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Abstract

We study entry deregulation in the Finnish pharmacy market where prices, markups, and the number and location of pharmacies are regulated. The number of pharmacies increases substantially with free entry, particularly in urban areas. Although almost all consumers benefit, rural areas and areas with older populations benefit less. The increase in aggregate consumer surplus is dominated by decreases in pharmacy profits and government tax revenue; thus, free entry turns is socially excessive. The prevailing entry restrictions may thus work reasonably well from a total welfare perspective, but with distributional consequences: Incumbent pharmacists benefit at the expense of customers.

JEL Classification: L43, L81, R12

Keywords: Entry regulation, Deregulation, Pharmacies, Pharmaceuticals, Welfare

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Free Entry and Social Inefficiency in Regulated Pharmacy Markets *

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Abstract

We study entry deregulation in the Finnish pharmacy market where prices, markups, and the number and location of pharmacies are regulated. The number of pharmacies increases substantially with free entry, particularly in urban areas. Although almost all consumers benefit, rural areas and areas with older populations benefit less. The increase in aggregate consumer surplus is dominated by decreases in pharmacy profits and government tax revenue; thus, free entry turns is socially excessive. The prevailing entry restrictions may thus work reasonably well from a total welfare perspective, but with distributional consequences: Incumbent pharmacists benefit at the expense of customers.

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1 Introduction

Entry barriers can distort market outcomes, but the benefits of free entry depend on the intensity of competition. In markets where competition is limited, perhaps due to government intervention (e.g., price regulation), the potential gains from free entry may not be fully realized. Conversely, if each new entrant incurs fixed costs, restricting entry may be socially efficient, especially when increased entry does not lead to significant market expansion. Free entry may also have distributional effects, both between and within sectors.

We examine the effects of removing entry barriers in Finland's highly regulated pharmacy sector. Like in many other countries, this sector is governed by strict regulations on entry, pricing and markups, ownership, professional qualifications, and pharmacy locations. We analyze how the pharmacy network would change if entry restrictions were lifted while other regulations remain in place, assessing the trade-offs involved, including their implications for different demographic groups and geographic areas.

We estimate a spatial demand model of pharmacy choice amending the model of Ellickson, Grieco, and Khvastunov (2020) by i) introducing random coefficients for the distaste for travel, ii) using travel time as the distance measure, and iii) including demographic variation in market potential. Second, as in Verboven and Yontcheva (2024), we model variable costs with a production function and, third, estimate fixed entry costs following Eizenberg (2014). Finally, we simulate a counterfactual scenario with free entry.

Our findings indicate that consumers generally dislike longer travel times, although preferences vary significantly between individuals. Entry into neighboring markets can draw less distance-sensitive consumers away from their local markets. Substitution to and from the outside option is limited, implying that new entry results mainly in business stealing instead of market expansion. Our production function estimates reveal the presence of notable economies of scale. Given regulated entry and limited exit, we rely on the incumbents' decision to remain in the market to estimate upper bounds of fixed costs separately for urban and rural pharmacies.

In the free entry counterfactual, the number of pharmacies increases from 818 to 2,277; a 178% rise. Pharmacies tend to enter urban areas with high aggregate demand for pharmaceuticals, while a few rural areas lose access to nearby pharmacy services. However, consumer surplus (CS) increases for 98% of the population, with younger consumers and urban residents gaining the most. Therefore, our counterfactual results suggest that the existing entry regulation leads to an undersupply of pharmacy services in cities, increasing the demand for pharmacies in a few sparsely populated areas.

In line with Mankiw and Whinston (1986), free entry is socially excessive despite the increase in CS. Three mechanisms explain why total welfare does not increase despite benefits to almost all consumers. First, the average increase in CS is modest at 14%. Second, each new pharmacy incurs a fixed cost, resulting in a 188% increase in total fixed costs. Third, new entry leads to minimal market expansion—whereas the number of pharmacies grows by 178%, total sales increase only 8%—resulting in lost economies of scale also in terms of variable costs. Free entry leads to substantial redistribution: Although the pharmacy industry incurs losses, the government absorbs the largest share due to reduced tax revenues. Total annual welfare declines by €76M (7%), with consumers gaining €68M (14%), pharmacies losing €42M (28%), and the government losing €103M (24%).

Our analysis does not support the primary justification for entry regulation—ensuring adequate pharmacy access for all consumers. Entry regulation seems to mitigate the welfare losses associated with excessive entry, suggesting that other forms of regulation—price- and markup-regulation and pharmacy taxation in the case of Finnish pharmacies—may need auxiliary regulation—entry regulation—as a complement. The efficiency gains generated by entry regulation come at the cost of customers, benefiting pharmacists and the government. Excessive free entry could potentially be managed through adjustments to price and pharmacy markup regulation and pharmacy taxation, thereby improving both consumer and total welfare, although the overall impact would depend on the specifics of deregulation.

The regulation of the Finnish pharmacy sector is broadly representative of many European systems. In the European Union (EU), 18 member states regulate pharmacies in a manner similar to Finland.[1] Our counterfactual—relaxing entry restrictions while maintaining price controls—is motivated by recent European pharmacy deregulation reforms, such as Sweden's 2009 reform. Although our analysis focuses on a regulated market, it may also be relevant for regimes without entry restrictions but facing challenges in pharmacy accessibility, such as the United States of America (US), where ongoing discussions address the so-called "pharmacy deserts" (e.g., Ying, Kahn, and Mathis 2022; Catalano, Khan, Chatzipanagiotou, and Pawlik 2024). More broadly, any market where competition leads to limited market expansion may be vulnerable to excessive entry. Such dynamics are observed in sectors including education, healthcare, energy and infrastructure.

Our work relates to three literatures. First, we contribute to research on entry and deregulation. Previous studies have shown that free entry can be excessive when

1. See Online Appendix Section B.1 for further information on EU regulation.

firms possess market power. New entrants may lower prices in unregulated markets but also lead to business stealing, higher total fixed costs, and reduced economies of scale. Spence (1976), Dixit and Stiglitz (1977), and Mankiw and Whinston (1986) theoretically examine excessive entry, whereas Berry and Waldfogel (1999) and Hsieh and Moretti (2003) provide empirical evidence on welfare distortions of free entry in the radio advertising and real estate markets. In contrast, restricted entry has received less attention. Ferrari and Verboven (2010) offer a brief overview of empirical applications and modeling approaches of restricted entry.

Three studies are particularly relevant. Schaumans and Verboven (2008) analyze the Belgian pharmacy market using data on the number and location of pharmacies. They find more pharmacies when entry restrictions are removed, and the removal of these restrictions, combined with a reduction in regulated markups, generates a significant shift in rents toward consumers without harming the availability of pharmacy services. Although their context is similar to ours, we incorporate revenue and cost data and focus specifically on entry restrictions without changes to price regulation. Seim and Waldfogel (2013) and Verboven and Yontcheva (2024) examine entry deregulation in different settings—the former in the Pennsylvania retail alcohol market and the latter in Belgium's Latin notary profession. Both studies find that entry regulation shifts surplus from consumers to the industry, and deregulation improves overall welfare. In contrast, our findings suggest that when market expansion is limited, consumer gains may be smaller than the losses incurred by the industry and the government.

We contribute to the methodology of empirical entry games by introducing the backward sequential myopic entry (BSME) algorithm which builds on the Seim and Waldfogel (2013) sequential myopic entry (SME) algorithm. Our algorithm produces outcomes that satisfy the same conditions as SME but is at least an order of magnitude faster for large-scale problems. Neither algorithm guarantees a Nash equilibrium. Therefore, we assess the counterfactual market structure: Only 1.4% of the entrants would prefer to switch locations. This robustness check improves existing methods for evaluating counterfactual outcomes.

The second literature to which we contribute concerns deregulation. Previous research has shown that deregulation can increase efficiency, reduce costs, stimulate economic growth, and improve consumer welfare (e.g. Winston 1993, 1998). Our contribution lies in examining the distributional implications of relaxing a policy designed to protect consumers from harm.

Finally, our work relates to the literature on local public good provision. Regulated pharmacies play a crucial role in delivering essential public health services, making them comparable to school and hospital networks. School consolidation, for example, can force students to travel longer distances, and demand reallocation can lead to network changes with adverse effects on student outcomes (Engberg, Gill, Zamarro, and Zimmer 2012; Brummet 2014; Beuchert, Humlum, Nielsen, and Smith 2018). Hospital network consolidations can have heterogeneous effects on patient outcomes: Although consolidation may improve the quality of care, increased travel distances can negatively impact health outcomes (Fischer, Royer, and White 2024; Avdic, Lundborg, and Vikström 2024).

The remainder of the article is structured as follows. In Section 2, we present the relevant institutions and regulations. We introduce the data and present descriptive statistics in Section 3, followed by our demand model in Section 4. Section 5 outlines our supply model, whereas Sections 6 and 7 describe the entry game and its results. Finally, Section 8 presents our conclusions.

2 Institutions

We now explain the institutional background and market regulations related to pharmaceutical pricing and reimbursement in Finland, a sparsely populated Nordic country with a population of 5.55M and a population density of 18/sq.km. (48 people/sq.mile). Consumers can buy both prescription (RX) and over-the-counter (OTC) pharmaceuticals only from pharmacies. The role of the online channel is very limited.[2] For more detail on the regulations, see Online Appendix Subsection B.1 and the map of Finland is presented in Online Appendix Subsection B.8.

Pharmacy regulation. Our definition of pharmacies includes only community pharmacies. Pharmacies are subject to strict quantity and location regulations, which we refer to as entry regulation. The Finnish Medicines Agency (Fimea) decides the number of pharmacies in each municipality and pharmacy locations.

A pharmacy must be owned by an independent pharmacist who meets the educational (M.Sc. in Pharmacy) and work experience requirements set by the regulator. Each pharmacist may operate only one main pharmacy and up to three subsidiary pharmacies. Being a main or subsidiary pharmacy does not directly affect the quality of pharmacy services. However, it may be correlated with other factors, such as shelf space or opening hours. When the regulator identifies the need to establish a new pharmacy, it asks qualified pharmacists to apply and selects the most qualified pharmacist for the task.

The structure of the pharmacy industry is highly regulated. Vertical integration between pharmacies, wholesalers, and/or pharmaceutical manufacturers is prohibited and pharmacies are not allowed to form chains. The only exceptions are the

2. According to Kokko, Hyvärinen, and Reinikainen (2024), share of online sales was only 0.5% of all pharmacy sales in Finland.

universities of Helsinki and Eastern Finland, which are permitted to operate their own pharmacy chains due their role in providing pharmacy education. Pharmacists have a dual role: As the owner, a pharmacist is the residual claimant. In addition, a pharmacist can work in the pharmacy as a staff member. This dual role is particularly significant in small pharmacies.

During our observation period in 2021, pharmacists faced regulated markups: The retail prices of RX and OTC pharmaceuticals were given by a government-dictated piecewise linear function of wholesale prices.[3] For non-pharmaceutical products and services, pharmacies are allowed to set prices freely. In 2022, non-pharmaceutical sales were around 7% of the total private pharmacy turnover excluding Value Added Tax (VAT) (Kokko, Hyvärinen, and Reinikainen 2024).

Pharmacies are not subject to the standard corporate tax; instead, they face a revenue-based pharmacy tax. The pharmacy tax applies to the total revenue of all pharmacies owned by the same pharmacist.[4] In addition to the pharmacy tax, pharmaceutical sales are subject to 10% VAT. Pharmacists can engage in legal tax planning by establishing a limited liability company as a side-business for selling non-pharmaceutical products and services. In 2024, 38% pharmacists had such a side-business. We do not model the tax effects of these side-businesses.

All in all, Finnish pharmacy regulations are in line with the international practice: Of the 27 EU countries, 19 (70%) regulate the number, 22 (81%) the location, 11 (41%) the ownership, nine (33%) the horizontal and 16 (59%) the vertical structure of pharmacies, and all but two the education of the pharmacy owner (see Online Appendix B.2).

3. Table B.1 in Online Appendix B.1 describes the markup regulation in detail.
4. We compare standard business taxation and pharmacy taxation in Online Appendix B.1.

Wholesale price regulation. Pharmaceutical manufacturers compete with each other in the wholesale market. Manufacturers face a product-specific maximum wholesale price for reimbursed pharmaceuticals, but are allowed to freely set wholesale prices for OTC and RX drugs that are not included in the reimbursement system. Manufacturers have to commit to uniform national wholesale prices. Uniform wholesale prices and regulated pharmacy markups imply uniform retail prices for pharmaceuticals across pharmacies.

Reimbursement policy. Consumers can receive a reimbursement of 40%, 65%, or 100% of the retail price and the annual out-of-pocket (OOP) expenditure on reimbursed pharmaceuticals is capped. Price regulation incentivizes consumers to substitute for an identical but cheaper product during our sample period (see Kortelainen, Markkanen, Siikanen, and Toivanen 2023).

3 Data

Data Sources. Most of the spatial information is derived from the Statistics Finland Grid Database ("the grid data"). These data divide Finland into 250 m $\times$ 250 m cells and include information on the population and age structure. The representative consumers are assumed to reside at the centroids of the cells.

Our data on pharmacies and their financial statements are from Fimea and contain standard accounting information on pharmacy profits and sales of RX and OTC pharmaceuticals as well as information on the pharmacy's cost structure for 2021. The data allow us to distinguish between labor, rental, and pharmaceutical wholesale purchases. We obtain pharmacy locations from Fimea's pharmacy registry, and geocode these to coordinates with OpenStreetMap data. We complement

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.	P10	P50	P90	N
Panel A: Cell characteristics						
Population	17.02	60.18	1.00	3.00	33.00	321950
City area	0.09	0.29	0.00	0.00	0.00	321950
Distance	13.18	12.23	3.63	10.91	24.13	321950
Choice set size	19.66	21.79	3.00	13.00	46.00	321950
Kela expenditure	453.52	139.49	306.90	440.63	601.08	321950
Market potential	604.23	167.39	428.28	588.76	781.29	321950
Panel B: Pharmacy characteristics (Demand model)						
Pharmaceutical sales	3.32	3.21	0.72	2.45	6.61	818
Inner city	0.35	0.48	0.00	0.00	1.00	818
Outer city	0.13	0.33	0.00	0.00	1.00	818
Rural center	0.08	0.27	0.00	0.00	0.00	818
Supermarket nearby	0.59	0.49	0.00	1.00	1.00	818
Mall nearby	0.21	0.41	0.00	0.00	1.00	818
Healthcare nearby	0.26	0.44	0.00	0.00	1.00	818
Public transport nearby	0.07	0.25	0.00	0.00	0.00	818
Population density	2.14	2.70	0.28	0.99	6.12	818
Jobs density	1.82	4.24	0.11	0.53	4.23	818
Main pharmacy	0.79	0.41	0.00	1.00	1.00	818
YA	0.02	0.15	0.00	0.00	0.00	818
Panel C: Pharmacy characteristics (Cost estimation)						
Pharmaceutical sales	3.85	2.21	1.45	3.48	6.74	402
Material costs	2.77	1.62	1.01	2.53	4.99	402
Gross profits	1.08	0.66	0.40	0.96	1.94	402
Price-cost margin	27.98	10.82	25.41	27.69	30.37	402
Labor costs	0.45	0.23	0.18	0.42	0.75	402
Capital costs	0.09	0.07	0.03	0.07	0.18	402
Net profits	0.15	0.08	0.06	0.14	0.25	402

Notes: This table presents descriptive statistics for consumer home cells (Panel A) and pharmacies (Panels B and C). Panel B includes the pharmacies used for estimating consumers' pharmacy choice, and Panel C the pharmacies used for estimating pharmacy cost function. Kela expenditure in Panel A is the per capita expenditure on RX drugs which we observe at a postal code level All figures in Panel C, except the Price-cost margin, are in €M.

pharmacy data with pharmacy visit and expenditure data at the postal code level from the Finnish Social Insurance Institution (Kela).

