Chain formation and consumer welfare on the retail pharmacy market

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Abstract

The present paper evaluates the effect of deregulated ownership and horizontal integration on the retail pharmacy market. Using data on the full population of reimbursed prescriptions in Slovakia in 2017, we examine whether outlets of pharmacy chains perform better than their independent counterparts in terms of consumer preferences and operating costs. Our preliminary findings indicate that consumers perceive pharmacy chains as having higher quality on average than independent outlets, although there is substantial heterogeneity in the effects, both across chain brands and across consumer types. We do not find evidence for substantial productivity gains due to chain affiliation.

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1 Introduction

The European retail pharmacy sector has experienced substantial regulatory changes during the past two decades. Most of these reforms have been directed towards lifting geographic entry restrictions and have resulted in similar regulatory environments across national jurisdictions.[1] However, substantial variation remains in the regulatory approach to ownership and horizontal integration on the market. While some countries have legalized the formation of chains and are experiencing considerable horizontal and vertical integration at the retail level, in others the establishment of multi-store pharmacies remains prohibited or limited to a small number of clustered locations (Kanavos et al., 2011).

The present paper aims to contribute to the debate regarding the effects of chain formation on perceived quality, costs and geographic coverage by empirically evaluating the role of chains on the Slovak pharmacy market. The Slovak market is characterized by the presence of multiple vertically integrated chains, as well as a substantial share of independent pharmacies. This allows us to capture not only the differences between chains and single-outlet sellers, but also the heterogeneity in outcomes across chain types.

In our analysis, we aim to address two broad questions. Firstly, we would like to evaluate to what a degree consumers perceive chain outlets as different from independent sellers. Falling quality has been cited as a major concern in the deregulation process, as pharmacists employed by chains may prioritize profitability over the quality of service (European Court of Justice, verdict C-171). We implement a spatial discrete choice model to investigate whether these concerns are reflected in consumer preferences. As the vast majority of transactions happen at the maximum regulated price, we expect that the variation in consumer utility across pharmacy formats is mainly driven by perceived quality differentials. The results of our model indicate that consumers do not systematically perceive chains as inferior to other outlets.

Secondly, we examine the production process within different pharmacy formats in order to evaluate the scope for cost reduction through chain affiliation. Economies of scale, more efficient distribution networks and improved managerial practices are a common argument for the liberalization of ownership in the industry (Anell, 2005). We do not find evidence that pharmacists employed within chains conduct a higher number of transactions than their independent counterparts. Similarly, we do not find evidence for substantial advantages for

[1] The deregulation wave began in the Netherlands, which forbade restrictions to entry in the pharmacy market in 1998 and also allowed the formation of chains. This was followed shortly thereafter by a similar deregulation in Sweden. In 2005, England relaxed its entry restrictions ("control of entry" test). Ireland revoked establishment regulation in 2007. See Vogler et al. (2012) for details on the deregulation process in selected OECD countries.

participants in so-called virtual chains (i.e. chains based on franchising contracts rather than transfer of ownership) during the entry process. Contrary to expectations, we find that chains based on ownership require higher variable profits on average than their independent counterparts in order to permit entry in a given location. As such, entry of chains is unlikely to substantially improve geographic coverage.

The remainder of the paper is structured as follows: Section 2 provides a brief overview of ownership regulation across different OECD jurisdictions (with a focus on Slovakia) and briefly discusses the empirical literature on pharmacy chains. Section 3 describes the data used in the analysis. Section 4 presents a spatial discrete choice model of pharmacy demand for prescriptions. The reduced-form model for other sales is presented in Section 5. Section 6 details the estimation of firm variable costs. Section 7 outlines a model of revealed preference driving the entry decisions of different pharmacy formats. Section 8 presents a discussion of the current findings and preliminary conclusions.

2 Ownership regulation of retail pharmacies

The regulation of the European retail pharmacy market has gone through substantial changes in the past two decades. The main focus of these reforms has been the easing of entry restrictions based on demographic and distance criteria. While these restrictions are intended to prevent the excess entry inherent on markets with high regulated prices and homogeneous products (Mankiw and Whinston, 1986), their application has been criticized as too restrictive from a social welfare perspective (Schaumans and Verboven, 2008). The first section of Table 1 reports the current state of entry regulation in a subsample of OECD countries. We find that the majority of OECD countries have substantially reduced the barriers to entry for retail pharmacies. Restrictions based on geographic and demographic criteria remain in Austria, Finland, France, Italy and Spain.

The Slovak market was also affected by the trend of entry liberalization. At the turn of the century, pharmacy licenses were issued based on decisions by the Slovak Chamber of Pharmacists. The ownership was limited to pharmacists and ownership of multiple outlets was forbidden (Smatana et al., 2016). Moreover, the Ethics Code of the Slovak Chamber of Pharmacists formulated distance and demographic criteria for new pharmacy licenses (a minimum distance of 500m from existing pharmacies and 5000 inhabitants per pharmacy). Despite not being an official act of the Slovak Republic, the Ethics Code regulated entry into the industry (Szalay et al., 2011). In 2002, a decision of the Competition Authority revoked the competence of the Chamber and established a free entry policy (Antimonopoly Office of

Table 1: Pharmacy Regulation in a Subset of OECD Countries

	Entry restrictions			Ownership		Pricing	
Country	General	Population	Distance	Pharmacist	Chains	Margins	Regressive
Austria	Y	Y (5500)	Y (500m)	Y	N	Y	Y
Czech Republic	N	N	N	N	Y	Y	Y
Canada	N	N	N	N	Y	O	O
Denmark	O	N	N	O	O	Y	Y
Finland	Y	O	Y	Y	N	Y	Y
France	Y	Y (2500)	N	Y	Y	Y	Y
Germany	N	N	N	Y	O	Y	Y
Italy	Y	Y (3300)	Y (200m)	N	N	Y	N
Netherlands	O	N	N	N	Y	Y	N
Norway	N	N	N	N	Y	Y	N
Slovak Republic	N	N	N	Y	Y	Y	Y
Spain	Y	Y (2800)	Y (250m)	Y	N	Y	Y
Sweden	N	N	N	N	Y	Y	Y
United Kingdom	N	N	N	N	Y	O	N
USA	N	N	N	N	Y	N	N

Notes: Y - yes/permitted, O - mentioned, but open to interpretation/partially allowed, N - no/not permitted. Source: compiled by authors based on country-specific regulation.

The Slovak Republic, 2002).[2]

While the deregulation of entry has taken place in many jurisdictions, the policy environment with regard to ownership is more mixed. The ownership of pharmacies is regulated along two dimensions. The first dimension specifies whether pharmacies must be owned and operated by a pharmacist (see the column denoted "Pharmacist" in Table 1). Many countries have enforced such regulations as a measure to ensure quality in light of the information asymmetry inherent in the dispensation of drugs. By linking the license to practice of a pharmacist to a specific location (through ownership restrictions), the regulation aims to make professional misconduct more costly, as damages to the reputation of the pharmacy will result in long-term financial costs to the owner. While several jurisdictions mention this requirement in regulatory texts, there is substantial diversity in how the rule is enforced. In Slovakia, upstream firms (distributors) are permitted to own pharmacies, as long as they hire a professional representative who is assigned to each outlet and register the outlet as a separate legal entity. Since these legal entities are owned by the upstream company, this implies that the representative pharmacist is tasked with the operation of the outlet and is legally responsible for the professional conduct in the pharmacy, but is not entitled to the profits of the business.

