tests or graphs of the common support condition. These are available upon request from the authors. In many, but nor all, of our PSM estimations we are able to achieve a decently balanced sample in terms of the covariates, and we thus assume that balance was achieved also in terms of unobservables.

Overall, the results of the PSM-DID are in line with those from the simple DID, though statistical significance is often lost. This may be a result of the smaller estimation samples used, as for each treated pharmacy we select only one matched untreated pharmacy.

[26]Different choices of caliper, number of neighbors matched, and bandwidth did not change our results.

S7 Overview of pharmacy regulations during 2005-2015

Table S7.1: Overview of pharmacy regulations during the period 2005-2015

Month & year	Legislation	Measures
August 2005	Decree-Law 134/2005	OTC drugs become available outside pharmacies.
February 2007	Ordinance 30B/2007	6% administrative price reduction for Government reimbursed drugs; Reduces margins for wholesalers and pharmacies.
March 2007	Decree-Law 60/2007	Introduces new rules for international price referencing to focus on low-price countries; Regulated drug prices become maximum prices and not fixed prices; Allows discounts at points of the value chain of pharmaceuticals in the ambulatory market (wholesale and retail), and sets a margin at each point.
June 2007	Decree-Law 238/2007	Enlarges the set of OTC drugs available outside pharmacies to include those subject to Government reimbursement; Reimbursement conditional on buying the drugs at a pharmacy.
August 2007	Decree-Law 307/2007	Liberalization of pharmacy ownership rules, with restrictions on the maximum number of pharmacies that can be owned by a single entity and on the professional categories that can own a pharmacy (ie. doctors, pharmaceutical companies, among others, cannot); Introduces exit restrictions (pharmacy opening restrictions were already in place).
November 2007	Ordinance 1430/2007	Changes the geographic criteria for the opening of new pharmacies by lowering number of inhabitants per pharmacy and the minimum distance between pharmacies.
October 2010	Ordinance 104-A/2010	6% administrative price reduction for Government reimbursed drugs.
January 2012	Decree-Law 112/2011	Introduces a new margin scheme for prescription drugs: there were changes in levels as well as the structure of the margins, with the introduction of a regressive margin. Also sets the price cap for the first generic entering the market to 50% of the price of the original drug.
May 2012	Ordinance 137-A/2012	Patients can substitute branded drugs for generics at the pharmacy; Pharmacies which must carry the 5 products with the lowest price in each reference group.
January 2013	Ordinance n 14/2013	Introduces some flexibility in terms of the opening times of pharmacies
February 2013	Decree-Law 34/2013	Demands an annual revision of the set of countries use for reference pricing, in order to ensure downward trend in prices.
February 2014	Decree-Law 19/2014	Further revises the margin scheme for pharmaceuticals by increasing the fixed component and decreasing the proportional component.

NOTES: The table features the most important regulations affecting pharmacy profitability during the years 2005-2015 and it is not exhaustive.