We supplement these data with several publicly available data sets. First, we use cell-level information on the community structure and urban/rural classification from Finnish Environment Institute (SYKE). Second, we use open access information on local amenities (e.g., nearby grocery stores and health centers) from various OpenStreetMap contributors. These data are complemented with postal code-level population data from Statistics Finland's Paavo database. We evenly allocate pharmaceutical expenditures into cells within each postal code area. Lastly, we use country boundaries from EuroGeographics, a $1\,\mathrm{km} \times 1\,\mathrm{km}$ population grid from Statistics Finland, and the Helsinki metropolitan area map from the city survey services of Helsinki, Espoo, Vantaa and Kauniainen. For the full list of data sources, see the Online Appendix Subsection B.3. We calculate the distances between cells, pharmacies, and potential entry locations using travel time by car, measured in minutes. Therefore, 'distance' refers to travel time.

Descriptive Statistics. We present cell-level consumer information in Panel A of Table 1. The average cell is a sparsely populated rural area with middle-aged residents. We define the choice set of a cell to include all pharmacies within 45 minutes (driving time).[5] The average driving time to the nearest pharmacy is 13 minutes and the average size of choice set is 20 pharmacies. Kela expenditure, the per capita expenditure on RX drugs, is observed at the postal code level and brings geographical variation in market potential into the demand model.[6] All variables exhibit large variation and skewed distributions. As examples, comparing the 10th

5. See Online Appendix Subsection B.4 for further details on travel time computation.

6. In the demand model, we also add a fixed €50 to Kela expenditure to represent the missing OTC expenditure. This also helps us deal with areas where Kela expenditure is zero.

percentile to the 90th, population increases 33 times; expenditures double; and the number of pharmacies within the choice set increases by a factor of 23. Only 9% of the cells are urban.

The key characteristics of the pharmacies are summarized in Panel B.[7] Most pharmacies are located in sparsely populated areas: The average population density is double the median population density. Job density figures suggest that nearby jobs could increase the demand for some pharmacies. 35% of existing pharmacies are located in an inner city area and almost 60% have a supermarket nearby. 80% of pharmacies are main pharmacies and only 2% belong to the Yliopiston Apteekki (YA) chain operated by the University of Helsinki. Only 20% of the pharmacies have a nearby mall and 26% have a nearby health center. The average pharmacy sold pharmaceuticals worth €3.32M, but the variation is large. In 2021 Finland had 822 pharmacies, but due to data issues we drop four pharmacies from the demand model sample.

We summarize pharmacies' key financial characteristics used in the production function estimation in Panel C. This sample only contains roughly half of the existing pharmacies because subsidiary pharmacies' financials are reported together with their main pharmacy. We therefore limit this sample to pharmacies that have no subsidiaries. We exclude pharmacies with significant non-consumer sales, had an entry, exit or ownership change during 2021, report zero capital or labor costs, or are a university pharmacy (which have slightly higher sales than the average). Material costs, which consist mainly of wholesale costs of pharmaceuticals, are the largest cost component, whereas labor and capital costs are modest. Average profits

7. Note that the locations of existing pharmacies are strictly regulated by Fimea, so it may be possible that the existing locations are not the most profitable locations for pharmacy operations.

net of material costs are slightly above €1M; profits net of labor and capital costs, as well as taxes, are €0.15M. The average price-cost margin ((Pharmaceutical sales - Material costs)/Pharmaceutical sales), is close to 30%. Deducting (variable) labor and capital costs leads to a price-cost margin of 14%.

4 Demand Model

A Spatial Model of Demand of Pharmacy Choice. We extend the discrete choice model of Ellickson, Grieco, and Khvastunov (2020) by incorporating random coefficients. This extension is important because it relaxes the common independence of irrelevant alternatives (IIA) assumption. Our second extension is that we weigh the market potential with the postal code-level pharmaceutical expenditure data from Kela. This reflects the fact that some areas have significantly higher pharmaceutical demand. The weighting procedure allows us to capture the exogenous variation in market potential and hence the model to match actual consumption patterns more closely.

Representative consumer i living in cell t obtains indirect utility from spending at pharmacy s:

$$u_{ist} = \delta_{st} + \mu_{ist} + \varepsilon_{ist}, \quad u_{i0t} = \varepsilon_{i0t} \tag{1}$$

where we have normalized the mean utility of the outside good, u_{i0t}, to zero. With a nested logit (NL) specification,

$$\varepsilon_{ist} = \bar{\varepsilon}_{ih(s)t} + \left(1 - \rho_{h(s)}\right) \bar{\varepsilon}_{ist} \tag{2}$$

where $h(s)$ denotes the nests and $\rho_{h(s)}$ the nesting parameter. As all inside goods, or pharmacies, are in the same nest and are thus closer substitutes to each other than to the outside good. The common utility component in equation (1) is defined as

$$\delta_{st} = x'_{st}\beta_0 + \xi_{st}. \tag{3}$$

We divide x_{st} into factors related to consumers' home cell t and factors related to the location of pharmacy s. The home cell specific variables in include a constant, distance to the pharmacy (driving time), an indicator for whether cell t is an urban area or not, and an interaction of driving time and the urban dummy. For pharmacy-specific characteristics, we include a dummy for whether there is a supermarket, mall, health center, or public transport hub close to the pharmacy; population and job density in the pharmacy's vicinity; and dummies for the pharmacy being a main pharmacy or a university pharmacy.[8] Other dimensions of pharmacy quality, e.g. opening hours, waiting times and service offerings, could also enter consumer utility. We have not incorporated them into our model due to the lack of data. We assume that the unobserved term ξ_{st} is orthogonal to x_{st}.

Because pharmaceutical prices are uniform across pharmacies, x_{st} does not include prices; this only changes the size of the constant in x_{st}. Most pharmacies also sell non-pharmaceutical products, such as shampoo and cosmetics. Because we do not have detailed sales data on these products, we assume that the choice probability of visiting a given pharmacy is determined solely by pharmaceutical demand. We define revenue of pharmacy s, R_s, as the sum of OTC and RX pharmaceutical sales. We discuss the implications of this assumption in Section 6.

8. An amenity is considered to be near a pharmacy if it is within 200 meters of the pharmacy. Population and job density are calculated as an average of the cells within 500 meters of the pharmacy, and they are scaled to thousand inhabitants or jobs per one square kilometer.

The heterogeneous utility component is defined as:

$$\mu_{ist} = x'_{st} \left(\Sigma_0 \nu_{it} \right). \tag{4}$$

The indirect utility can also be written as $u_{ist} = x_{st}\beta_{it} + \varepsilon_{ist}$ with $\beta_{it} \sim \mathcal{N}(\beta_0, \Sigma_0)$. The additive ε_{ist} term is assumed to be i.i.d., drawn from a standard Type 1 extreme value distribution, yielding mixed multinomial logit choice probabilities:

$$p_{st}(\theta) \int \frac{\exp\left(\delta_{st} + \mu_{ist}\right)}{\exp\left(u_{i0t}\right) + \sum_{k \in S_t} \exp\left(\delta_{kt} + \mu_{ikt}\right)} dF\left(\beta_{it}\right), \tag{5}$$

with $\theta = (\beta_0, \Sigma_0)$. In equation (5), we define the choice set C_t of consumers in cell t as $C_t = S_t \cup 0$ where $S_t = \{s : d_{ts} \leq D\}$.[9] Consumers' choice sets thus consist of i) pharmacies at most distance D away from the centroid of their home cell t, and ii) the outside good. D is defined in terms of travel time in minutes. The outside good corresponds to the consumer not buying pharmaceuticals. For our random coefficients nested logit (RCNL) model, the choice probabilities are

$$p_{st}(\theta) = \int \underbrace{\frac{\exp\left(\left(\delta_{st} + \mu_{ist}\right) / \left(1 - \rho_{h(s)}\right)\right)}{\exp\left(I_{ih(s)} / \left(1 - \rho_{h(s)}\right)\right)}}_{\text{Within nest probability}} \times \underbrace{\frac{\exp\left(I_{ih(s)}\right)}{\exp\left(I_i\right)}}_{\substack{\text{Probability of} \\ \text{choosing nest } h(s)}} dF\left(\beta_{it}\right) \tag{6}$$

with

$$I_{ih(s)} = \left(1 - \rho_{h(s)}\right) \ln \sum_k \exp\left(\left(\delta_{kt} + \mu_{ikt}\right) / \left(1 - \rho_{h(s)}\right)\right). \tag{7}$$

The set $C_{t,h(s)} = \{q \in C_t : h(s) = h(q)\}$ is the set of pharmacies that are in the same nest per each choice set. In our RCNL setting (Grigolon and Verboven 2014),

9. In our estimations, we impose a minimum size of three for the choice sets.

where one nest contains all pharmacies and the other contains only the outside option, the inclusive value takes the form $I_i = \ln\left(\exp\left(u_{i0t}\right) + \exp\left(I_{ih(s)}\right)\right)$. The revenue that pharmacy s receives from consumers in cell t can be expressed as

$$\hat{R}_{st}(\theta, \alpha) = g\left(\alpha, r_t\right) \times N_t \times p_{st}(\theta), \tag{8}$$

where N_t is the number of consumers in cell t, and the $g\left(\alpha, r_t\right)$ represents the potential per capita expenditure on pharmaceuticals. That is, consumers can spend up to $g\left(\alpha, r_t\right)$ euros on pharmaceuticals, including the inside goods and the outside good. Hence, the observed pharmaceutical spending is $g\left(\alpha, r_t\right)$ times the market share of inside goods. We define $g\left(\alpha, r_t\right) = \alpha \times r_t$ and estimate α which represents market potential as a factor of observed pharmaceutical spending and r_t represents our postal-code level per capita expenditure data from Kela (*Kela expenditure* in Table 1).

Importantly, our choice model considers the utility of a single one-way trip to a pharmacy. We adjust our welfare calculations for the fact that consumers make multiple two-way trips to pharmacies by using data on the number of pharmacy visits (see Appendix Subsection A.4). Our model and interpretation are consistent with a representative consumer who visits a pharmacy n_t times a year, because for each visit, they choose a specific pharmacy with the same probability $p_{st}(\theta)$.

Defining $L_s = \{t : s \in C_t\} = \{t : d_{st} \leq D\}$ as the set of cells that have pharmacy s in their choice set, we can express the total revenue of pharmacy s as

$$\hat{R}_s(\theta, \alpha) = \sum_{t \in L_s} \hat{R}_{st}(\theta, \alpha). \tag{9}$$

Observed revenues are given by

$$R_s = \exp(\zeta_s) \times \hat{R}_s(\theta_0, \alpha_0), \tag{10}$$

where e^{ζ_s} is the measurement error and θ_0, α_0 denote the true parameter values. We estimate the model with non-linear least squares by minimizing the squared log-difference of the predicted revenue and the observed revenue:

$$(\hat{\theta}, \hat{\alpha}) = \underset{\theta,\alpha}{\operatorname{argmin}} \sum_s \left(\log\left(\hat{R}_s(\theta, \alpha) \right) - \log(R_s) \right)^2. \tag{11}$$

The identification of parameters follows Ellickson, Grieco, and Khvastunov (2020). We identify α from the variation in the number of pharmacies and the total revenue between pharmacies in a given market. α measures potential expenditure on pharmaceuticals, $\alpha > 1$ suggesting market potential that exceeds current sales.

We estimate both the simple logit model with $\Sigma_0 = 0$, and a logit model with a random coefficient on the distance term. The random coefficient terms for driving time, σ, are identified from the variation in pharmacy locations between different cells and from the demographic variation surrounding pharmacy and consumer cells. Appendix Subsection A.1 provides a more detailed discussion on identification of the demand model.

Demand Model Results. We estimate: 1) a standard logit model, 2) a NL model where all inside goods are in one nest and the outside good in another, 3) a random coefficients logit (RC) model with a random coefficient on the distance term, and 4) a RCNL model that incorporates both the nesting structure and the distance term random coefficient. As shown in Table 2, all specifications yield precise and negative estimates for distance. The RC model provides the most negative estimate at -0.269, with a corresponding random coefficient estimate of 0.138. The logit model yields an estimate of -0.201. The nested models show significantly smaller effects, at -0.029 (NL) and -0.034 (RCNL). The RCNL model's σ parameter is estimated at 0.015. The absolute ratio between the mean and standard deviation estimates (β and σ) is 1.9 in the RC and 2.3 in the RCNL model, indicating that RCNL has slightly fatter tails, implying stronger heterogeneity in consumers' distaste for distance.[10] The difference in the parameter estimates between the models with and without a nesting structure is likely due to limited substitution to the outside good; the nesting parameter ρ obtains relatively high values at 0.865 for the NL and 0.871 for the RCNL model.

Because urban consumers have significantly larger choice sets than rural consumers, the model mechanically forces them to spend more on inside goods (due to non-zero choice probabilities). The negative coefficient of the urban dummy probably negates some of the effect of market expansion in urban areas caused by the larger choice set. At the same time, estimates for the interaction of distance with the urban dummy are small and imprecise across all models. The AIC, BIC, and MSE metrics indicate that the RCNL model performs best. We use its parameter estimates for our post-estimation statistics and as the basis of our entry game.

The market potential of a consumer is defined by $g(\alpha, r_t) = \alpha \times r_t$ where r_t is the per capita pharmaceutical spending observed at the postal code level. Thus, the α's in Table 2 represent a multiplying factor for the size of the market potential. The

10. The share of positive individual distance parameters $P(\beta_i > 0)$ for consumers in rural areas is $P\left(Z > \frac{0.2689}{0.1381} = 1.947\right) \approx 0.0258$ (2.58%) for the RCs model and $P\left(Z > \frac{0.0341}{0.0149} = 2.289\right) \approx 0.0111$ (1.11%) for the RCNL model. For consumers in urban areas, the share is a bit smaller due to the negative interaction term between distance and the urban dummy.

Table 2: Demand Model Main Results

Utility specification Model	Logit (1)	NL (2)	RC (3)	RCNL (4)
β Intercept	10.6436 ***		5.1818 ***	
	(2.6244)		(1.0359)	
β Distance	-0.2008 ***	-0.0288 ***	-0.2689 ***	-0.0341 ***
	(0.0165)	(0.0062)	(0.0268)	(0.0082)
β Dist. $\times$ Urban	-0.0310	-0.0032	-0.0224	-0.0003
	(0.0369)	(0.0052)	(0.0440)	(0.0056)
β Urban	-9.4842 ***	-0.4733 ***	-5.1704 ***	-0.5888 ***
	(2.6645)	(0.1170)	(0.9579)	(0.1245)
σ Distance			0.1381 ***	0.0149 **
			(0.0306)	(0.0049)
ρ		0.8651 ***		0.8706 ***
		(0.0296)		(0.0312)
α	1.0106 ***	2.0839 ***	1.1220 ***	2.1538 ***
	(0.0184)	(0.0371)	(0.0430)	(0.0450)
AIC	2410	2402	2403	2393
BIC	989	980	995	985
MSE	5.10e12	5.08e12	5.05e12	5.03e12

Notes: Distance refers to travel time by car. Model statistics: Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and Mean Squared Error (MSE). Robust standard errors are presented in parenthesis; * p< 0.1, ** p< 0.05, *** p< 0.01.

standard logit model implies that the market potential is 1.01 times the observed pharmaceutical sales. The RC model has the second smallest value at 1.12. The nested models provide significantly larger α estimates at 2.1 (NL) and 2.2 (RCNL). The difference is likely explained by limited substitution between the outside good and the inside goods implied by the large estimated nesting parameter.

Regarding the remaining parameters (see Appendix Table A.1), consumers prefer pharmacies located near amenities and dislike pharmacies located in densely

Table 3: Post Estimation Results

Variable	Mean	Std. Dev.	P10	P50	P90	N
Own Elasticity	-3.55	1.08	-4.82	-3.57	-2.31	6330641
Cross-Elasticity	0.08	0.23	0.00	0.02	0.15	271023390
HHI	4490.62	2546.34	1454.34	4086.45	8356.93	3007

Notes: This table presents post estimation results for our main demand specification. Elasticities are calculated with respect to driving distance in minutes. Own elasticities are computed for every cell × pharmacy pair, while cross-elasticities are computed for every cell × pharmacy × competing pharmacy combination in a choice set. HHIs are population-weighted averages of cell level HHIs aggregated to postal code level.

populated areas or in areas with many workplaces. The latter could reflect consumers who want to visit pharmacies accessible by car, rather than those in city centers or commercial districts. Consumers prefer main pharmacies over subsidiaries and have a strong preference for university pharmacies, probably due to a wider selection of drugs and, regarding the latter effect, due to a known brand.