[2] Similar processes have been observed in to other European countries such as the UK Competition Authority (2001) and Sweden (Dalen, 2003).

Given the relatively lax requirements regarding pharmacist ownership, we will focus on the second dimension of ownership regulation, which determines the total number of outlets which can be owned by a legal entity or pharmacist (denoted by "Chains" in Table 1). Many countries prohibit multi-store ownership completely (Austria, Finland, Italy, Norway and Spain), while others impose constraints on the total number of outlets owned by one entity (Germany). Proponents of the prohibition of chain formation argue that chain outlets have an incentive to take the profitability of their owners (drug manufacturers or distributors) into account when offering certain products (especially with regard to generic substitutes and over-the-counter drugs) to the detriment of consumers Federal Union of German Associations of Pharmacists (2021).

Empirical evidence on the subject of over-treatment (excessive prescription of medication or diversion to company-owned products) in pharmacy chains has not yielded support for this hypothesis so far. Janssen and Zhang (2023) investigate dispensing behavior of chain pharmacies during the opioid pandemic in the United States. Their findings indicate that independent pharmacies on average dispense 40.9% more opioids and 61.7% more OxyContin, with a substantial portion of this use being categorized as "recreational". The authors suggest that independent pharmacies could have stronger financial incentives for misconduct in dispensation, as they have a lower cost of misdoing due to lower levels of oversight. Alternatively, they argue that the lax dispensation behavior could be driven by the lower availability of information on patients' medical history. The authors also find that misconduct is more likely on markets where independent pharmacists are faced by higher competition, suggesting that an analysis of the effect of deregulation on quality would need to take into account indirect effects of chain entry.

Vogler et al. (2012) conduct cross-country interviews with stakeholders regarding the effects of ownership deregulation on quality, but do not find systematic evidence of quality differences. They state that some interview partners identified pharmacy chains as drivers of quality standards, while others insisted that sustainable quality assurance is more likely to be achieved by independent pharmacists. The authors identify excess entry as a potential driver of lower quality, as there are fewer pharmacists per pharmacy. Thus, if chain entry contributes to lower numbers of pharmacists per pharmacy, this may have an indirect effect on quality. Our results address this question by evaluating the labor demand of pharmacies according to chain type.

One of the main arguments in favour of chain formation is the potential for economies of scale and access to capital through vertical and horizontal integration (Kanavos et al., 2011). In 2004, Germany allowed multi-store ownership. The lifting of the prohibition on ownership of multiple stores was subject to the restriction that each pharmacist can own no more than four outlets and these outlets should be located in close geographic proximity to each other to ensure accountability on the local market (German Council of Economic Experts, 2003). Rostam-Afschar and Unsorg (2021) investigate the effect of the deregulation on entry behavior and employment levels using a reduced form model. Their findings indicate that the lifting of the ban on multi-store ownership resulted in an increase in entry rates relative to a counterfactual without liberalization. In addition, they indicate that by lowering concentration on local markets, the deregulation of entry led to an increase in employment levels. We shed light on this topic by evaluating the entry decisions of independent and chain pharmacies.

Descriptive evidence suggestive of the cost efficiencies realized by chains can also be found in entry patterns in countries which have fully lifted restrictions on multi-store ownership. Chain pharmacies represent 10.4% of all pharmacies within the EU due to their growing share in deregulated jurisdictions (Písek, 2018). In a case study on the Irish market, Foley et al. (2015) also document growth in the share of chain-affiliated pharmacies. According to their study, the percentage of independently owned pharmacies in Ireland fell from 44% in 1993 to 24% in 2001. Similar patterns, described below, were observed in Slovakia after the ownership deregulation.

3 Data

In our analysis we rely on several data sources provided by the National Health Information Centre and the Ministry of Health of the Slovak Republic. Our primary data source regarding outlet profitability and demand consists of information on all individual prescriptions dispensed in Slovak pharmacies during 2017, amounting to a total of 56,408,000 transactions. We observe both the number of units purchased and the price per unit (consisting of the insurer's payment and the copayment of the patient) for each prescription. We use this information to calculate firm-level revenues from prescription drugs, as well as the total number of days in which a pharmacy was active. This data is supplemented by reported revenues and sales of non-prescription products (over-the-counter drugs and cosmetics) for 2,044 pharmacies provided by the National Health Information Center.

The average pharmacy is open on 260 days each year and earns around €480,610 in revenue from prescription drugs and €168,250 from non-prescription sales (over-the-counter drugs and cosmetics). It hires 2.14 pharmacists and 1.03 pharmacy technicians.[3]

[3]See Section 6 for details regarding the qualifications of these two employee groups.

Table 2: Summary Statistics

Variable	Mean	SD	$p10$	$p90$
Revenue from prescriptions (€1,000)	480.61	672.53	66.21	1017.00
Revenue from OTC (€1,000)	168.25	381.74	23.55	324.07
Sales of prescription medication (1,000 units)	38.49	35.99	6.99	79.04
Sales of OTC medication (1,000 units)	28.67	51.03	4.83	56.80
No. of pharmacists	2.14	1.39	1.00	4.00
No. of technicians/assistants	1.03	1.20	0.00	2.00
No. of work days open per year	230.21	54.53	168.00	256.00
No. of days open	259.61	71.19	184.00	338.00
Nonstop (open > 50 weekends)	0.08	0.28	0.00	0.00
Distance to closest hospital (km)	6.29	7.20	0.28	17.34

Notes: Based on 2,116 observations.

We augment the information on revenues with the exact locations of all 2,116 individual pharmacies, as well as data on the locations of prescribing physicians and local hospitals. The data on the addresses of these health care providers was gathered from the National Health Information Centre. We observe more than 30,000 individual doctors and 63 general hospitals. Summary statistics from the pharmacy dataset are reported in Table 2.

We collected the information on the affiliation of each outlet from firm websites at the end of 2017 and in early 2018. Since the deregulation from 2004, both private and legal entities can own pharmacies which enabled them to form chains. Two types of chains emerged since the liberalisation of multi-store ownership. The first, so-called "standard" chains, are outlets with one management and a joint owner. In many cases, the owner is either a wholesale distributor or another entity that owns both distribution networks and pharmacy retail outlets. The second, known as "virtual" chains, consist of networks of pharmacies, which do not have a shared ownership and management, but cooperate with regard to marketing initiatives and have close connections to wholesale distributors. Many of the decisions are thus left to pharmacists at the outlet level. About a third of all pharmacies have remained independent and are not part of any chain.

Table 3 summarizes chain market shares in 2017 and provides additional information on the presence of vertical ties within chains. Among the four brands with a market share above 10%, all are characterized by some form of vertical integration. The Dr.Max chain is the only non-virtual (standard) chain with a significant market share.

Table 3: Chain market shares and ownership structure

Chain	Freq.	Revenue-based market share	Unit-based market share	Virtual chain	Vertical integration
Plus	444	16.32	19.58	Y	Y
Dr.Max	276	19.54	15.09	N	O
Partner	235	9.05	11.54	Y	Y
VASA lekaren	216	9.18	9.99	Y	Y
Benu	61	5.05	2.31	N	Y
Druzstvo lekarni	49	1.55	1.71	Y	N
Farmakol	48	1.67	4.86	N	Y
Schneider	44	2.14	1.39	N	N
Moja lekaren	28	0.80	1.03	Y	Y
Apotheke	5	0.16	0.27	N	Y
Independent	710	34.53	32.22	-	-

Notes: Y - yes; N - no; O - integration with other health care providers (health insurance companies).

4 Demand

4.1 Demand specification

In order to investigate consumer attitudes towards chains, we estimate a discrete spatial demand model. We allow consumers to belong to a specific consumer class c, to capture potential heterogeneity in consumer preferences. The probability that a consumer falls within a given consumer group ϕ_c follows a logistic distribution:

$$\phi_c = \frac{\exp(\rho_c)}{\sum_C \exp(\rho_c)},\ c = 1, ..., C \tag{1}$$

with ρ_2 normalized to zero. Conditional on the consumer class c, an individual i derives the following utility by purchasing from pharmacy j at choice occasion n[4]:

$$\begin{aligned} \tilde{u}_{ijnc} &= u_{jnc} + \varepsilon_{ijnc} \\ &= \gamma_c d_{jn} + x'_{jn}\beta_c + \xi_{bt} + \varepsilon_{ijnc} \end{aligned} \tag{2}$$

In the above equation, d_{jn} represents the distance between pharmacy j and the prescribing physician of individual i for prescription n. Since we rely on the location of the dispensing physician to determine the distance, it will vary between prescriptions fulfilled by the same individual. Over 90% of all prescriptions are realized within 10 kilometers of the

[4]Note that in our specification choice occasion is synonymous with prescription.

prescribing physician's office. We therefore constrain each patient's choice set for prescription n, J_n, to pharmacies located within a 10 kilometer radius of the physician's location. This is synonymous with assuming that demand originates at the moment of prescription.[5]

The vector x contains pharmacy characteristics: distance to the nearest hospital, number of days per year in which the pharmacy is open, as well as a dummy for pharmacies which are open seven days a week (which implicitly controls for shopping mall locations, as these are most regularly characterized by this type of operating hours). The parameter ξ_{bc} is a chain fixed effect, measuring consumer preferences within the latent class c for a specific chain brand b. For ease of notation, we will attribute independent pharmacies to the null chain $b = 0$ and constrain $\xi_{0c} = 0$. We further allow each set of parameters to differ based on the age of the patients, by estimating a set of parameters for patients above and below the age of 65. The model of individual utility is completed by a type-1 extreme value distributed shock ε_{ijnc}. This yields a conditional logit model of demand for each latent consumer class c. The likelihood of the model with discrete mixing distributions over latent consumer classes is thus defined as:

$$\mathcal{L} = \sum_i \ln \sum_{c=1}^{C} \phi_c \prod_{n=1}^{N_i} \prod_{j=1}^{J_n} \left(\frac{\exp(\gamma_c d_{jn} + x'_{jn}\beta_c + \xi_{bc})}{\sum_{k=1}^{J_n} \exp(\gamma_c d_{kn} + x'_{kn}\beta_c + \xi_{bc})} \right)^{\iota_{in}} \tag{3}$$

where N_i is the total number of prescriptions fulfilled by patient i, and ι_{in} is an indicator variable equal to 1 if j is the chosen alternative of patient i at the choice occasion n, and 0 otherwise.

The number of latent classes is determined in a step-wise manner: estimation starts with two latent classes. Further classes are introduced until the log-likelihood fails to improve. The introduction of latent classes representing consumer types allows us to mix across different conditional logit estimates of purchase probabilities, capturing unobserved consumer heterogeneity and substitution patterns across pharmacies. In particular, this model relaxes the assumption of a unimodal distribution of preference parameters (Heckman and Singer, 1984). With the traditional parametric approach, the correct specification of the underlying distribution is crucial and carries drawbacks, as pointed out by Train (2008) and Pacifico (2013). Discrete choice models with latent classes were first explored by Swait (1994) and Bhat (1997), and later employed in analysis of labor supply by Pacifico (2013) or in analysis of hospital choice by Červený (2023).

[5] When estimating the parameters of consumer demand, we exclude prescriptions realized outside this prescription-specific market, as we assume that patients who travel more than 10 kilometers to fulfill a prescription are more likely to not have physically visited the physician prior to the purchase. Approximating their location with the physician's office would bias the estimates of distance sensitivity.

Demand is estimated at the transaction level using a maximum-likelihood algorithm. Since the estimation of the parameters using the full dataset would place prohibitively high computational requirements, a random sample of five percent of all prescriptions is used.

We merge the information on purchase probabilities with data regarding the type of medication m purchased, the number of units of the medication in the prescription q_{mn}, the wholesale and distribution cost of the medication c_m^W and the final price of the product p_m. Based on this we predict outlet-level prescription numbers denoted as $\hat{q}_j^{\mathrm{Rx}}$, and revenues from prescription drugs net of wholesale costs denoted as $\hat{r}_j^{\mathrm{Rx}}$:

$$\hat{q}_j^{\mathrm{Rx}} = \sum_{i=1}^{N_j} \sum_{n=1}^{N_i} \Pr\left(\iota_{in} = j\right) q_{mn} \tag{4}$$

$$\hat{r}_j^{\mathrm{Rx}} = \sum_{i=1}^{N_j} \sum_{n=1}^{N_i} \Pr\left(\iota_{in} = j\right) q_{mn} \left(p_{mn} - c_{mn}^W\right). \tag{5}$$

4.2 Empirical results

Table 4 reports the parameter estimates. Two heterogeneous consumer groups were identified ($C = 2$). The first group, which we will refer to as Group 1, is less sensitive to distance and therefore puts a relatively higher weight on other pharmacy characteristics, including chain affiliation. Group 2 is characterized by a strong preference for minimizing transportation costs. The decisions of these consumers appear to be driven almost exclusively by the distance between the prescribing doctor and the pharmacy. Our estimates suggest that this group forms approximately 50% of the market.

Since prices do not vary substantially within our sample, the utility estimates are scale-free measures of the value of each pharmacy characteristic.[6] In order to illustrate the relative importance of chain branding, we report the level by which the distance to an independent pharmacy would have to fall, in order for it to yield the same utility as a visit to a chain outlet of a specific brand (calculated as $-\xi_{bc}/\gamma_c$) in Table 5.

Given the relatively lower transportation costs of Group 1, it is unsurprising that this group is willing to travel an additional distance to visit its preferred brand of seller. In general, consumers in this group prefer to make purchases in pharmacies belonging to large chains with more than 200 outlets (with exception of VASA lekaren, which is only preferred by consumers over the age of 65). The opposite appears to hold true for smaller chains, which consistently preform worse than their independent counterparts. The cross-sectional character of the data does not permit us to comment on the direction of causality: chains

[6] Figure A1 in the Appendix illustrates the share of transactions which happen at the maximum price.