We also calculate several post-estimation results based on our demand model.[11] We provide consumer level descriptive statistics on distance elasticities and HHI in Table 3. The average own-distance elasticity is -3.6.; the cross-elasticities are positive but small. We plot the elasticity distributions in Appendix Figure A.1. The cell-level HHI measures indicate high concentration as defined by the EU merger guidelines, with a mean HHI of 4490 and a median of 4086.

11. Most of the formulas for the post-estimation results can be found in Ellickson, Grieco, and Khvastunov (2020) and Train (2009).

5 Supply Model

We now introduce the supply model to identify variable labor and material cost parameters and fixed costs. The total costs of a pharmacy consist of material costs, i.e., pharmaceutical purchases at wholesale prices, labor costs, taxes, and fixed costs. We treat material costs, labor costs, and taxes as variable. Fixed costs consist of capital costs and, maybe mostly, of the opportunity cost of the owner-pharmacist.[12]

Production Function. The regulations that govern the Finnish pharmacy market restrict competition in terms of both pricing (of pharmaceuticals) and location choice. Pharmacies are required to order and supply a prescribed pharmaceutical product if it is unavailable. Minimum service quality is ensured by regulations on the education of pharmacy staff. It is also likely that unobserved quality attributes, such as opening hours and staff quality, do not have a first-order impact on our main objective: The choice of location in our entry game. We assume that, conditional on the observable pharmacy characteristics included in our demand model, there are no systematic quality differences between pharmacies. The institutional feature supporting our quality assumption is that in Finland there is no shortage of individuals who meet the educational and work experience requirements required for the pharmacy license (National Supervisory Authority for Welfare and Health of Finland 2024). Due to these reasons and the unavailability of data, we do not include these factors in our model. As a result, we consider pharmacies to be cost-minimizers.

12. The owner's reimbursement is not included in labor costs. As the owner is required to have a M.Sc. in Pharmacy and to be an experienced professional, they could pursue jobs in the public sector (e.g., the regulator, other health policy institutions) as well as the private sector (e.g., pharmaceutical companies). Therefore, the opportunity cost is probably non-negligible.

We assume that the variable costs of pharmacies consist of the wholesale costs of pharmaceuticals and labor costs, measured as total labor costs (including rental labor). We observe the expenditure on these inputs. Although there are concerns in the literature about the use of expenditure measures (De Loecker and Syverson 2021) in production function estimation, these are unlikely to apply to the Finnish pharmacy sector due to regulated wholesale and retail prices and due to relatively strict labor laws. We assume that the pharmacies' production function is

$$F(L,M) = \min\{\exp(A+\omega_L) \times L^{\kappa}, (B+\omega_M) \times M\} \tag{12}$$

and their objective is

$$\begin{aligned} \min_{L,\,M} \quad & C(L,M) = L + M, \\ \text{s.t.} \quad & F(L,M) \geq R \end{aligned} \tag{13}$$

Pharmacies have two inputs (equation (12)), labor (L) and material (M). Productivity is captured by three productivity parameters (A), (B) and (κ), and two productivity shocks (ω_L) and (ω_M). We observe L and M from the accounting data. It is reasonable to assume that pharmacies cannot substitute labor for material or vice versa, and hence the production function is Leontief.

The parameter A represents labor productivity. It can be thought of as the proportion in which labor is needed to be increased when output increases. κ represents returns to scale with respect to labor. The interpretation of the parameter B in equation (12) is straightforward: $1 - B$ is the mean markup. We do not allow for returns to scale to material inputs because pharmaceutical wholesale costs are uniform across pharmacies and any rebates from manufacturers or wholesalers to pharmacies are explicitly prohibited. The pharmacy-specific productivity shocks ω_L and ω_M capture differences in input use. These are potentially correlated with unobserved demand shocks and therefore with revenue R. For example, a pharmacy can employ more productive workers who work faster. Similarly with material costs, some pharmacies may serve areas that have higher markups than observationally similar pharmacies, hence implying correlation between R and ω_M. Equation (5) results in the following optimality conditions:

$$R = \exp(A + \omega_L) \times L^{\kappa} = (B + \omega_M) \times M. \tag{14}$$

This can be further transformed into:

$$\begin{aligned} \ln(L) &= \frac{1}{\kappa}\ln(R) - \frac{1}{\kappa}A - \frac{1}{\kappa}\omega_L \\ M &= \frac{1}{B + \omega_M} \times R. \end{aligned} \tag{15}$$

As unobserved productivity shocks may be correlated with revenues, we use predicted revenues as instrument. Given regulated prices, predicted revenue is by design correlated with the observed output, but is uncorrelated with the unobserved productivity shocks (see Verboven and Yontcheva 2024).

We present the estimates in Table 4. The cost model is estimated using data on 402 pharmacies, as we cannot separate the accounting data on costs between main and subsidiary pharmacies operated by the same pharmacist. The production function parameters, which are transformations of the estimated parameters, are presented at the bottom of the table. First, focusing on the labor cost estimates, we find an upward OLS bias in the revenue coefficient. The bias can be explained by the fact that pharmacies with smaller productivity shocks use more labor.

Table 4: Production Function Estimates

Estimator:	OLS		IV	
Model:	(1)	(2)	(3)	(4)
Dependent Variable:	$\ln(L)$	M	$\ln(L)$	M
Variables				
$\ln(R)$ or R	0.88***	0.72***	0.94***	0.72***
	(0.03)	(0.00)	(0.03)	(0.00)
Intercept	-0.35		-1.17***	
	(0.47)		(0.45)	
Observations	402	402	402	402
R^2	0.82	0.99	-	-
F-statistic	-	-	728.45	2857.56
Transformations				
Return to scale (κ)	1.14		1.07	
Productivity (A or B)	0.39	1.39	1.25	1.39

Notes: The point estimates and the standard errors are for the parameters in equation (15), and the transformations give the respective values in the first-order equation (14). The F-statistic represents the weak instrument test from Olea and Pflueger (2013) and Pflueger and Wang (2015) where the critical value for rejecting the null hypothesis with a significance level of 5% is 37.42. Robust standard errors in parentheses; * p< 0.1, ** p< 0.05, *** p< 0.01.

This behavior can be explained by the need to comply with industry regulations. The coefficient estimate implies returns to scale (κ>1) for labor. Due to the upward bias in the revenue coefficient (= $1/\kappa$), we have a downward OLS bias in labor productivity. For materials, the OLS and Two-Stage Least Squares (2SLS) estimates are practically identical. This is natural in our setting because material inputs consist of wholesale costs of pharmaceuticals and the wholesale costs have a mechanical relationship with the pharmaceutical revenue due to regulated markups. Our instruments are strong, as shown by the large F-statistics and weak instruments tests.

The predicted variable costs in our entry model can be obtained as:

$$C(\hat{R}) = \underbrace{\left(\frac{\hat{R}}{\exp(A)}\right)^{\frac{1}{\kappa}}}_{\substack{\text{Predicted}\\ \text{Labor costs}}} + \underbrace{\frac{1}{B} \times \hat{R}}_{\substack{\text{Predicted}\\ \text{Material costs}}} \quad . \tag{16}$$

Modeling Fixed Costs. Our estimator of fixed costs is based on Eizenberg (2014): The idea is to use entries and exits to back out the bounds of fixed costs that rationalize these decisions. However, the number of entry and exits in the Finnish pharmacy market is very low. The few exits are because of, e.g. tax evasion. Moreover, due to due entry regulation, we lack information on locations where no one was willing to enter. The only information available is the decision of the incumbents to remain in the market. This information allows us to estimate an upper, but not a lower, bound for the fixed costs.

We use the same 402 pharmacies for fixed cost estimation that we used for production function estimation. We first calculate predicted revenues and demand shocks $\hat{\zeta}$ using our RCNL demand model. We then use our production function estimates to obtain the productivity shocks $\hat{\omega}_L$ and $\hat{\omega}_M$ to estimate the joint distribution of the three shocks.

$$\begin{aligned}\Pi = \overbrace{\hat{R} \times \exp(\zeta)}^{\text{Revenue}} - \overbrace{\frac{1}{B + \omega_M} \times \hat{R} \times \exp(\zeta)}^{\text{Material costs}} \\ \underbrace{- (\frac{\hat{R} \times \exp(\zeta)}{\exp(A)})^{\frac{1}{\kappa}} \times \exp(-\frac{\omega_L}{\kappa})}_{\text{Labor costs}} - \underbrace{T(\hat{R} \times \exp(\zeta))}_{\text{Taxes}}\end{aligned} \tag{17}$$

Equation (17) depicts pharmacy gross profits (profits before fixed costs) as a function of predicted revenue ($\hat{R}$) and demand and productivity shocks (ζ, ω_L, ω_M).

Following Eizenberg (2014), we take Y draws from the joint distribution of shocks and calculate the gross profits for each pharmacy and each draw. By averaging gross profits over the draws, we obtain expected gross profits for each pharmacy. As these pharmacies choose to remain in the market, the estimation yields the upper bound of fixed costs (for details, see Algorithm 1 in Appendix A.2).

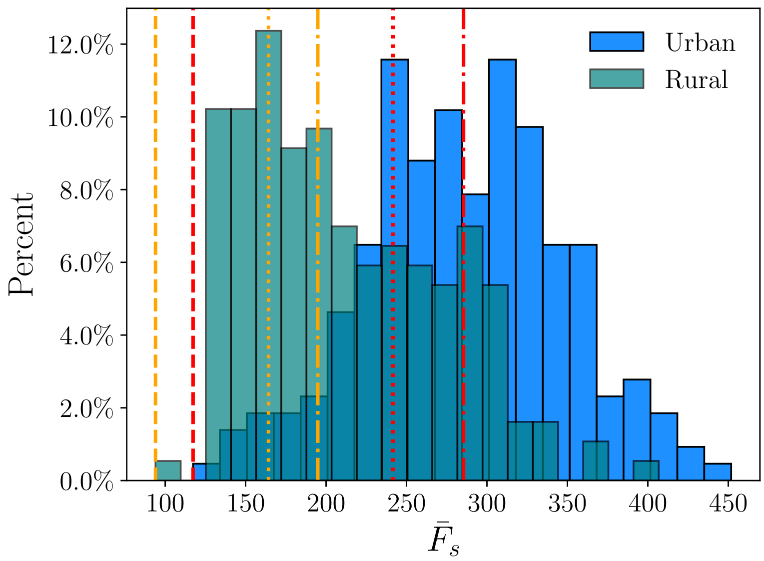
Figure 1 shows the fixed cost distribution for urban and rural pharmacies. We use the minimum fixed costs as our estimates for counterfactual entry locations; see dashed lines in Figure 1. The thresholds are ca. €94,000 for rural areas and €117,000 for urban areas. The difference can be attributed to the variation in the opportunity cost of pharmacists who tend to be older and more experienced in urban pharmacies and to higher real estate expenses in urban locations.

6 Solving the Entry Game

We next simulate entry into the Finnish pharmacy market in a free entry counterfactual, keeping the existing price regulation in place. Deregulation of this type resembles past deregulation policies in Europe, where entry restrictions have been relaxed, and price controls have remained. Online Appendix Section B.2 and Table B.4 describe the deregulation policies that have been implemented in the EU. Pharmacies decide on entry based on expected profits net of fixed costs.

Solving the equilibria of entry games even much smaller than ours is computationally impossible. We could use the sequential myopic entry (SME) algorithm (Seim and Waldfogel 2013); SME adds a pharmacy to the market until no new profitable entry locations remain. Each myopic entrant chooses the location with the highest profits at the time of entry, ignoring the business-stealing effect caused

Figure 1: Fixed Cost Estimates



Notes: The figure plots the fixed cost estimates for urban and rural pharmacies. Orange lines represent rural pharmacies, and red lines represent urban pharmacies. Dashed lines denote the minimum values (main specification), dotted lines indicate the 25th quantile, and dash-dotted lines indicate the median. Fixed costs $\bar{F}_j^s$ are denoted in thousands of euros.

by and to subsequent entrants. If any existing pharmacy turns unprofitable after new entry, it will exit. SME results in a configuration in which no pharmacy wants to enter or exit, but is not guaranteed to yield a Nash equilibrium. We follow Verboven and Yontcheva (2024) and limit potential entry locations to sites next to grocery stores, reducing the number of locations from 300,000 to approximately 4,000. However, our problem remains larger than in previous applications using SME.[13] Online Appendix Table B.6 in Subsection B.8 displays the potential entry locations.

13. Verboven and Yontcheva (2024) analyzed 16,353 notary markets and 2,413 potential entry locations in Belgium, whereas Seim and Waldfogel (2013) used 3,125 census tracts in Pennsylvania.

We introduce a significantly faster algorithm, the backward SME (BSME) which produces a configuration that satisfies the conditions of SME. BSME (see Algorithm 3 in Appendix A.3) starts by populating all entry locations with a pharmacy and iteratively removing the pharmacy with the largest negative profit until all remaining pharmacies are profitable, producing a set of locations that support a pharmacy. These locations are allocated new entrants if they can support them. Due to consecutive exits in the first stage, the resulting configuration may have locations that are profitable to enter. We therefore finish the algorithm by running the SME. Typically, this last step adds only a handful of pharmacies.

The first step of BSME converges to the approximate final number of pharmacies much faster than SME because the backward step checks only the profits of the existing stores instead of calculating profits for the much larger set of all possible entry locations. The BSME configuration satisfies the same conditions as SME, but the configurations need not be the same. The main downside of BSME is that it does not produce an order of entry; this may matter if the entrants are different.

Our demand model uses pharmaceutical revenue, but in reality, pharmacies also sell non-pharmaceutical products. As a consequence, we may underestimate the amount of entry. We do not believe this to be qualitatively important because non-pharmaceutical sales make up only a small fraction of pharmacies' total sales and because such sales would mainly scale our estimated fixed cost.

We may also overestimate entry. First, our entrants are myopic: They do not anticipate future entrants or try to strategically block competition through their location choices. Second, the model does capture the possible effect of entry on input prices: An increase in demand could raise wages and rents. Another consideration is that the resulting configuration is not necessarily a Nash equilibrium, because some pharmacies might want to change their locations after subsequent entry. We study this issue is Section 7. The outcome of any entry game crucially depends on the estimated fixed costs. We test robustness of our counterfactual results to alternative fixed costs in Online Appendix Subsection B.6.

7 Counterfactual Results

Pharmacy entry restrictions are often justified by the need to ensure nationwide services. We simulate a free entry counterfactual to assess the role of the existing entry regulation in maintaining pharmacy coverage throughout the country. We keep all other regulations, in particular, the price- and mark-up regulations and the tax regime, in place. We calculate changes in consumer welfare, pharmacy revenues, government tax revenue, travel distance to pharmacy, and changes in market concentration (HHI). We convert our distance estimates from the (dis)utility of travel time to monetary units following Einav, Finkelstein, and Williams (2016).[14] We also discuss the performance of the BSME algorithm. Our results are robust to variation in the fixed costs (see Online Appendix Subsection B.6).