Table 4: Demand Estimates: Prescriptions

Variable	Group 1		Group 2	
Panel A. Patients below age of 65				
Distance (km)	−0.346	(0.002)	−16.300	(0.123)
Dr.Max (standard chain)	0.270	(0.010)	0.553	(0.020)
Benu (standard chain)	−0.258	(0.018)	−0.225	(0.054)
VASA lekaren (virtual chain)	−0.037	(0.012)	−0.029	(0.020)
Plus (virtual chain)	0.123	(0.010)	0.113	(0.018)
Partner (virtual chain)	0.088	(0.011)	0.094	(0.022)
Small chains	−0.192	(0.013)	0.024	(0.021)
Nonstop (open > 50 weekends)	−0.267	(0.012)	−0.555	(0.033)
Distance to hospital (km)	0.082	(0.001)	1.257	(0.058)
No. of work days open	0.012	(0.000)	0.009	(0.000)
Population	0.018	(0.001)	0.013	(0.007)
Panel B. Patients above age of 65				
Distance	−0.390	(0.002)	−14.720	(0.133)
Dr.Max (standard chain)	0.357	(0.011)	0.753	(0.022)
Benu (standard chain)	−0.572	(0.026)	−0.268	(0.063)
VASA lekaren (virtual chain)	0.050	(0.013)	0.012	(0.022)
Plus (virtual chain)	0.146	(0.010)	0.165	(0.020)
Partner (virtual chain)	0.142	(0.012)	0.082	(0.025)
Small chains	−0.182	(0.014)	0.001	(0.024)
Nonstop (open > 50 weekends)	−0.823	(0.015)	−0.908	(0.037)
Hospital	0.078	(0.002)	−1.447	(0.112)
No. of work days open	0.011	(0.000)	0.010	(0.000)
Population	0.012	(0.001)	0.008	(0.008)
ϕ_1	0.494 (0.001)			
ϕ_2	0.505 (0.001)			

Notes: Standard errors in parentheses. Based on 22,457,958 observations.

Table 5: Chain Utility as Distance Reduction ($-\xi_{bc}/\gamma_c$)

	Group 1		Group 2	
Panel A. Patients below age of 65				
Dr.Max (standard chain, $n = 276$)	0.783	(0.029)	0.033	(0.001)
Benu (standard chain, $n = 61$)	−0.746	(0.034)	−0.014	(0.001)
VASA lekaren (virtual chain, $n = 216$)	−0.107	(0.027)	−0.002	(0.001)
Plus (virtual chain, $n = 444$)	0.355	(0.053)	0.007	(0.003)
Partner (virtual chain, $n = 235$)	0.255	(0.032)	0.006	(0.001)
Small chains ($n < 50$)	−0.556	(0.037)	0.001	(0.001)
Panel B. Patients above age of 65				
Dr.Max (standard chain, $n = 276$)	0.917	(0.028)	0.051	(0.002)
Benu (standard chain, $n = 61$)	−1.466	(0.066)	−0.018	(0.004)
VASA lekaren (virtual chain, $n = 216$)	0.126	(0.032)	0.001	(0.002)
Plus (virtual chain, $n = 444$)	0.375	(0.026)	0.011	(0.001)
Partner (virtual chain, $n = 235$)	0.363	(0.030)	0.006	(0.001)
Small chains ($n < 50$)	−0.466	(0.037)	0.000	(0.002)

Notes: Standard errors in parentheses. The value of n measures the number of pharmacies in the chains. The indicated numbers show the additional distance (in kilometers) which consumers are willing to travel in order to visit a specific chain.

with low perceived quality may have a higher rate of bankruptcy and thus fail to grow. The majority of smaller chains, as well as Benu outlets, are part of non-virtual chains. This may explain why pharmacists cannot unilaterally leave the chain, despite the negative demand effect from the affiliation. Furthermore, chain affiliation seems to make these outlets more attractive when it comes to sales of non-prescription drugs (see Section 5), suggesting differentiated marketing strategies across chain types.

For Group 2 the relative importance of branding is limited compared to the value of geographic proximity. While many of the estimated travel distances are significantly different from 0, none of them are economically significant. The maximum utility gain is earned from the presence of a Dr.Max pharmacy. It corresponds to a distance saving of just 34 meters. The maximum disutility from chains is reached for patients visiting Benu and corresponds to an additional distance traveled of 14 meters.

In summary, we first two main trends in the data regarding demand for prescriptions. First, consumers differ in their sensitivity to distance, likely due to using different transportation modes. The sensitivity to distance is only marginally affected by age, suggesting that this is not due to differences in physiological mobility or value of time across consumers. Although chain effects are significantly different from zero for most chains, they are only economically significant for mobile consumers.

Second, we find that consumers do not systematically perceive chains as offering lower quality. The perceived quality of chains correlates with their size. This could be driven by more efficient delivery systems, as large chains are usually organized by distributors (see Table 3), who therefore have an incentive to offer higher quality services to the members of their chains. An alternative explanation would be that consumers have a preference for large chains due to the price rebates offered by the chains. In order to investigate this, we re-estimate the demand model based only on transactions with no patient co-payment. The results are reported in Table A2 in the Appendix. For Group 1, which is sensitive to chain identity, the preferences for chains among young individuals (below the age of 65) are on average weaker when rebates are not possible, but retain their sign in all but one case (Partner). For individuals above the age of 65, the absence of rebates leaves preferences practically unaltered. This leads us to conclude that differences in perceived quality are not entirely driven by the availability of rebates.

5 Over-the-counter sales

Besides prescription drugs, pharmacies also sell other products, such as over-the-counter medication[7]. Nevertheless, their main revenue source is indeed the market for prescription drugs. Table 6 shows the share of prescription drugs in total revenues according to brand. The average pharmacy makes 73% of its revenues through the sale of prescription drugs. However, some brands, such as Benu, specialize in over-the-counter sales, indicating that an analysis of profitability which does not account for this category of goods would result in a negative bias.

As we do not have access to consumer-level data for the OTC sales, we model these sales in reduced-form at the outlet level. The National Health Information Center provided us with data on OTC sales for 2,044 pharmacies, which represents 96.7% of pharmacies in the market.

We model the revenues r_j^{OTC} and quantities q_j^{OTC} of non-prescription sales for the individual pharmacy as (omitting the constant):

$$\ln(r_j^{\mathrm{OTC}}) = z_j'\beta^r + \xi_b^r + \delta_r^r + \varepsilon_j^r \quad (6)$$

$$\ln(q_j^{\mathrm{OTC}}) = z_j'\beta^q + \xi_b^q + \delta_r^q + \varepsilon_j^q \quad (7)$$

The vector z contains both individual pharmacy characteristics (number of days open, information on weekend services), as well as demographic information regarding the sur-

[7]This data includes cosmetics sales. For ease of exposition, we will refer to the group of products for which no prescription is necessary as over-the-counter drugs.

Table 6: Revenue Share of Prescription Drugs by Network

Network	Mean	SD	$p10$	$p90$
Apotheke	0.78	0.13	0.58	0.92
Benu	0.44	0.23	0.21	0.85
Dr.Max	0.65	0.18	0.37	0.86
Druzstvo lekarni	0.76	0.13	0.64	0.88
Farmakol	0.85	0.09	0.71	0.98
Independent	0.74	0.18	0.48	0.91
Moja lekaren	0.78	0.09	0.64	0.89
Partner	0.76	0.13	0.62	0.91
Plus	0.76	0.14	0.62	0.90
Schneider	0.55	0.25	0.24	0.85
VASA lekaren	0.73	0.16	0.55	0.89
Average	0.73	0.18	0.46	0.90

rounding area, such as the population density of the 1×1km grid in which the pharmacy falls, as well as the population in the contiguous cells. The same information is collected for the number of competitors in the immediate vicinity. We also control for the median income, household size and educational structure at a more aggregated (municipal) level. The parameter ξ_b is the chain fixed effect for a brand b, and δ_r is a regional fixed effect for each of the eight Slovak regions.