Free Entry Counterfactual. Our counterfactual simulation has five main results (see Table 5). First, free entry increases the number of pharmacies by 1459 or 178%, leading to total fixed costs increasing by 188%. Second, because counterfactual pharmacies are smaller in size, there is a loss of economies of scale: Labor costs increase €57.5M (20%). The increase in labor costs stems from both market expansion and decreased labor productivity due to smaller average pharmacy size. In the current regime, the ratio of predicted revenues to labor costs was

14. We explain further details of our welfare calculations in Appendix Subsection A.4.

Table 5: Counterfactual Results

Variable	**Absolute**	**Relative**
	Panel A: Consumers	
Δ Consumer surplus (CS)	67.94	14%
Sum of negative Δ CS	-1.79	-29%
Average Δ weigh. distance	-0.48	-3%
	Panel B: Pharmacies	
Δ Number of pharmacies	1459	178%
Δ Revenue	197.55	8%
Δ Labor costs	57.54	20%
Δ Fixed costs	162.07	188%
Δ Gross profits	120.25	51%
Δ Net profits	-41.73	-28%
	Panel C: Government and Total Surplus	
Δ Pharmacy tax	-122.38	-71%
Δ Value-added tax	19.76	8%
Δ Total surplus	-76.41	-7%

Notes: This table shows aggregate changes in the market under free entry counterfactual relative to the current pharmacy network. All monetary values are in €M. Gross profits are calculated as revenue minus material costs, labor cost and taxes. Net profits are calculated as gross profits minus fixed costs.

8.5. After deregulation, this ratio drops to 7.7, reflecting a 9.8% decrease in the revenue/labor cost-ratio. This implies that for every euro of sales, the pharmacy sector spends nearly 10% more on labor after deregulation.

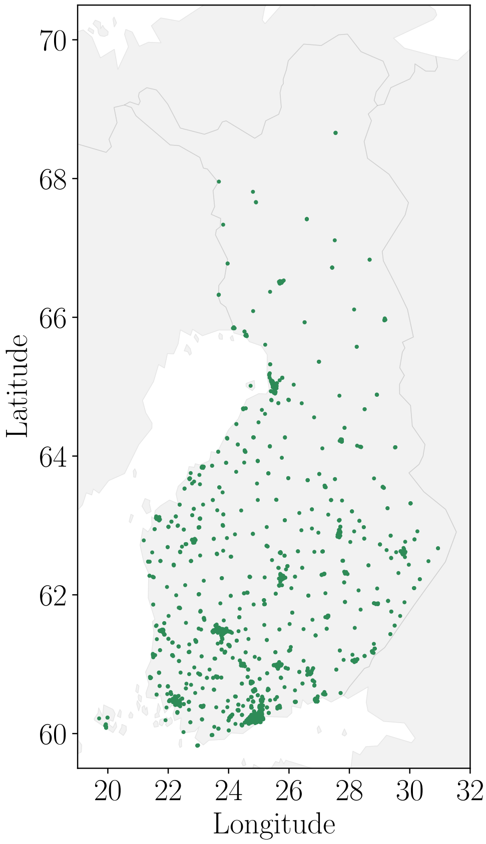
Third, consumer surplus (CS) increases by €67.9M (14%). The increase is driven by reduced travel times (-3%) for consumers who already purchase the inside good and the shift of consumers from the outside good to the inside good, the market expanding by €197.55M (8%). The size of the market expansion effect requires contextualization: Kari, Nurminen, Rättö, and Koskinen (2024) report that in 2020, 13% of prescriptions in Finland were never filled. One possible explanation for the market expansion result is that a fraction of consumers who previously did not fill their prescriptions may start doing so. The second explanation is that consumers may increase their spending on OTC drugs. At the same time, less than 1.5% of the population experience a negative CS change (Online Appendix Figure B.3). the sum of negative CS changes is around €1.8M which amounts to a 29% decrease for those consumers. Online Appendix Subsection B.7 provides additional evidence on how the benefits of free entry to consumers are distributed between demographic groups and Online Appendix Subsection B.5 presents results on how CS and HHI are distributed.

Figures 2a and 2b that show the counterfactual and the existing pharmacy networks illustrate where the losses in consumer surplus take place. Urban areas tend to get more pharmacies under deregulation, but increased urban entry does not mean exit/relocation of rural pharmacies. The most significant change in the pharmacy network occurs in sparsely populated Northern Finland, where from the 67th latitude onwards the number of pharmacies clearly decreases.

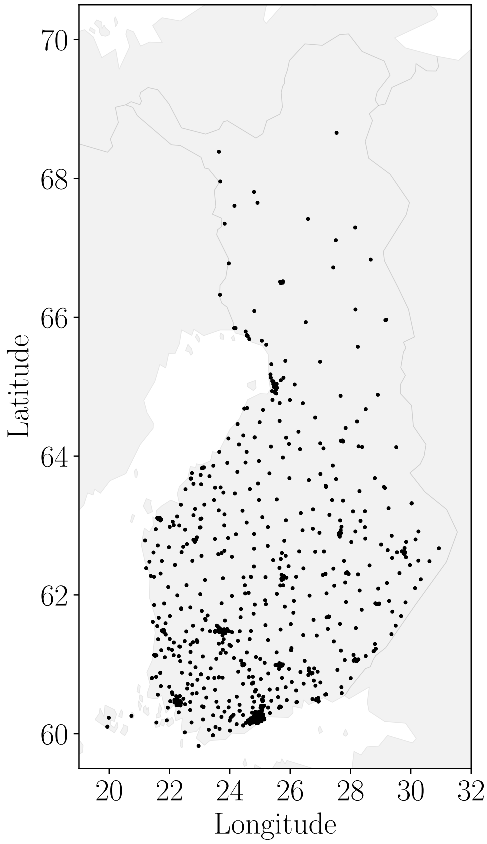
Fourth, government tax revenue is greatly affected: As the pharmacy tax is progressive and based on revenue, pharmacy tax revenue decreases by 71% because average pharmacy size is reduced by 2/3 (see also Online Appendix Table B.6 Panel C). The increase in VAT, which is proportional to the 8% market (revenue) expansion, cannot compensate this tax revenue loss.

Fifth, free entry is socially excessive (Mankiw and Whinston 1986): Deregulation decreases total welfare (CS+producer surplus (PS)+taxes) by €76.5M (7%), with only (most) consumers benefiting. Even though the market expands, the increases in fixed and labor costs lead to a decrease in industry profits, and decreased average sales lead to a substantial reduction of pharmacy tax revenue for the government.

Figure 2: Counterfactual Pharmacy Network



(a) Counterfactual Network



(b) Existing Pharmacy Network

Notes: The figure on the left plots the post entry game pharmacy network. The figure on the right shows old pharmacy network.

Consequently, fifth, deregulation causes substantial redistribution across sectors: The government incurs a sharp reduction in tax revenue (€142M, -23%) and pharmacy profits decrease significantly (€41.8M, -28%).

One should keep in mind that standard welfare calculations cannot account for the health effects of increased pharmaceutical spending. On the one hand, this spending could be directed towards less effective or redundant treatments.

On the other hand, increased spending could result from, for example, distance-sensitive individuals, such as elderly or low-income households, gaining access to nearby pharmacy services. In such cases, the health effects are likely to be positive. However, vulnerable populations are not disproportionately represented among those who forgo filling prescriptions in Finland, and this can downplay potential positive health benefits (Kari, Nurminen, Rättö, and Koskinen 2024).

Increased labor costs suggest that deregulation would increase labor demand. The additionally required workforce does not seem unrealistically large compared to the existing pharmaceutical workforce. Assuming an average salary of €39,000 and a 30% overhead, the increase in labor costs corresponds to an increase of some 1,100 pharmacists (B.Sc. in Pharmacy). Finland had 10,606 licensed pharmacists (B.Sc. in Pharmacy) under the age of 65, alongside 3,139 licensed pharmacists with an M.Sc. in Pharmacy (National Supervisory Authority for Welfare and Health of Finland 2024) in 2021. With approximately 4,500 pharmacy professionals employed in the pharmacy sector (Kokko, Hyvärinen, and Reinikainen 2024), it appears that labor supply would be sufficient to meet the additional demand. These calculations do not account for potential wage adjustments caused by increased labor demand: It is likely that wages would rise, shifting income from pharmacy owners to employees. Our model also does not account for the effects of free entry on the real estate market. Property owners might have incentives to restrict the entry of competing pharmacies to protect or enhance their rental income.

BSME Performance. We ran both algorithms: BSME converges in 90 minutes, compared to 3900 minutes for SME, an improvement of 98%.

Furthermore, and to our knowledge, first in the literature, we checked how close to a Nash equilibrium the entry (BSME) configuration is; see Table 6. Only

Table 6: Descriptives for Moving Pharmacies

Variable	**Mean**	**Std. Dev.**	**P10**	**P50**	**P90**	**N**
Δ Profit	6067	6895	456	2904	14144	32
City area	0.03	0.18	0.00	0.00	0.00	32
Distance (minutes)	8.34	8.81	0.38	6.72	22.02	32
Distance (km)	8.98	10.61	0.14	4.42	26.85	32
Δ Closest rival (minutes)	-4.83	7.32	-16.68	-0.39	0.46	32
Δ Closest rival (km)	-5.89	8.81	-17.26	-0.39	0.37	32

Notes: This table presents descriptive statistics of the pharmacies that wish to change location. A total of 32 (1.4%) pharmacies wished to move. Their share of total profits was is 1.50%.

32 pharmacies out of 2,277 (1.4%) would switch location. Only one (3%) of the moving pharmacies is an urban pharmacy. Given that no new pharmacy wants to enter in the BSME configuration, alternative locations are by necessity ones where the moving pharmacy would capture some of the demand it attracted in the initial location. It is therefore not surprising that most moving pharmacies would relocate by only a small distance: The 10th relocation distance percentile is 0.4 min (0.14 km), the median 6.7 min and (4.4 km), and the 90th percentile 22 min (27 km). The change in profits is small, with a mean change of €6,000 and even the 90th percentile change only €14,000. In terms of vicinity of competition, more than 10% of the new locations are further from the nearest rival than the initial location, but the median change is a small decrease in distance (less than 0.5 min or km). At the 90th percentile the distance decreases by roughly 17 min and km.

8 Conclusions

We study the effects of entry deregulation in the Finnish pharmacy market by i) estimating a spatial model for pharmacy choice, ii) and a production function to model pharmacies' variable labor and material costs, and by iii) backing out the upper bound of fixed entry costs from the location choices of existing pharmacies. Free entry results in a significant increase in the number of pharmacies, primarily concentrated in densely populated areas. CS increases for 98% of the population, although the benefits are unevenly distributed. About 2% of consumers experience a decline in welfare due to the need to travel further for pharmacy services. Our results confirm that partial deregulation a heavily regulated market can be a mixed bag: Some consumers gain, but others may be left worse off and total welfare may suffer (Joskow 2005).

Consumers benefit from a larger variety of pharmacies and shorter travel times, but these benefits are outweighed by a significant decrease in industry profits and government tax revenue. The entry of ca. 1400 new pharmacies is excessive from a welfare perspective, even with conservative fixed cost estimates. Additionally, the proliferation of smaller pharmacies post-deregulation leads to reduced labor productivity due to foregone economies of scale. We find that the free entry of pharmacies, at least in the absence of other reforms, can lead to a decrease in total welfare compared to the current highly restrictive entry and location regime. Although our results suggest that the current pharmacy regulation may work reasonably well from a total welfare perspective, with entry regulation complementing other regulations (price- and mark-up regulation, and pharmacy taxation in particular), it has potentially undesirable distributional consequences, as it leads to high pharmacy profits and lower CS than the free entry regime. If distributional and efficiency effects were a concern, a possible remedy could be simultaneous adjustments to pharmacy taxation and/or price- and mark-up-regulation.

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A Appendix

We discuss identification of the demand model and present demand model coefficients of pharmacy cell characteristics as well as elasticity distributions in Subsection A.1. We outline our fixed cost estimation in Subsection A.2 and algorithms of the entry game in Subsection A.3 while describing the CS formulas in Subsection A.4.

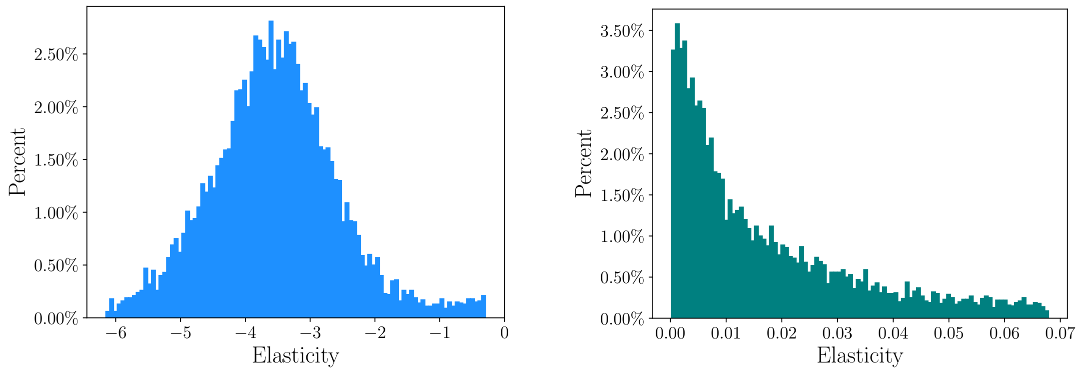
A.1 Demand Model Identification and Additional Results

The identification of demand parameters is based on variation in the geographical distribution of population, demographics, pharmacy characteristics, and pharmacy revenues. We assume that consumers take their own and the pharmacy locations as given and that $(\epsilon_{its}, \zeta_s)$ are independent of both pharmacy and consumer location as well as location characteristics.

In Ellickson, Grieco, and Khvastunov (2020), the parameter α—denoting the expenditure share of total income potentially allocated to pharmacy purchases—is identified from variation in the total number of outlets in otherwise identical markets. In our application α denotes a multiplying factor such that the product of α and observed pharmaceutical expenditure is the amount of euros that a consumer could potentially spend on pharmaceuticals. If $\alpha = 1.5$, then cells with observed expenditure of €100 and €200 have a market potential of €150 and €300. α is identified from the variation in the total number of pharmacies in observationally identical markets (consumer choice sets) and by observing the change in total revenue across all pharmacies. Increasing the number of pharmacies within choice sets may lead to substitution from the outside to inside goods and to redistribution of revenues between pharmacies. The identification of the demand parameters and the nesting parameter is similar to Ellickson, Grieco, and Khvastunov (2020) and follows from variation in pharmacy and consumer characteristics.

Additional Demand Model Results. We report the demand model coefficients of pharmacy location characteristics in Table A.1 and the own- and cross-distance elasticity distributions in Figure A.1b. The size of the elasticity matrix is N^2, where N is the number of cell-to-pharmacy pairs. We plot the distributions for a random sample of 10,000 observations from the elasticity estimates.

Figure A.1: Elasticity Distributions



(a) Own Elasticities

(b) Cross-Elasticities

Notes: The figure on the left plots the distribution of cell $\times$ pharmacy own-elasticities with respect to distance in minutes. The figure on the right plots the respective cross-elasticities. Both distributions are plotted from a random sample of 10,000. Extreme tails are excluded from the plots.

A.2 Fixed Cost Algorithm

Our fixed cost estimation algorithm (Algorithm 1) is based on Eizenberg (2014) and proceeds in three steps. First (step 1), the joint probability distribution of demand, labor and material costs shocks is estimated. Prior to this, the demand system

Table A.1: Demand Model Secondary Results

Utility specification Model	Logit (1)	NL (2)	RC (3)	RCNL (4)
		Pharmacy Characteristics		
β Supermkt Nearby	0.3572 ***	0.0479 ***	0.3680 ***	0.0471 ***
	(0.0517)	(0.0124)	(0.0540)	(0.0130)
β Mall Nearby	0.0407	0.0054	0.0307	0.0039
	(0.0595)	(0.0081)	(0.0618)	(0.0081)
β Health Nearby	0.0125	0.0013	0.0099	0.0012
	(0.0562)	(0.0076)	(0.0605)	(0.0077)
β Transit Nearby	0.0912	0.0125	0.1038	0.0120
	(0.1051)	(0.0146)	(0.1108)	(0.0144)
β Pop. Density	-0.0568 ***	-0.0077 *	-0.0660 ***	-0.0076 *
	(0.0172)	(0.0031)	(0.0180)	(0.0031)
β Jobs Density	-0.0238	-0.0032	-0.0229	-0.0028
	(0.0167)	(0.0023)	(0.0174)	(0.0023)
β Main Pharm.	1.0830 ***	0.1461 ***	1.1670 ***	0.1481 ***
	(0.0636)	(0.0323)	(0.0724)	(0.0354)
β YA Pharm.	1.5276 ***	0.2046 ***	1.5848 ***	0.1991 ***
	(0.1535)	(0.0519)	(0.1645)	(0.0528)
AIC	2410	2402	2403	2393
BIC	989	980	995	985
MSE	5.10e12	5.08e12	5.05e12	5.03e12

Notes: Model statistics: AIC, BIC and MSE. Robust standard errors are presented in parenthesis; * p< 0.1, ** p< 0.05, *** p< 0.01.

and production function have been estimated. Second, (steps 2-6), Y demand and cost shocks are drawn and gross profits are calculated for each draw, allowing the computation of the upper bound of fixed cost. Third, (step 7), the fixed cost upper bound estimate is obtained by averaging the gross profits over the Y draws.