The estimation results for revenues and quantities are reported in Table 7. Higher sales are associated with urban, densely populated areas. As expected, pharmacy sales respond strongly to the population density in the immediate neighborhood of each pharmacy and to a lesser degree to density at the municipal level.

The two largest standard chains (Dr.Max and Benu) have significantly higher revenues from the non-prescription medicines and other products compared to independent pharmacies, suggesting that chains may place a higher emphasis on expanding their product portfolios beyond prescription drugs.

Since we are interested in the profitability resulting from sales of non-prescription products, we would ideally like to observe firm margins for this category of products. Unfortunately, this information is not readily available. We therefore work with a fixed mark-up $\mu^{\text{OTC}} = 0.14$, which corresponds to the median mark-up for prescription drugs at the pharmacy level. Based on anecdotal evidence from interviews of managers of chains, we believe that this is likely the lower limit of mark-ups on these products. We thus also report estimates assuming double mark-ups ($\mu^{\text{OTC}} = 0.28$) for this group in our entry model (reported in Section 7).

Conditional on assumptions regarding the mark-up levels for OTC sales, we can thus

Table 7: Demand Estimates: OTC Sales

Variable	Revenues (log) (1)		Quantity (log) (2)	
Panel A. Chain fixed effects				
Apotheke	0.162	(0.316)	0.290	(0.297)
Benu	0.519	(0.102)	0.363	(0.096)
Dr.Max	0.365	(0.055)	0.266	(0.052)
Druzstvo lekarni	0.120	(0.105)	0.078	(0.099)
Farmakol	−0.033	(0.110)	0.001	(0.103)
Moja lekaren	0.039	(0.138)	−0.019	(0.130)
Partner	0.038	(0.055)	0.007	(0.052)
Plus	0.115	(0.044)	0.101	(0.041)
Schneider	0.255	(0.116)	0.165	(0.109)
VASA lekaren	0.159	(0.056)	0.154	(0.053)
Panel B. Regional characteristics				
Rural (dummy)	−0.128	(0.068)	−0.152	(0.064)
City population (log)	0.017	(0.028)	0.022	(0.027)
Grid populaton (log)	0.106	(0.041)	0.090	(0.038)
Grid pharmacies (log)	−0.011	(0.028)	−0.020	(0.026)
Median income (log)	−0.098	(0.196)	−0.152	(0.185)
Hungarian minority (share)	0.002	(0.001)	0.002	(0.001)
Second. educated (share)	0.011	(0.004)	0.010	(0.004)
Pre-productive pop. (share)	2.238	(1.028)	2.719	(0.967)
Panel C. Pharmacy characteristics				
Nonstop	0.671	(0.073)	0.676	(0.069)
No. of days open	0.005	(0.000)	0.005	(0.000)
Household size	−0.002	(0.008)	−0.002	(0.008)
Hospital pharm. (dummy)	2.119	(0.140)	1.996	(0.130)
Revenues from prescriptions (log)	0.328	(0.018)		
Post office distance (log)	−0.036	(0.015)	−0.044	(0.014)
Sales of pres. medication (log)			0.372	(0.019)
Constant	−1.247	(1.419)	4.862	(1.343)
R^2	0.618		0.625	

Notes: Standard errors in parentheses. Based on 2,044 observations.

calculate net revenues from this product category:

$$\hat{r}_j^{\text{OTC}} = \mu^{\text{OTC}} \exp\left(z_j' \hat{\beta}^r + \hat{\xi}_b + \hat{\delta}_r^r\right) \tag{8}$$

6 Labor costs

6.1 Labor demand model

Besides the wholesale and distribution costs paid by retail pharmacies, operation also requires investment in labor. Each pharmacy selects a combination of pharmacists (n^P) and pharmaceutical laboratory technicians (n^T) in order to satisfy demand. These two types of employees differ in their qualifications. Pharmacists need to fulfill higher educational requirements (a degree in pharmacology) and are responsible for the safety of the prescribed medications. Pharmacists are assisted by laboratory technicians, who complete a shorter specialized vocational training of two to three years. The difference in responsibility and skills between the two groups is reflected in their wage differential, with pharmacists earning w^P=€1,744 per month on average, compared to w^T=€1,276 for technicians. Both values are reported for a full time equivalent of 40 hours per week.[8]

Regulation requires that at least one pharmacist is connected to a pharmacy location, but there are no restrictions on the number of hours that the pharmacist should work. This allows chains to potentially hire one pharmacist to manage the prescription process across multiple locations, thus reducing their cost of production. In fact, despite their educational differences, pharmacists and technicians appear to be close substitutes in our data. Figure 1 illustrates the relationship between employment levels of pharmacists and technicians and the number of fulfilled prescriptions. Each cell in the graph reports the median number of prescriptions (in thousands) sold by pharmacies with a given combination of pharmacist and technician employees. The graphic appears to indicate that similar levels of output can be produced with different combinations of employee types, thus rejecting a Leontief specification of the production function with regard to labor.

Since pharmacists and technicians appear to be close substitutes, we will measure labor

[8]This wage ratio closely corresponds to the estimated marginal product of these two types of employees based on a naive regression of total number of prescription medications sold per outlet on the number of employees of each type, reported in table A1 in the Appendix. The results suggest that the marginal product of a technician is 12,115 units of medication compared to 15,272 units per pharmacist. In other words, technicians generate 79% of the output attributable to a fully qualified pharmacist. The productivity ratio appears to correspond to their earnings ratio, with technicians earning 73% of a pharmacist's average wage. Data source: the ISCP Quarterly Statement on Labour Costs (MPSVR SR)1-04, calculations by Trexima Bratislava.

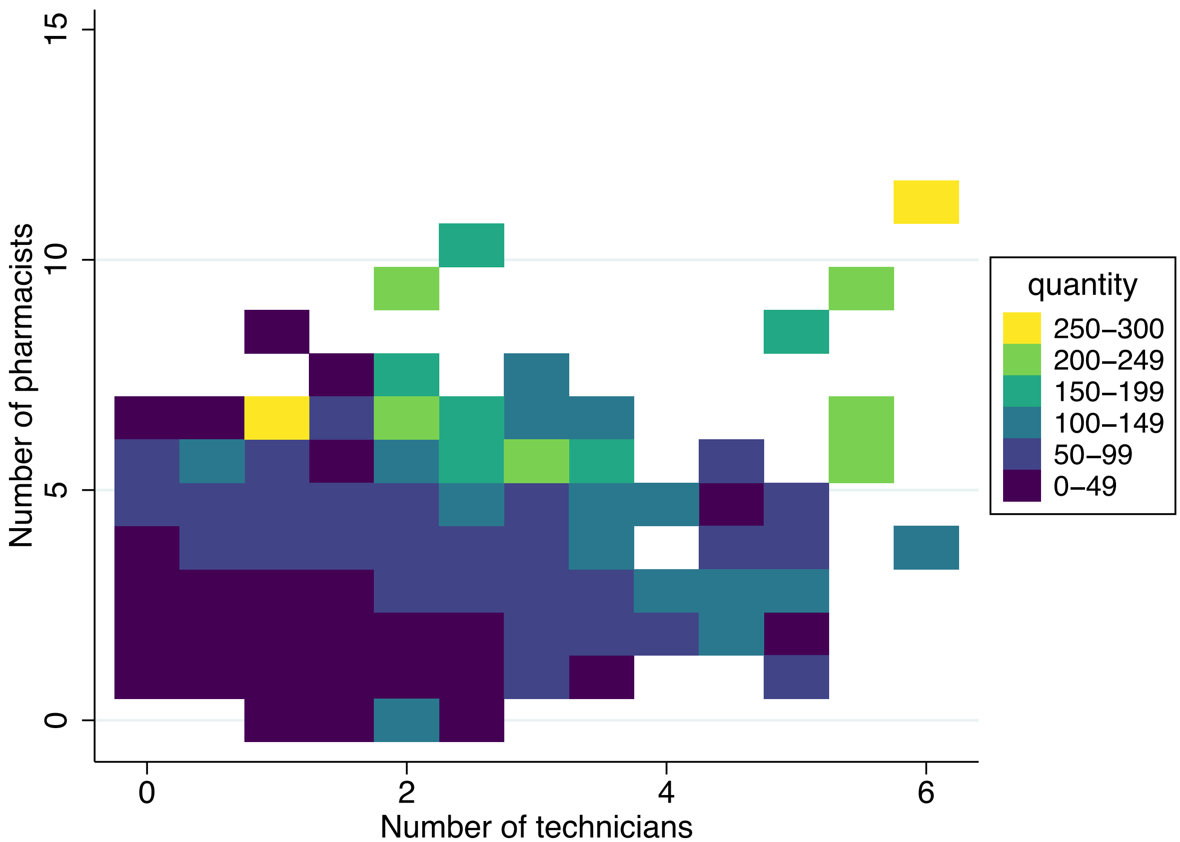

Figure 1: Employee Levels and Prescription Output

Notes: The number of pharmacists and technicians is calculated in FTEs and rounded to the nearest 0.5 FTE value. Each cell reports the median number of prescription medications sold (in 1,000 units) for a given combination of pharmacist and technician FTEs.

inputs within each pharmacy j in terms of weekly working hours for "quality-weighted" pharmacists l_j:

$$l_j = 40\left(n_j^P + \frac{w^T}{w^P} n_j^T\right) \tag{9}$$

We assume that firms produce output according to the following production technology:

$$\left(q_j^{\mathrm{Rx}}\right)^{\alpha}\left(q_j^{\mathrm{OTC}}\right)^{1-\alpha} = \exp(\gamma_0 + \gamma_b + \gamma_r + \omega_j) l_j^{\nu}, \tag{10}$$

where α measures the relative labor requirements of prescription medication, γ_0 represents the baseline labor productivity in independent pharmacies, γ_b measures the deviation from baseline productivity within chain b, while γ_r captures regional differences in labor demand. Stochastic variation in productivity is captured by ω_j, which is an outlet-specific shock. The model is completed by the parameter ν, which captures potential economies of scale. This results in a firm-level labor demand given by:

$$\ln l_j = \frac{1}{\nu}\left(\alpha \ln q_j^{\mathrm{Rx}} + (1-\alpha)\ln q_j^{\mathrm{OTC}} - \gamma_0 - \gamma_b - \gamma_r - \omega_j\right) \tag{11}$$

Pharmacies which invest in higher quality services may require more employees, while also experiencing higher than average sales. This would result in an underestimation of productivity for these outlets. Alternatively, more productive pharmacists may encourage additional demand, resulting in an overestimation of economies of scale. In order to address this issue, we rely on variation in sales resulting from the geographic distribution of patients and residential population. In particular, we calculate the expected sales of firms if no chain affiliation were possible ($\hat{q}_{j,b=0}^{\mathrm{Rx}}$ and $\hat{q}_{j,b=0}^{\mathrm{OTC}}$ respectively) and use these variables to capture variation in sales which is independent of the relative productivity of firms or their chain affiliation.

6.2 Empirical results

The estimation results are illustrated in table 8. We begin by specifying a model with constant returns to scale in order to observe differences in average productivity across brands. Our findings (reported in Columns 1 and 2 of Table 8) indicate that pharmacists working within chains have a higher labor productivity than their independent counterparts.

The results reported in Columns 3 and 4 of Table 8 suggest that this finding is predominantly driven by economies of scale. Once economies of scale have been accounted for, the productivity advantage becomes insignificant for all chains except Plus. This suggests that the productivity gains realized by chains are likely the result of their location choices: entry

Table 8: Labor Demand Estimates

Variable	OLS (1)	GMM (2)	OLS (3)	GMM (4)
Panel A. Chains				
Dr.Max	0.261	0.286	−0.278	−0.103
	(0.047)	(0.048)	(0.076)	(0.068)
Plus	0.227	0.215	0.155	0.164
	(0.040)	(0.040)	(0.060)	(0.053)
Benu	0.199	0.307	−0.156	0.046
	(0.088)	(0.097)	(0.135)	(0.127)
Vasa lekaren	0.179	0.181	0.012	0.061
	(0.050)	(0.050)	(0.076)	(0.066)
Partner	0.145	0.128	0.009	0.031
	(0.048)	(0.049)	(0.073)	(0.064)
Small chains	0.124	0.121	−0.027	0.012
	(0.054)	(0.055)	(0.083)	(0.072)
Intercept	5.213	5.191	0.752	1.981
	(0.047)	(0.048)	(0.250)	(0.222)
Panel B. Other parameters				
α	0.399	0.307	0.319	0.254
	(0.016)	(0.036)	(0.025)	(0.047)
ν			2.013	1.729
			(0.054)	(0.048)
Regional fixed effects	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses. Based on 1,815 observations.

into areas of high demand allow chain outlets to realize economies of scale and thus decrease their costs. This finding suggests that the formation of chains does not necessarily result in improvements in productivity relative to independent pharmacies.

Comparing the results of the OLS estimation (Column 3) to the GMM parameters (Column 4) suggests that patients tend to prefer pharmacies with a higher productivity per pharmacist, thereby resulting in an overestimation of economies of scale in the OLS specification. The estimated α parameter suggests that OTC transactions require relatively more labor to fulfill than prescriptions. This is likely due to additional marketing tasks related to this group of products.

The reported estimates allow us to predict firm labor costs (c^L), conditional on the expected sales of prescription and OTC drugs:

$$\hat{c}^L = w^P \frac{\exp\left(\frac{1}{\hat{\nu}}\left(\hat{\alpha}\ln\hat{q}_j^{\text{Rx}} + (1-\hat{\alpha})\ln\hat{q}_j^{\text{OTC}} - \hat{\gamma}_0 - \hat{\gamma}_b - \hat{\gamma}_r - \hat{\omega}_j\right)\right)}{40}.$$

7 Firm entry [*Work in progress*]

In the final step of our analysis we aim to quantify the potential fixed cost savings available to pharmacies who join a chain. The results of this analysis would provide an indication for the impact of chain formation on geographic coverage, a key determinant of the impact of ownership deregulation on consumer welfare.