Algorithm 1 Fixed Cost Estimation Algorithm

1: Use realized demand, labor and material shocks $\hat{\zeta}$, $\hat{\omega_L}$, and $\hat{\omega_M}$ to estimate joint probability distribution of the shocks $f_{\zeta,\omega_L,\omega_M}$
2: Take Y draws from the joint distribution $(\zeta_y, \omega_{Ly}, \omega_{My}) \sim f_{\zeta,\omega_L,\omega_M}$
3: **for** each pharmacy s and each draw y **do**
4: Calculate gross profits:

$$\Pi_{sy} = \overbrace{\hat{R}_s \times \exp(\zeta_y)}^{\text{Revenue}} - \overbrace{\frac{1}{B+\omega_{My}} \times \hat{R}_s \times \exp(\zeta_y)}^{\text{Material costs}}$$
$$- \underbrace{(\frac{\hat{R}_s \times \exp(\zeta_y)}{\exp(A)})^{\frac{1}{\kappa}} \times \exp(-\frac{\omega_{Ly}}{\kappa})}_{\text{Labor costs}} - \underbrace{T(\hat{R}_s \times \exp(\zeta_y))}_{\text{Taxes}}$$

5: Compute the upper bound fixed cost:

$$\bar{F}_{sy} = \Pi_{sy}$$

6: **end for**
7: Estimate the fixed cost upper bound by taking the average over Y draws:

$$\bar{F}_s = \frac{1}{Y}\sum_{y=1}^{Y} \bar{F}_{sy}$$

A.3 Entry Algorithms

SME and BSME are presented in Algorithms 2 and 3. Depending on the size of the entry game, BSME is at least an order of magnitude faster than SME and more than 40 times faster in our application, taking ca. 90 minutes compared to SME's 3900 minutes.[15] BSME does'nt necessarily converge to a Nash equilibrium either (Seim and Waldfogel 2013; Verboven and Yontcheva 2024).

In our implementation, we also force SME to terminate if the aggregate number

15. The simulations were conducted on a server with 128 GB of RAM and an Intel Xeon Gold 6342 processor running at 2.8 GHz

Algorithm 2 Sequential Mopic Entry Algorithm

Initialize a list of potential locations L
Initialize an empty list of store locations S
while there exists a profitable location in L **do**
  For each location $l \in L$, calculate the profit given the existing stores in S
  Find the location $l_{\max}$ with the maximum profit
  if profit at $l_{\max}$ is positive **then**
    Add $l_{\max}$ to S
    For each store $s \in S$, if it is not profitable; remove s from S
  end if
end while
The algorithm terminates when no further profitable locations are found or $\|S\|$ does not change for 10 iterations

of pharmacies has not increased in 10 consecutive iterations. This avoids the algorithm getting stuck in a loop.

A.4 Welfare Calculations

To calculate consumer surplus in monetary terms, we convert travel times to monetary terms with an outside estimate of travel cost t_{dt} . We assume that the marginal utility of the distance traveled is independent of consumer income. The rationale is that the regulatory and reimbursement system make consumer choices less income-dependent. The change in CS for post code t is:

$$\Delta E\left(\mathrm{CS}_t\right) = \int \frac{t_{dt}}{\beta_i^{dist}}\left[I_i^1 - I_i^0\right] d\beta_i, \tag{18}$$

where β_{dist} is the distance parameter from the demand model and the I terms represent the log-sum from equation (6) with superscript 0 denoting the baseline model and superscript 1 the counterfactual scenario (Train 2009). $\Delta E(CS_t)$ is the change in average CS for the sub-population who have the same utility as

Algorithm 3 Backward Sequential Myopic Entry Algorithm

Initialize a list of potential locations L
Initialize a list of store locations S so that $S = L$
Initialize choice probabilities $\forall s \in S$
while there exists an unprofitable store in S **do**
    Find the store $s_{\min}$ with the minimum profit
    if profit at $s_{\min}$ is negative **then**
        Remove $s_{\min}$ from S
        For each store $s \in S$, update profits
    end if
end while
Initialize a list of stores $S^* = S$
for $s \in S$ **do**
    while s can accommodate a new entrant **do**
        Add a new entrant s to S^*
        For each store $s \in S^*$, if not profitable; remove s from S^*
    end while
end for
Fill the rest of locations with the SME algorithm.

individual i. This idea can be used to calculate surplus changes for consumers living in a certain geographic area (Hackmann 2019) or with respect to certain consumer demographics (Conlon and Rao 2023). The total CS is calculated as the weighted sum of equation (18) with weights representing the number of consumers who share the same representative utility (Train 2009).

Adding t_{dt} to the numerator in equation (18) allows us to monetize consumer utility. The previous literature contains two alternative approaches for obtaining the t_{dt}. Verboven and Yontcheva (2024) use travel cost estimates from previous studies. Einav, Finkelstein, and Williams (2016) calculate the income a consumer loses if they need to travel to a pharmacy instead of using that time for work. This approach only requires information on the travel time to the pharmacy and consumer income. We use this method and calculate (t_{dt}) as

$$t_{dt} = 2 \times \text{average hourly wage} \times N_{trips} \tag{19}$$

Equation (19) provides our travel cost estimate for cell t. We base our travel cost on using data sources, as we are not aware of studies that estimate Finnish health service travel costs. We use the average hourly wage in Finland and the average number of pharmacy visits by each postal code area in equation 19. We multiply the number of trips with two to allow for a return trip. We plot the distribution of pharmacy visits in Online Appendix Figure B.1 together with the transactions which show that consumers typically make several purchases per visit.

Our CS calculation does not include welfare gains or losses from increased pharmaceutical use. On one hand, one may argue that the increase is over-consumption from a medical perspective, but on the other hand, one could also interpret the increase to be pharmacologically effective use by distance-sensitive consumers who would otherwise forego their medical treatments.

B Online Appendix

This secondary appendix contains supplementary materials and is structured as follows. We provide institutional background of the Finnish pharmacy market in Subsection B.1 of this Appendix and Subsection B.2 offers an overview of EU regulatory frameworks across member states. Subsection B.3 describes the datasets used in the analysis and their sources. Subsection B.4 explains the methodology for calculating travel times between locations. Subsection B.5 provides additional free entry counterfactual results and Subsection B.6 presents free entry counterfactual with different fixed cost specifications. We provide an analysis of how cell characteristics are associated with consequences of counterfactual entry—changes in CS, HHI—in Subsection B.7. Finally, Subsection B.8 provides several maps of descriptive statistics and counterfactual simulation results.

B.1 Institutional Background

Finnish Pharmacies and Relevant Regulation. We exclude hospital pharmacies which cannot sell pharmaceuticals; they can administer drugs free of charge for immediate use or for the start of outpatient care. See Finnish Medicines Act Section 7 65 §.

Fimea determines the number and locations of pharmacies according to need and pharmaceutical availability. A pharmacist must be granted a personal pharmacy license by Fimea which requires an M.Sc. in pharmacology, the ability to manage a pharmacy, and that the pharmacist has not have been declared bankrupt, appointed a conservator, or convicted of a crime relevant to the operation of a pharmacy. The application form and basic rules can be found on the web-page of the regulator, Fimea. The key categories are 1) previous experience in pharmacies and pharmaceutical services and 2) relevant studies and management skills. The available materials do not give any indication on how the various aspects are weighed in the choice of the pharmacist.

A pharmacist can operate only one main pharmacy at a time but can own up to three additional subsidiary pharmacies that are established at the initiative of Fimea, the pharmacist, or the municipality if Fimea considers it necessary to ensure pharmaceutical availability, but for which there are no prerequisites for an independent pharmacy. In some cases, a pharmacy license can be conditional on the operation of a subsidiary pharmacy in a designated rural area. For detail on subsidiary pharmacies, see the Finnish Medicines Act 395/1987 52§. As an exception, the University of Helsinki is allowed to own and operate a main pharmacy and up to 16 subsidiary pharmacy branches. Furthermore, the University of Eastern Finland is allowed to operate one pharmacy. Beyond usual pharmacy activities, the university-owned pharmacies have the responsibility to carry out pharmaceutical education and medical research. The manager of a branch pharmacy must have a pharmacy degree.[16]

Pricing of Pharmaceutical Products in Finland. Only pharmacists (with a pharmacology degree) are allowed to dispense prescription drugs. Wholesalers are required to set nationwide prices.[17] Retail prices for prescription drugs are determined by a formula based on wholesale prices, plus a dispensing fee and VAT. Since 2021, the pricing of OTC drugs is regulated separately, with a formula based

16. See the Finnish Medicines Act 395/1987 43 b §. The pharmacy priviledges for universities are detailed in 42 §, and the subsidiary regulations in 52 §.

17. For the dispensing rules, see Fimea order 2/2016 Sectio 4.2. Price discrimination at the wholesale-level is forbidden by the Finnish Medicines Act 37 a §.

Table B.1: Retail prices for RX and OTC drugs in Finland

Wholesale price (WP)	Retail price (2003)	Retail price (2014)	Retail price (2023)
0–9.25 / 0–7.49	1.5 × WP + 0.50 €	1.45 × WP	1.42 × WP
9.26–46.25 / 7.50–39.99	1.4 × WP + 1.43 €	1.35 × WP + 0.92 €	1.35 × WP + 0.52 €
46.26–100.91 / 40.00–99.99	1.3 × WP + 6.05 €	1.25 × WP + 5.54 €	1.24 × WP + 4.92 €
100.92–420.47 / 100.00–399.99	1.2 × WP + 16.15 €	1.15 × WP + 15.63 €	1.15 × WP + 13.92 €
over 420.47 / 400.00–1499.99	1.125 × WP + 47.68 €	1.1 × WP + 36.65 €	1.10 × WP + 33.92 €
over 1 500			1 × WP + 183.92 €

Notes: This table presents the markup regulation for RX and OTC pharmaceuticals in Finland. The first column gives the brackets used in 2003–2022 on the left and the brackets for 2023 and onwards on the right. The second column the retail price formulas applied to RX products between 2003–2013 and for OTC products between 2003–April 2022, after which they apply as maximum pharmacy markups. The third column gives the RX formulas for 2014–2022 and the fourth column presents the current markup formula for RX drugs.

on the wholesale price determining the maximum retail price.[18] The reimbursement rate (of 40%, 65% or 100%, depending on the product) is based on the reference price. The reimbursement system includes an annual minimum copayment of €50; the maximum copayment is capped at ca. €610(in 2024). The Pharmaceutical Pricing Board (Hila) establishes reference price groups based on substitutable drugs in generic markets within the reimbursement system.[19] In 2021, Kela reimbursements amounted to 1.7 billion euros, representing 47% of total pharmaceutical and 62% of retail market expenditure (Finnish Medicines Agency and Finnish Social Insurance Institution 2022).

Pharmacy Taxation. The pharmacy tax, rates of which are shown in Table B.2, has been in place since 2016. Unlike standard business taxes that are based on gross profits, the tax is based on pharmacist's total revenue from the main pharmacy and any subsidiaries. Although the highest tax brackets in Table B.2 exceed the current markups in Table B.1, the revenues from pharmaceutical sales exceeding the

18. Pharmacy prices are governed by the Finnish Medicines Act 58 §, whereas the markups are set by a government decree. The markups during our data sample are given in Decree 713/2013, while the OTC rules were changed in Decree 193/2022.

19. The reimbursement rates are set in Section 5 of the Finnish Health Insurance Act 1224/2004. The reference price system has been in place since April 2009. It is governed by Section 6 18–24 §.

Table B.2: Pharmacy Tax Rates

Revenue Range (€)	Base Tax at Lower Bound (€)	Tax Percentage for Excess Revenue (%)
871,393–1,016,139	0	6.10
1,016,139–1,306,607	8,830	7.15
1,306,607–1,596,749	29,598	8.15
1,596,749–2,033,572	53,245	9.20
2,033,572–2,613,212	93,432	9.70
2,613,212–3,194,464	149,657	10.20
3,194,464–3,775,394	208,945	10.45
3,775,394–4,792,503	269,652	10.70
4,792,503–6,243,857	378,483	10.95
Over 6,243,857	537,406	11.20

Notes: Tax rates are based on pharmacy revenues.

€1,683.92 retail price level are not included in the revenues used in the calculation of the tax.[20] We maintain the tax system in place in our counterfactual simulation. To illustrate, consider the median pharmacy with taxable revenue of €3,480,000 and a profit net of materials and labor of €490,000. This revenue falls in the range of €3,194,464 to €3,775,394 in the tax table. The base tax at the lower bound of this range is €208,945, and the tax percentage for the revenue exceeding the lower bound is 10.45%. To calculate the total tax, first determine the excess revenue over the lower bound: Excess Revenue = €3,480,000 - €3,194,464 = €285,536. Tax on Excess Revenue = €285,536 $\times$ 0.1045 = €29,838.51. To arrive at total tax, add the base tax at the lower bound: Total Tax = €208,945 + €29,838.51 = €238,783.51. For comparison, the standard corporate tax of 20% would result in a tax of €94,722.40.

20. The tax rates have been adjusted to benefit small and branch pharmacies and have remained constant since 2013. See Amendment 977/2013 2 a §.

B.2 Pharmacy Regulation in the EU

Table B.3 shows an overview of pharmacy regulation in EU countries. Most countries impose restrictions on the number of pharmacy licenses issued, which are often based on the number of inhabitants per pharmacy. In most EU countries, pharmacy ownership is not restricted to pharmacists. However, in those countries where ownership is restricted to pharmacists, only Estonia, Hungary, and Poland allow a pharmacist to own multiple pharmacies. The amount of higher education required for pharmacy technicians or assistants ranges from none to four years with an average of 2.5 years. The degree of horizontal integration regulation varies between countries, with most countries allowing pharmacy chains. Bulgaria, Estonia, Hungary, Poland, and Portugal limit the chains to four pharmacies. Branch pharmacies and minority stakes are not included in horizontal integration. Most EU countries allow pharmacies to be owned by pharmaceutical wholesalers, making vertical integration possible. In particular, the regulation of horizontal and vertical integration is highly correlated, and in many countries, wholesalers also own pharmacy chains.