As in Eizenberg (2014), we infer these gains following a revealed preference approach to estimate the bounds of fixed costs across different pharmacy types. In particular, the demand and cost models outlined in the previous sections allow us to calculate expected variable profits from prescription drugs of each pharmacy outlet. These estimates are conditional on the current distribution of firms across the set of possible entry locations A:

$$E[\pi_j^V(A)] = \hat{r}_j^{\text{Rx}}(A) + \hat{r}_j^{\text{OTC}}(A) - \hat{c}_j^L(A) \tag{12}$$

From the perspective of each chain b, the potential entry locations can be divided into two subsets: A_b^1 contains all locations in which entry has occurred; A^0 is the complementary set of locations without entry.[9] We denote with a_j the selected action in location j, where $a_j = 1$ if entry occurred and 0 otherwise. Deviations from the current equilibrium are denoted by $A+1_j$ if the deviation represents entry into location j, and $A-1_j$ if the deviation represents exit from location j.

For each brand b[10] operating pharmacies in the location set $A_b^1 \in A^1$, the expected variable profits are given by the sum of expected variable profits across all branch locations:

$$E[\Pi_V^b(A)] \equiv \sum_{j \in A_b^1} E[\pi_j^V(A)].$$

In line with previous research, we assume that firms play a two-stage game.

In the first stage, each firm forms expectations regarding variable profits from entry in location j and realizes a draw of its firm-specific fixed costs in the location: $f_j^b = f_b + \nu_j$,

[9]While the set of locations with entry is identified in the data, the set A^0 is theoretically infinite. Having visualized the data, we determined that chains select specific types of locations for entry (e.g. Dr.Max pharmacies tend to open in urban areas). We therefore follow a three-step process to identify the set of locations which remain uncovered, but are likely to have been in the consideration set of managers from a particular chain (A_b^0). In the first step, we draw a random sample of 1 million locations in Slovakia. In the second step, we drop all locations which are within 1km of an existing outlet of the chain. In the third step, we perform propensity score matching based on local market characteristics to obtain a set of points which is sufficiently similar to the locations selected by a specific chain. This sample of matched locations forms the set A_b^0. Details on this process will be provided in an updated draft, which will be made available prior to the conference.

[10]For ease of notation, we will model independent pharmacies as chain brands with one outlet.

where f_b is the mean of the fixed cost distribution for chain b and ν_j represents stochastic variation around the mean fixed costs at location j. Firms make simultaneous entry decisions and incur fixed costs in the locations where they choose to enter. In the second stage, demand shocks are realized and firms earn profits which depend on the equilibrium distribution of entrants.

Multiple equilibria are possible in the game described above. While the realized equilibrium is assumed to be a Subgame Perfect Nash Equilibrium, we do not impose that it is the unique equilibrium of the game.

Our equilibrium concept implies that for each location in the entry set A_b^1, the expected additional variable profits from entry for chain b must be sufficient to offset the fixed costs[11] of operating:

$$\Delta\Pi_V^b(A_b, A_b - 1_j) \equiv \Pi_V^b(A_b) - \Pi_V^b(A_b - 1_j) \geq f_j^b \text{ for } \forall j \in A_b^1$$

Similarly, for the set of available entry locations A_b^0 we can conclude that:

$$\Delta\Pi_V^b(A_b + 1_j, A_b) \equiv \Pi_V^b(A_b + 1_j) - \Pi_V^b(A_b) < f_j^b \text{ for } \forall j \in A_b^0$$

The calculated variable profit levels for the set of locations A_b^1 are plotted in Figure 2 based on two possible assumptions: that margins for non-prescription drugs are the same as those for prescription drugs ($\mu^{\text{OTC}} = 0.14$) and that non-prescriptions offer a margin which is twice as large ($\mu^{\text{OTC}} = 0.28$).[12] The estimated values can be interpreted as upper bounds of the fixed costs. A detailed overview of the estimated averages is provided in Table 9. Assuming that mark-ups for OTC sales are identical to those for prescription drugs, our results suggest that chain formation does not necessarily result in lower costs of entry.[13] The observation that the average upper bound of the fixed cost is higher for some chains than for independent pharmacies is surprising, given the rapid growth in chain market shares. A potential explanation of this finding is that chains require higher investments to open and maintain a branch. This may be due to investment in quality, which generates positive

[11] Fixed costs consist predominantly of rent costs and equipment.

[12] Outliers are excluded from the graph to avoid the identification of individual outlets.

[13] Some outlets appear to be making negative variable profits. We are currently investigating the source of this phenomenon. Two explanations seem plausible in this context. The first is related to the relatively low price of drugs on the Slovak market, when compared to neighboring European countries. Due to this price differential, we expect that pharmacies close to the Slovak border may engage in export of medication, which would not be captured in our data, as our main source of information comes from health insurance claims of Slovak residents. A second source of unobserved profitability are contracts with hospitals, who may buy specialized equipment via a pharmacy outlet. Since data on the exact locations of hospitals and pharmacies is available in our data, we are investigating these additional potential profit channels.

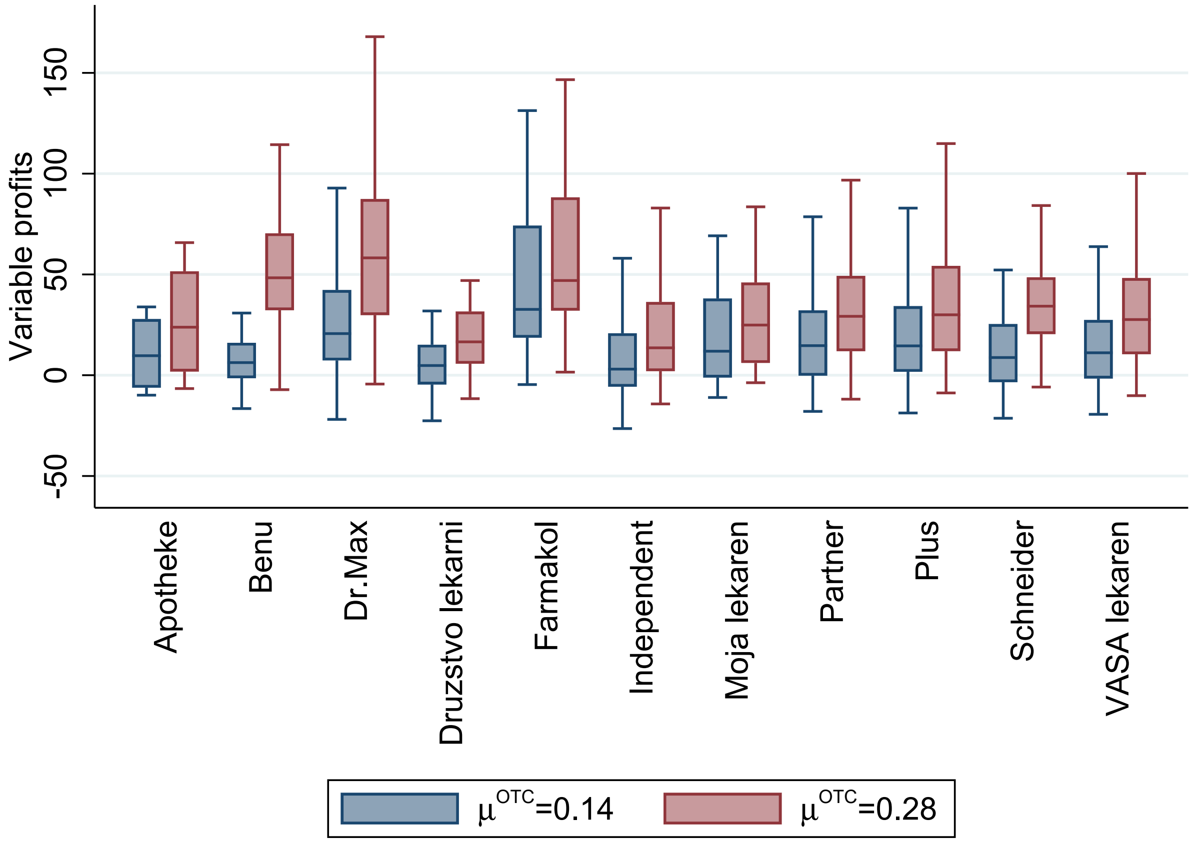

Figure 2: Estimated Variable Profits by Network

Notes: Excludes outside values. Values in €1,000.

reputation externalities for other outlets of the same brand.