Table B.4 presents past pharmacy regulation policies focused on price setting, specifically in countries that do not regulate the number or location of pharmacies. The key takeaway is that even when a country allows more flexibility regarding pharmacy quantities or locations, some form of price regulation remains in place, and pharmacy pricing is rarely unregulated. The only exceptions are Sweden and Germany, where pharmacies have some discretion in pricing over-the-counter (OTC) drugs. This suggests that our free-entry counterfactual scenario with regulated pharmacy pricing closely mirrors an institutional framework with partial

Table B.3: Pharmacy Regulation in the European Union (EU)

Country	Pharmacy Quantity	Pharmacy Location	Ownership Limits	Tech Educ.	Integration Horz.	Integration Vert.
Austria	Yes	Yes	Yes	2–3 y	No	No
Belgium	Yes	Yes	No	3 y	Yes	Yes
Bulgaria	No	No	No	3 y	Yes*	Yes
Croatia	Yes	Yes	No	4 y	Yes	Yes
Cyprus	No	Yes	Yes	None	No	No
Czechia	No	No	No	3 y	Yes	Yes
Denmark	Yes	Yes	Yes	3 y	No	No
Estonia	Yes	Yes	Yes	3 y	Yes*	No
Finland	Yes	Yes	Yes	3 y	No	No
France	Yes	Yes	Yes	2 y	No	No
Germany	No	No	Yes	2.5 y	No	No
Greece	Yes	Yes	No	2 y	Yes	Yes
Hungary	Yes	Yes	Yes	None	Yes*	No
Ireland	No	No	No	2 y	Yes	Yes
Italy	Yes	Yes	No	-	Yes	Yes
Latvia	Yes	Yes	No	2.5 y	Yes	Yes
Lithuania	No	Yes	No	3 y	Yes	Yes
Luxembourg	Yes	Yes	-	-	-	-
Malta	Yes	Yes	No	2 y	Yes*	Yes
Netherlands	No	No	No	2 y	Yes	Yes
Poland	Yes	Yes	Yes	2 y	Yes*	No
Portugal	Yes	Yes	No	4 y	Yes*	Yes
Romania	Yes	Yes	No	3 y	Yes	Yes
Slovakia	-	Yes	No	-	No	-
Slovenia	Yes	Yes	No	4 y	No	No
Spain	Yes	Yes	Yes	2 y	No	No
Sweden	No	Yes	No	$<$2 y	Yes	Yes

Notes: Overview of pharmacy regulation in the EU. “Pharmacy Quantity” refers to restrictions on the number of pharmacies that can operate. “Pharmacy Location" indicates restrictions on pharmacy locations. “Ownership Limits” describes whether ownership is limited to pharmacists. “Tech Educ.” refers to the education requirements for pharmacy technicians in years. “Integration (Horz. & Vert.)” reflects the allowance of horizontal and vertical integration within the pharmacy sector. *Limited to four pharmacies, or one per town for Malta. Source: World Health Organization (2019).

Table B.4: Pharmacy Market Deregulation and Pricing in the EU

Country	Price Regulation	Free Pricing
Bulgaria	Yes	No
Cyprus	Yes	No
Czechia	Yes	No
Germany	Yes	No (RX), Yes (Non-RX)
Ireland	Yes	No
Lithuania	Yes	No
Netherlands	Yes	No
Slovakia	Yes	No
Sweden	Yes	No, Yes (OTC)

Notes: This table provides price regulation information for countries listed in Appendix Table B.3 that have implemented some form of entry deregulation. “Price Regulation” refers to existence of price regulation policies when some part of the pharmacy market entry regulation is lifted. “Free Pricing” refers whether pharmacies can set prices freely or not. Sources; Bulgaria: (Rohova, Dimova, Mutafova, Atanasova, Koeva, Ginneken, et al. 2013; Dimova, Rohova, Atanasova, Kawalec, and Czok 2017; Medicines for Europe 2022, 2023; Vogler, Arts, and Habl 2006) Cyprus: (Zimmermann and Haasis 2021; Medicines for Europe 2023; Kanavos and Wouters 2014) Czechia: (Skoupá 2017; Medicines for Europe 2022, 2023) Germany: (Reese and Kemmner 2023; Medicines for Europe 2022, 2023) Ireland: (Medicines for Europe 2022, 2023; Doyle-Rossi and Gallagher 2023; Vogler, Arts, and Habl 2006) Lithuania: (Enterprises 2021; Medicines for Europe 2022, 2023) Netherlands: (Zuidberg, Vogler, and Mantel 2010; Medicines for Europe 2022, 2023) Slovakia:(Smatana, Pažitnỳ, Kandilaki, Laktišová, sdláková, Palušková, Ginneken, and Spranger 2016; Medicines for Europe 2022, 2023) Sweden: (Medicines for Europe 2022, 2023; Panteli, Arickx, Cleemput, Dedet, Eckhardt, Fogarty, Gerkens, Henschke, Hislop, Jommi, et al. 2016)

liberalization.

Table B.5: Data Sources

Data	Source	Open source	Usage
Pharmacy accounting data	Fimea	No	Analysis
Grid Database	Statistics Finland	No	Analysis
Zip-code RX expenditure	Kela	No	Analysis
Zip-code pharmacy visits	Kela	No	Analysis
Community structure data	SYKE	Yes	Analysis
Urban/Rural classifications	SYKE	Yes	Analysis
Pharmacy register	Fimea	Yes	Analysis, Maps
Country boundaries	EuroGeographics	Yes	Maps
Population Grid Data 1 km $\times$ 1 km	Statistics Finland	Yes	Maps
Paavo postal code area data	Statistics Finland	Yes	Analysis, Maps
Helsinki Metropolitan Area map	Helsinki	Yes	Maps
Pharmacy addresses, local amenities and travel distances	OpenStreetMap contributors	Yes	Analysis, Maps

Notes: This table lists our data sources. The first three sources are proprietary and used in the empirical estimations. We use publicly available data to calculate distances and travel times, to characterize population at the post code-level and as well as for plotting maps.

B.3 Data Sources

We list our data sources in Table B.5. The first three data sources are proprietary data from Fimea, Statistics Finland, and Kela. The grid database is a commercial product available for purchase. In addition to this data, we use publicly available data from several institutions and open source projects. Data from SYKE cover several classifications for the urban and rural characterization of the cells. For further information, see Finnish Environment Institute (2021a, 2021b).

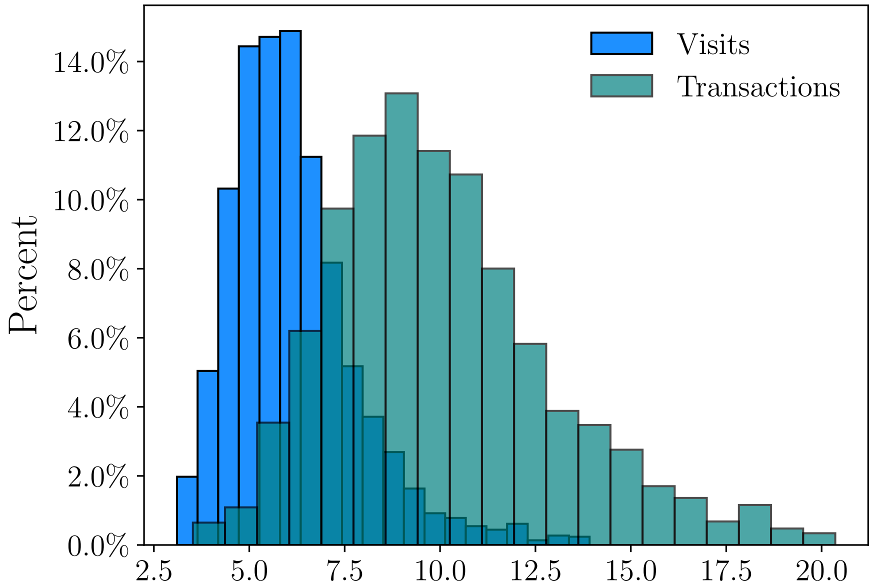
Most importantly, we use several data sources and software from various Open-

StreetMap contributors and projects. We use Nominatim and OpenStreetMap contributors (2024) data and software to map our pharmacy addresses to geolocations. We use OverPy and OpenStreetMap contributors (2024) data and software to locate nearby amenities for all pharmacies and our entry game locations. Finally, we use Geofabrik and OpenStreetMap contributors (2024) data to compute the travel time distances between the cells and pharmacies or the cells and the entry locations. We describe the computation of these distances in the next subsection.

B.4 Travel Time Distances

We use the open source route planner OpenRouteService (2024) to calculate the travel distances between the pharmacy and the cells in its catchment area. We also repeat this for all the possible entry locations and their catchment areas. Due to the large number of cells and destinations (more than fifty million distances), we do not use the publicly available API. Instead, we run the OpenRouteService (2024) as a local instance from their pre-build Docker image. The travel distances are computed for car travel for all cells within 80 kilometer Euclidean distance from every pharmacy and entry location. We use the default options of the OpenRouteService (2024) image and do not use elevation data.

Figure B.1: Pharmacy Visits and Transactions



Notes: The figure plots the distributions of pharmacy visits and transactions across postal code areas.

B.5 Additional Counterfactual Simulation Results

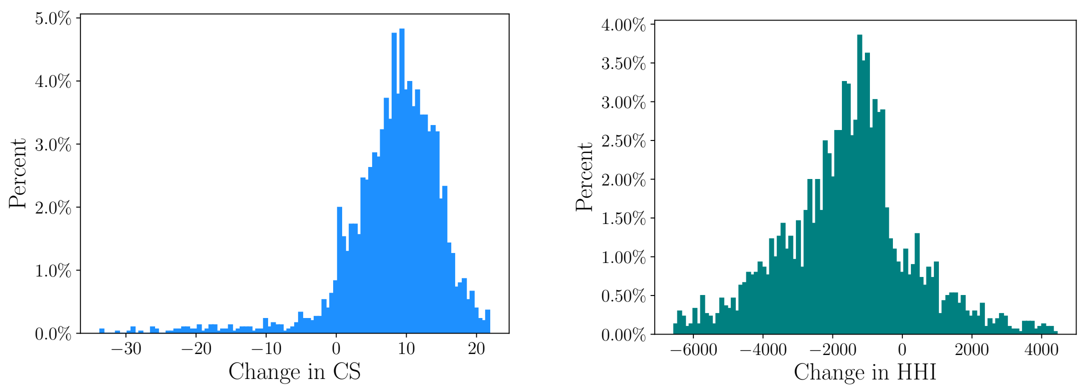
In this Subsection we provide additional results on how free entry affects market concentration and CS changes at the cell and at the population level. These analyses are presented in Figure B.2 and Figure 2 displays the pharmacy network configuration under regulated and free entry.

Figure B.2 plots the cell-level distribution for changes in CS (Figure B.2a) and HHI (Figure B.2b). There are two important insights. First, CS is positive for almost all cells, but the distribution's left tail is very long, and this indicates that the policy benefits are very unequally distributed. Another observation is that market concentration increases for a substantial share of cells (around 13%), but these cells have low population density—Appendix Figure B.3 shows that only around 1.5% of the Finnish population face an increase in market concentration. At the same time Figure B.3 shows that for 1% of the population, welfare decreases despite a reduction in market concentration.[21] This interesting pattern occurs when consumers lose access to local services and must travel to more distant areas with higher competition. Our findings demonstrate that, in some edge cases, improvements in market concentration metrics can counterintuitively lead to welfare losses. In Subsection B.7 we use descriptive regressions to show how CS, HHI, and negative CS changes are associated with consumer demographics and geographical areas.

Table B.6 presents the descriptive statistics for the free entry counterfactual scenario. In Panel A, we show the statistics at the representative consumer (cell)

21. Appendix Figure B.3 cross tabulates CS and HHI changes on the basis of the CS and HHI sign changes. The majority of CS increases coincide with HHI decreases, and vice versa (96% of consumers).

Figure B.2: Δ CS and Δ HHI Distributions



(a) Δ CS (b) Δ HHI

Notes: The figure on the left plots the distribution of the cell-level changes in CS per capita. The figure on the right plots the changes in HHI. Both figures show the 1–99 percentile range.

level for changes in HHI concentration, CS and two different distance measures and Panel B represents the same statistics for the actual population that lives in these cells. The first distance measure is the weighted distance, where we weight the distance to pharmacies with their consumer-level choice probabilities. The minimum distance simply gives the minimum distance in the choice set. Most importantly, the results in Table B.6 Panel A show that, on average, consumer welfare increases through increased competition, which is denoted by the substantial average decrease in HHI. Importantly, in most areas, consumer welfare increases as shown by the positive 10th percentile threshold. Comparisons between CS distribution 10th, 50th and 90th percentile in Table B.6 Panels A and B show that consumer surplus increases are mainly positive, but unevenly distributed in the population. We present the empirical distributions of the cell-level HHI and CS changes in main text Figure B.2.

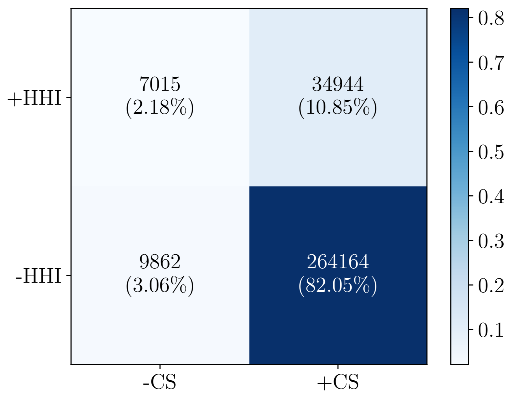
Table B.6: Entry Descriptive Statistics

Variable	Mean	Std. Dev.	P10	P50	P90	N
Panel A: Cell characteristics						
Δ HHI	-1914.91	2186.36	-4656.22	-1774.99	442.45	315985
Δ CS	211.04	840.80	3.62	27.59	388.43	321950
Weigh. distance	16.04	12.78	6.56	14.45	25.93	315980
Min distance	12.99	13.94	3.12	10.86	24.40	315985
Panel B: Consumer characteristics						
Δ HHI	-1814.04	1594.27	-4079.24	-1414.29	-465.57	5461663
Δ CS	12.40	6.50	7.57	13.04	17.46	5480966
Weigh. distance	9.70	6.53	4.45	8.88	15.42	5461654
Min distance	4.97	6.92	1.11	3.16	11.22	5461663
Panel C: Pharmacy characteristics						
Revenue	1183.56	208.68	945.13	1150.51	1479.06	2276
Labor costs	154.23	20.26	137.28	146.12	184.84	2276
Pharmacy tax	21.48	15.51	4.50	18.44	43.65	2276
Net profit	46.03	23.61	11.85	47.34	76.55	2276

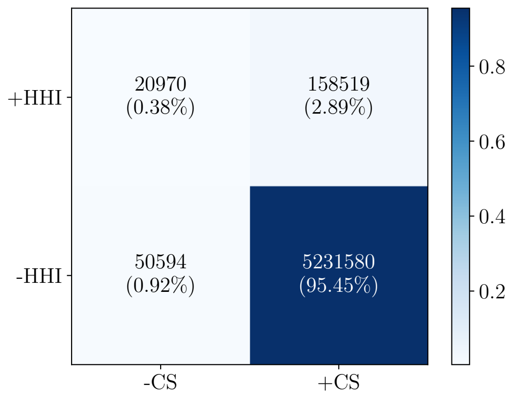
Notes: This table presents descriptive statistics of the free entry counterfactual. The first panel consists of cell-level measures, second panel of consumer-level measures, and third panel of pharmacies. The 2277 pharmacies in the market are located in 2191 unique locations. All variables are in absolute values. Panel C monetary values are in thousands.

Table B.6 Panel C displays descriptive statistics for pharmacies that enter the Finnish market in our counterfactual. Due to free entry, the number of pharmacies increases substantially from the regulated baseline scenario. Counterfactual pharmacies are on average smaller and less profitable than pharmacies in the regulated scenario (compare Table 1 Panel C and Table B.6 Panel C). This change is an expected result, because business stealing between pharmacies significantly decreases the revenue per pharmacy whereas the market expansion effects are modest. At

Figure B.3: HHI and CS combinations



(a) Cells



(b) Population

Notes: The figure on the left plots the combinations for HHI and CS pairs between cells. The figure on the right scales these by population. The population counts differ slightly from Table B.7 because of missing HHI values due to loss of service.

the same time the average labor input decreases. Labor costs do not vary between counterfactual pharmacies as much as costs vary in the regulated scenario.

Figure B.3 tabulates cell and population specific CS and HHI changes. This tabulation clearly shows that, after the removal of entry restrictions, most cells and a majority of the Finnish population experience an improvement in consumer CS. Figure B.3a shows that 82% of cells are such that market concentration decreases and consumer surplus increases and only around 2% of the cells are such that market concentration increases and consumer surplus decreases. Welfare decreases only for 5% of the cells in comparison to the regulated scenario. The results are qualitative the same when the effects of the deregulation policy on the whole population are studied in Figure B.3b. Now it is important to observe that the magnitude of adverse effects shrinks, because in reality many people can live in the same cell. If cells facing adverse effects are small in comparison to cells that benefit from the policy, then this should reduce the number of people who do not gain from the policy. Only around 1.5% of the Finnish population lose in terms of consumer welfare. It is worthwhile to mention that almost 95.5% consumers face increases in consumer surplus and a reduction in market concentration.

B.6 Free Entry Counterfactual with Alternative Fixed Costs

This analysis revisits our free entry counterfactual by changing the fixed costs used in the analysis. Analyses with increased fixed costs intuitively mean that we artificially raise the minimum profit requirement for operating a pharmacy both in rural and urban areas. We use this analysis to understand how robust our headline results are to changes in the fixed costs. We adjust our counterfactuals with fixed costs set to the 25th quantile and the median of the distribution of estimated fixed cost upper bounds and we calculate separate costs for urban and rural regions.

Table B.7 presents the main results for different fixed costs specifications. The first column presents the main results discussed in Section 7 as a benchmark, whereas the second and third columns present results for the alternative fixed costs. Even with unrealistically high fixed cost, the change in total surplus (TS) remains negative, but the negative surplus change is much smaller than in the main results (Table B.7 column 1). Changes in TS are mainly explained by decreased aggregate fixed and labor costs in addition to increased pharmacy tax revenue.

Increasing fixed costs decreases aggregate CS in comparison to the main results, but the aggregate CS does not decrease linearly. With fixed costs set in the 25th Quantile, the change in aggregate CS is 6 pp. smaller than in the main results, but

Table B.7: Counterfactual Results With Different Fixed Costs

Variable	**Fixed Costs Quantile 0**	**Fixed Costs Quantile 25**	**Fixed Costs Quantile 50**
	Panel A: Consumers		
Δ Consumer surplus (CS)	67.94	39.23	25.45
	(14%)	(8%)	(5%)
Sum of negative Δ CS	-1.79	-3.72	-7.01
	(-29%)	(-25%)	(-19%)
Average Δ weigh. distance	-0.48	-0.06	0.49
	(-3%)	(-0%)	(3%)
	Panel B: Pharmacies		
Δ Number of pharmacies	1459	429	136
	(178%)	(52%)	(17%)
Δ Revenue	197.55	92.59	35.24
	(8%)	(4%)	(1%)
Δ Labor costs	57.54	22.34	10.48
	(20%)	(8%)	(4%)
Δ Fixed costs	162.07	90.26	35.92
	(188%)	(55%)	(18%)
Δ Gross profits	120.25	50.61	21.74
	(51%)	(22%)	(9%)
Δ Net profits	-41.73	-39.49	-13.99
	(-28%)	(-56%)	(-35%)
	Panel C: Government and Total Surplus		
Δ Pharmacy tax	-122.38	-46.98	-22.34
	(-71%)	(-27%)	(-13%)
Δ Value-added tax	19.76	9.26	3.52
	(8%)	(4%)	(1%)
Δ Total surplus	-76.41	-37.98	-7.35
	(-7%)	(-4%)	(-1%)

Notes: This table shows aggregate changes in the market under free entry counterfactual relative to the current pharmacy network. The columns represent different specifications for fixed costs. All monetary values are in €M. Gross profits are calculated as revenue minus material costs, labor cost and taxes. Net profits are calculated as gross profits minus fixed costs.

with median fixed costs, the change in CS is only 9 pp. smaller. It is worthwhile to note that even with Quantile 50 fixed costs (Table B.7 column 3) the number of pharmacies increase by 136 pharmacies (17%). The sum of negative CS changes increases in absolute value. The sum of negative CS either doubles (Quantile 25) or almost quadruples (Quantile 50). This means that even with unrealistically high fixed costs, the negative CS changes are in per capita terms quite modest and it should be relatively easy to find ways to compensate individuals who are hurt by the reform.

Table B.7 Panel B displays changes in pharmacy revenue, labor costs, fixed costs, and gross and net profits for the different fixed cost specifications. With Quantile 25 fixed costs, pharmacy revenue is 4 pp. smaller than in baseline results, but for median fixed costs, the difference is only 1 pp. . At the same time, labor costs are 12 pp. (Quantile 25) or 16 pp. (Quantile 50) smaller than in the baseline scenario. At the same time net pharmacy profits remain smaller than in the regulated scenario but net profits are larger than in the free entry counterfactual. Sum of net profits changes non-linearly between different columns in Table B.7 because same fixed costs are applied to the status quo situation and to the counterfactual scenario.

The change in pharmacy and value added taxes is reported in Table B.7 Panel C. Tax revenue from pharmacy taxes is smaller than it was under entry regulation because tax is revenue based, but with Quantile 25 or Quantile 50 fixed costs tax revenue from pharmacy tax increases in comparison to free entry counterfactual (Table B.7 column 1 vs columns 2 and 3). The opposite happens with value added tax, because aggregate pharmacy market sligthly expands in counterfactual scenario. Market expansion mechanically leads to value added tax revenue increasing in comparison to regulated scenario.

B.7 Heterogeneity Analysis

Our results show that allowing free entry into the Finnish pharmacy market leads to a large majority of consumers experiencing an increase in welfare, with a modest average increase in aggregate CS. Here we examine how the benefits of free entry are distributed across different demographic groups and geographical areas. We aggregate our data to the postal code level because most of the demographic information is censored at the cell-level. We estimate linear regression models:

$$\Delta\bar{y}_p = \bar{X}_p\beta + \bar{Z}_p\gamma + \bar{\varepsilon}_z. \tag{20}$$

Our outcome variables ($\Delta\bar{y}_p$) are: The percentage change in CS, the percentage change in HHI, and an indicator for a negative change in CS. We regress these outcomes on demographics $\bar{X}$ and regional characteristics $\bar{Z}$. $\bar{X}$ contains log average income, log average age, share of pensioners, share of unemployed, and the share of population with only comprehensive education. We include dummies "Suburban" and "Rural" into $\bar{Z}$, the base group being urban areas.

The results in Column 1 of Table B.8 (change in CS) are consistent with rural areas with an older population and more pensioners benefiting less from free entry. Regions characterized by higher unemployment, lower educational attainment, and suburban locations exhibit an increase in CS as a result of deregulation. Only age and the Suburban-dummy obtain statistically significant coefficients.

Results in Column 2 show that higher average income, the share of pensioners and unemployed, and the suburbia indicator are associated with a decrease in HHI. Areas with older and less educated populations, as well as suburban areas, see an increase in HHI. Statistically significant coefficients are found for income, age, the

Table B.8: Heterogeneity Analysis

Dependent Variable: Model:	% Δ CS (1)	% Δ HHI (2)	Δ CS < 0 (3)
Dependent Variable Mean	.1125	-.4101	.0758
	(.0036)	(.0077)	(.0048)
Independent Variables			
Log Average income	.0404	-.245***	-.0286
	(.0327)	(.0657)	(.0458)
Log Average age	-.0032*	.0256***	.007***
	(.0017)	(.0035)	(.0024)
% pensioners	-.073	-.3383	.0594
	(.1037)	(.2089)	(.1455)
% unemployed	.0445	-1.244***	-.355
	(.1803)	(.3647)	(.2528)
% comprehensive education only	.0832	.3333**	.2391**
	(.0796)	(.1601)	(.1116)
Suburban	.0278***	-.0253	-.0163
	(.0095)	(.019)	(.0133)
Rural	-.0253***	.143***	.0186
	(.0087)	(.0175)	(.0122)
Constant	-.1388	.911	-.0182
	(.3326)	(.6688)	(.4665)
Observations	2910	2897	2910
R^2	.0347	.2235	.0639

Notes: Municipality groups follow Statistics Finland definitions: Urban: Cities, Suburban: Densily populated municipalities, Rural: Rural municipalities. Clustered standards errors in parentheses; * p< 0.1, ** p< 0.05, *** p< 0.01.

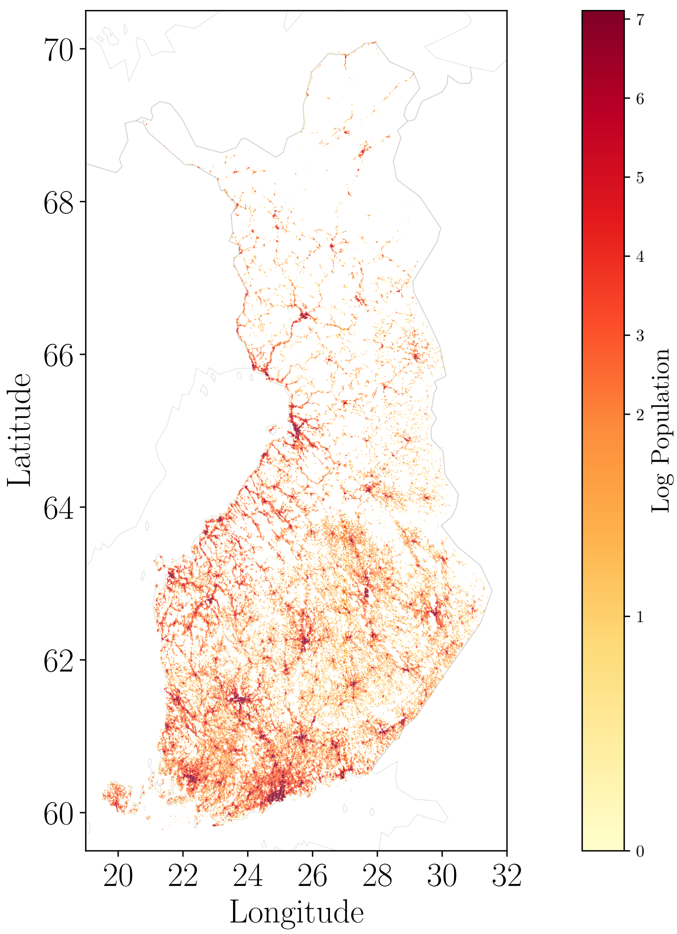
share of pensioners, education, and the suburban dummy.

Results in Column 3 show that the age of the population, the share of pensioners, the share of consumers with only comprehensive education, and suburban areas face a decrease in CS relatively more often. The opposite applies to areas with higher average income, higher unemployment, and areas that are considered urban.

B.8 Additional Maps

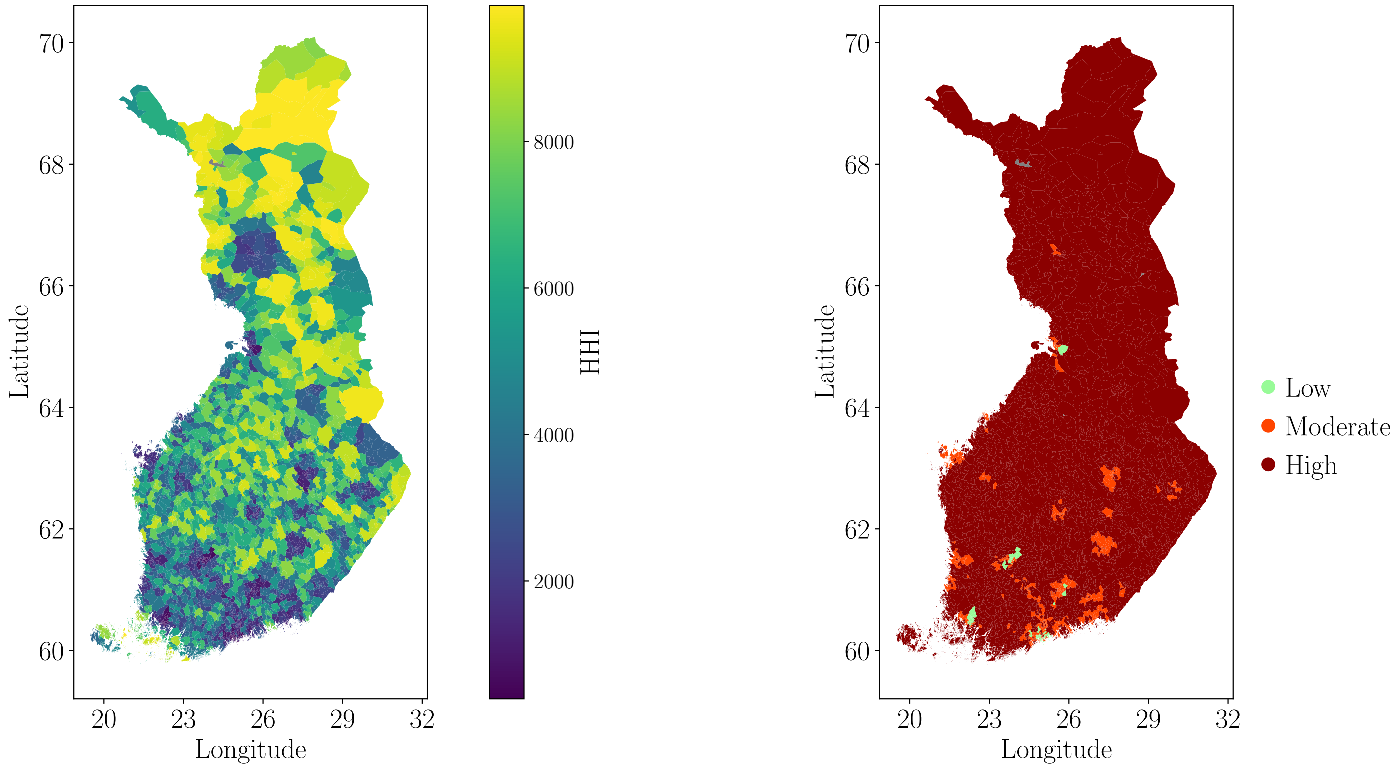
Descriptive Statistics. We present the map of Finland with log population densities in Figure B.4. Finland's population is highly unevenly distributed, with the majority concentrated in the southern and southwestern regions. In contrast, much of Finland's northern and eastern regions are sparsely populated.

Figure B.4: Finland Population Map



Demand Estimation HHI Results. The spatial variation in HHIs is illustrated in Figure B.5 in Panel B.5b, next to a map showing the locations of existing pharmacies in Panel B.5a. The lowest HHIs markets are typically located in and around the largest population centers.

Figure B.5: HHI Maps



(a) Map of HHIs

(b) Map of HHI categories

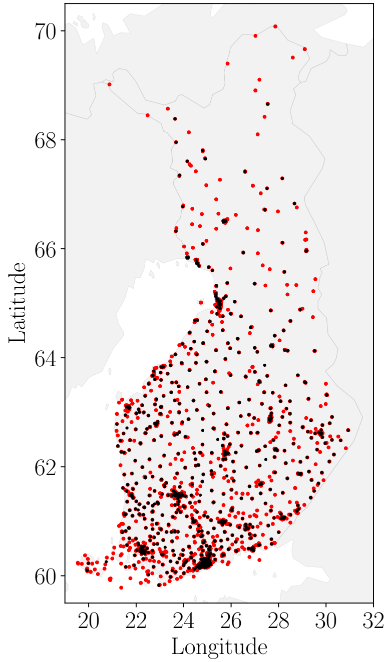
Notes: The figure on the left shows the aggregated HHIs for postal code areas in Finland. The right figure categorizes them based on EU merger guidelines: 'High' (> 2000), 'Moderate' (1000–2000), and 'Low' (< 1000). Source: Statistics Finland (2021).

Potential Entry Locations. The computationally most challenging part in the SME and BSME algorithms is related to the size of the set of potential entry locations L. With our 250m$\times$250m sized map, the number of potential entry locations is in the hundreds of thousands, so iterating over the entire set is slow. Faced with similar problems, Verboven and Yontcheva (2024) restrict L to locations close to post offices. We take a similar approach and restrict entry to all locations next to a grocery store in Finland, which yields roughly 4000 potential entry locations. The choice to use grocery stores, supermarkets and key retail centers as potential entry location comes from the Finnish policy discussion where significant policy interest is on should groceries be allowed to sell pharmaceuticals as pharmacies do. We plot the possible entry locations in Figure B.6.

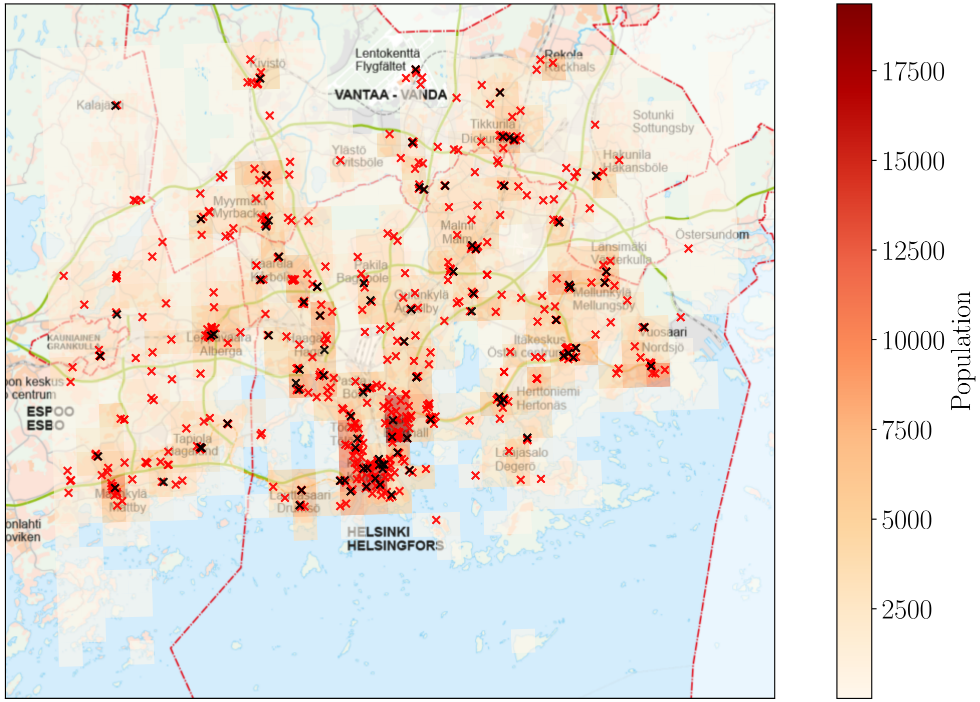
For several reasons, we argue that this is a rather conservative approach. First, we allow the entry of multiple pharmacies in the same location, which means that the number of entrants can exceed the number of locations. Second, the deregulation of the pharmacy markets in Norway and Sweden gives us a good benchmark for the number of pharmacies in equilibrium. In Norway, the number of pharmacies increased from 395 pharmacies in 2000 to 1045 pharmacies in 2023 (Rudholm 2008; Norwegian Pharmacy Association 2024). In Sweden, the number of pharmacies increased from 929 to 1407 between the years 2010–2022 following entry deregulation in 2009 (Swedish Pharmacy Association 2023). Furthermore, OECD (2023) reports an average of 28 pharmacies per 100,000 inhabitants in OECD member countries in 2021. For Finland, below the mean with 15 pharmacies per 100,000 inhabitants per pharmacy, an average rate or a maximum rate of 47 would correspond to 1600–2600 pharmacies.[22] Thus, we expect that our restriction on L has limited influence on our results, but it significantly reduces computational time.

22. In 2021, Spain had approximately 47 pharmacies per 100,000 people. Greece had the highest rate of 97, more than double that of Spain.

Figure B.6: Potential Entry Locations



(a) Whole Finland



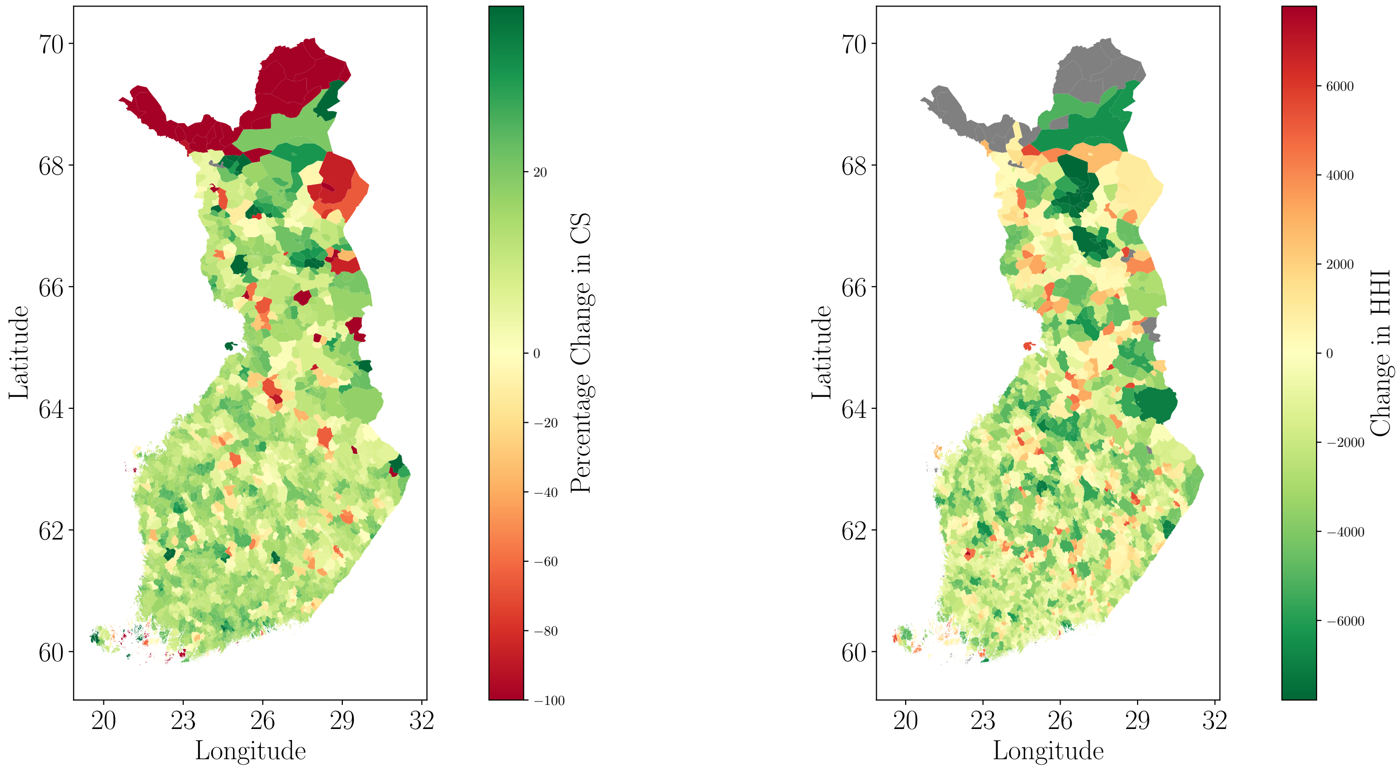
(b) Helsinki

Notes: The figure on the left plots the entry locations and pharmacy locations. The figure on the right shows the same locations in Helsinki. Sources for the maps: Fimea (2021), Nominatim and OpenStreetMap contributors (2024), Statistics Finland (2023), Helsinki City Survey Services, Cities of Espoo, Vantaa, and Kauniainen (2022), and EuroGeographics (2024).

Free Entry Counterfactual Results in Spatial Form. We present the changes in CS and HHI below, along with the HHI classifications. Finally, we provide the map of our counterfactual simulation (main specification).

In Figure B.7, we aggregate our cell-level results to the postal code level and plot maps showing how CS and HHI illustrate changes in postal code-specific consumer welfare and HHI across Finland. These maps show that adverse CS effects mainly come from Northern and Northeast Finland, and because these areas are sparsely populated, the direct population impact remains modest. The increases in market concentration are distributed more evenly across Finland than decreases in CS.

Figure B.7: Postal Code-level Changes in CS and HHI

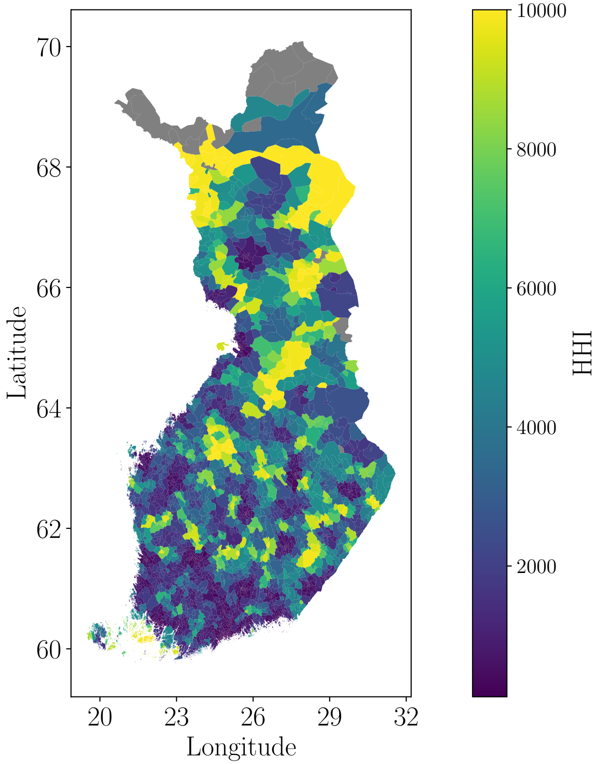


(a) Change in CS (b) Change in HHI

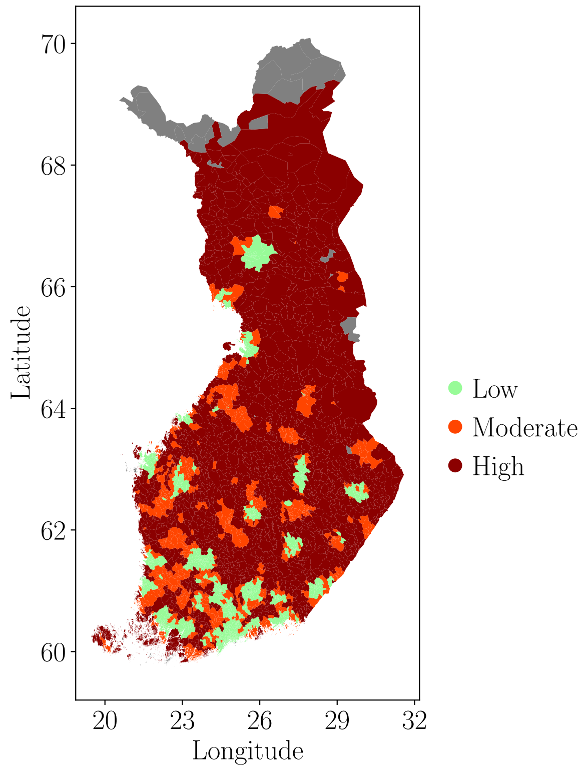
Notes: The figure on the left shows the change in CS for all postal code areas in Finland. The figure on the right shows the change in HHI. Gray areas denote loss of pharmacy access. Source: Statistics Finland (2021).

Figure B.8 illustrates the market concentration in the counterfactual scenario. Figure B.8a displays post code-level HHI and Figure B.8b displays HHI split into categories Low (green), Moderate (orange) and High (Red). Two important facts can be seen from HHI figures. Most of the heavily concentrated (HHI close to 10,000) postal code areas are located in Northern Finland which is inline with the CS changes presented in Figure B.7a. Secondly, the use of HHI thresholds reveals that in the counterfactual scenario only large cities and densely populated areas are the locations where market concentration measured in HHI is low. The usual caveats and challenges related to HHI use must be taken into consideration when Figure B.8 is interpreted through the lens of market concentration.

Figure B.8: HHI Entry Game Maps



(a) Post Entry Game Map of HHIs

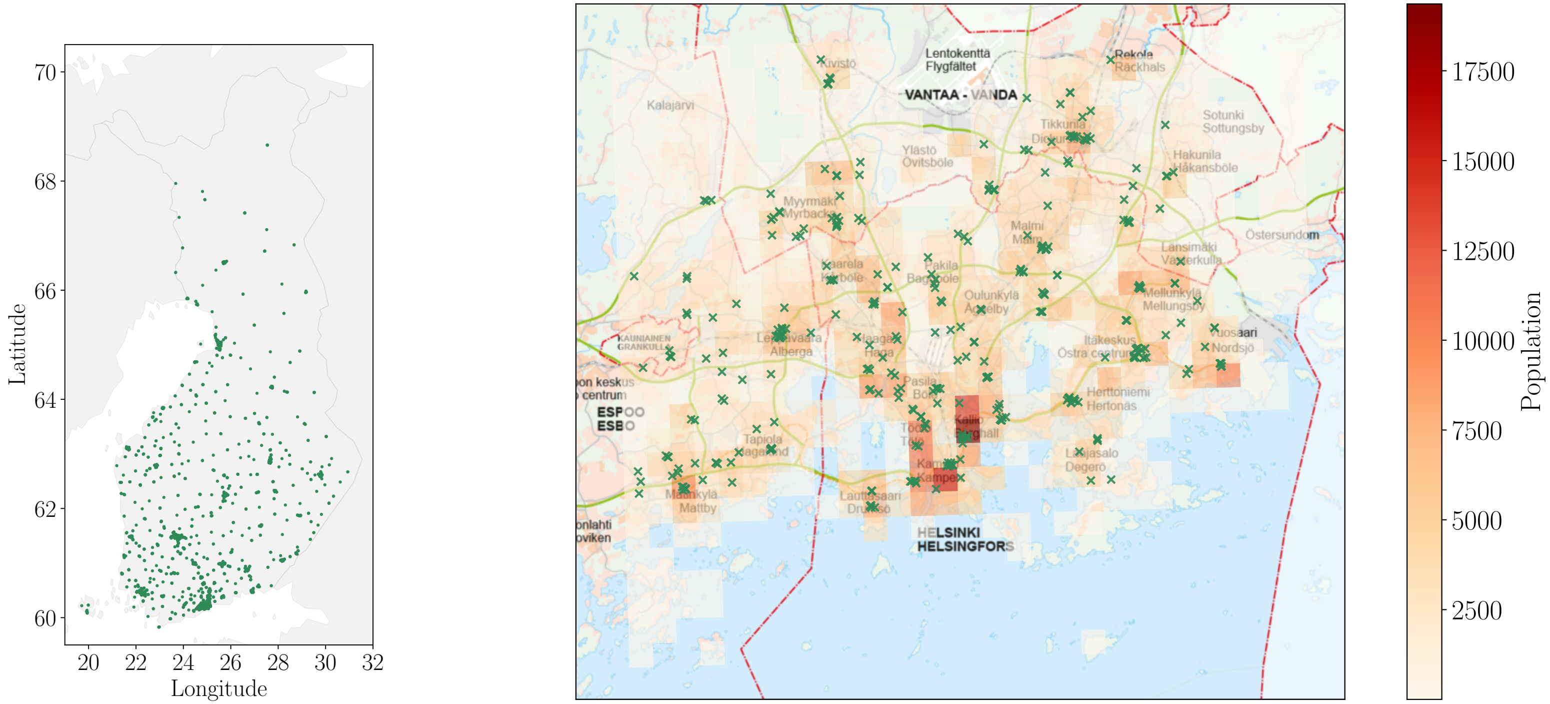


(b) Post Entry Game Map of HHI categories

Notes: The figure on the left shows the aggregated HHIs for all postal code areas in Finland. Gray areas denote loss of pharmacy access. Source: Statistics Finland (2021).

Figure B.9 displays the free entry counterfactual pharmacy network for whole Finland (Figure B.9a) and the Helsinki Capital Region (Figure B.9b). The main text Figure 2a displays the map of Finland. In free entry counterfactual we see that most pharmacies enter locations that are on the fringes of densely populated locations. When a pharmacy is located outside a densely populated area, demand for its services comes from both the population center and the surrounding areas. This explains why only a few pharmacies are located in the centroids of the most populated areas (dark red in Figure B.9b), because then a large part of the demand would come from the highly populated area.

Figure B.9: Post-Entry Pharmacy Network



(a) Whole Finland

(b) Helsinki Capital Region

Notes: The figure on the left plots the post entry game pharmacy network in Finland. The figure on the right shows the same locations in Helsinki. Sources for the maps: Fimea (2021), Nominatim and OpenStreetMap contributors (2024), Statistics Finland (2023), Helsinki City Survey Services, Cities of Espoo, Vantaa, and Kauniainen (2022), and EuroGeographics (2024).

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