A complete analysis of the bounds of firm fixed costs requires the estimation of lower bounds based on a subset of locations in which firms chose not to enter (A^0). Due to the computational burden related to the estimation of the lower bounds, these are not reported in the current draft, but will be made available in an updated copy of the paper prior to the conference.

Table 9: Variable Profitability of Chains Relative to Independent Pharmacies

	$\mu^{\text{OTC}} = 0.14$			$\mu^{\text{OTC}} = 0.28$		
	π_b^V	$\pi_b^V - \pi_0^V$	$\pi_b^V = \pi_0^V$	π_b^V	$\pi_b^V - \pi_0^V$	$\pi_b^V = \pi_0^V$
Chain	(1)	(2)	(3)	(4)	(5)	(6)
Independent	20.50	-	-	38.49	-	-
Panel A. Large chains ($n > 50$)						
Benu	9.48	−11.02	−3.10	50.82	12.33	2.12
Dr.Max	33.72	13.22	3.55	66.15	27.66	5.71
Partner	24.40	3.90	1.06	40.68	2.19	0.42
Plus	25.61	5.11	1.61	42.11	3.63	0.81
Vasa lekaren	25.24	4.74	0.99	42.89	4.40	0.74
Panel B. Small chains						
Apotheke	10.84	−9.66	−0.91	26.70	−11.79	−0.72
Druzstvo lekarni	5.86	−14.63	−4.64	18.90	−19.59	−4.46
Farmakol	67.05	46.56	3.14	82.07	43.58	2.75
Moja lekaren	22.01	1.51	0.19	34.28	−4.21	−0.45
Schneider	12.39	−8.16	−2.04	35.60	−2.89	−0.56

Notes: π_b^V denotes the average level of variable profits for chain brand b, $\pi_b^V - \pi_0^V$ corresponds to the difference in average profits relative to average variable profits of independent pharmacies (€20,500). The reported values in column (6) correspond to a two-sample t-test with unequal variances.

8 Conclusion

Ownership deregulation allowing for the formation of chains has resulted in substantial growth in the market shares of chains on the European market[14]. The implications of this process for consumers are of key importance, both in terms of the perceived quality of service, and in terms of changes in geographic coverage.

Our preliminary results appear to indicate that the rapid growth of chains on deregulated markets is driven by higher investment in (perceived) quality, as well as economies of scale generated via the selection of locations with above-average demand levels. The findings of our demand model call into question expectations regarding falling quality due to chain formation, as consumers do not systematically avoid purchasing from chains. Concerns pertaining to the hiring of fewer pharmacists per outlet are also not systematically reflected in the data: the results of our labor demand model indicate that the relatively lower number of employees per transaction is driven by economies of scale, rather than chain-specific hiring policies.

A key driver of chain success, which remains to be investigated in greater detail in subsequent drafts of this article, appears to be the location choice of chains. Preliminary results investigating entry patterns suggest that chain outlets locate in relatively more densely-populated urban areas, thereby realizing higher sales and economies of scale. From this perspective, the deregulation of ownership is unlikely to significantly improve geographic coverage on the market, thereby undermining one of the key arguments for this policy.

The present paper is focused on quantifying the effects of chain formation at the retail level. However, it is crucial to take into account the high portion of vertically integrated sellers on the market and to consider the potential for foreclosure and rising concentration following the rapid growth of pharmacy chains. Capturing the full social effect of chain formation would involve taking into account dynamic concerns regarding changes in the competitive structure of the market, which is beyond the scope of the current research.

References

Anell, A. (2005). Deregulating the pharmacy market: the case of Iceland and Norway. *Health policy 75*(1), 9–17.

[14]The Dr. Max chain is currently running 1,300 pharmacies in Central and Eastern Europe. In 2023, it has announced plans to merge with the chain Apotheke, thereby increasing its market presence in Slovakia by 41 pharmacies. In addition, it has also completed the acquisition of the distribution company Medical Group SK a.s., resulting in rising vertical integration of its operations.

Antimonopoly Office of The Slovak Republic (2002). Act 2002/kh/r/2/165. `https://www.antimon.gov.sk/data/att/1336.rtf`. Accessed: 2020-09-10.

Bhat, C. R. (1997). An endogenous segmentation mode choice model with an application to intercity travel. *Transportation Science 31*(1), 34–48.

Competition Authority (2001). Submission of the competition authority to the pharmacy review group. Technical report, The Competition Authority, Dublin.

Dalen, D. M. (2003). Legemiddelmarkedet etter apotekreformen: Regulering, markedsstruktur og konkurranse. Technical report, University of Oslo.

Eizenberg, A. (2014). Upstream innovation and product variety in the US home PC market. *Review of Economic Studies 81*(3), 1003–1045.

Červený, J. (2023). Selective referral or learning by doing? An analysis of hospital volume-outcome relationship of vascular procedures. *Health Economics*, Forthcoming.

Federal Union of German Associations of Pharmacists (2021). Ownership requirements of pharmacies in the EU. `https://www.abda.de/en/pharmacies-in-europe/ownership-requirements-of-pharmacies-in-the-eu`. Accessed: 2022-01-09.

Foley, M., R. Harris, E. Rich, A. Rapca, M. Bergin, I. Norman, and M. Van Hout (2015). The availability of over-the-counter codeine medicines across the European Union. *Public Health 129*(11), 1465–1470.

German Council of Economic Experts (2003). Jahresgutachten 2003/04 bt-drs.15/2000. Technical report, German Council of Economic Experts.

Heckman, J. and B. Singer (1984). A method for minimizing the impact of distributional assumptions in econometric models for duration data. *Econometrica 24*, 271–320.

Janssen, A. and X. Zhang (2023). Retail pharmacies and drug diversion during the opioid epidemic. *American Economic Review 113*(1), 1–33.

Kanavos, P., W. Schurer, and S. Vogler (2011). The pharmaceutical distribution chain in the European Union: structure and impact on pharmaceutical prices. Technical report, European Commission.

Mankiw, N. G. and M. D. Whinston (1986). Free entry and social inefficiency. *The RAND Journal of Economics 17*(1), 48–58.

Pacifico, D. (2013). On the role of unobserved preference heterogeneity in discrete choice models of labour supply. *Empirical Economics 45*(2), 929–963.

Písek, J. (2018). How strong are the pharmacy chains within the EU? In *The 11th International Conference INPROFORUM 2017.*

Rostam-Afschar, D. and M. Unsorg (2021). Entry regulation and competition: Evidence from retail and labor markets of pharmacists. Working paper, University of Hohenheim.

Schaumans, C. and F. Verboven (2008). Entry and regulation: evidence from health care professions. *RAND Journal of Economics 39*(4), 949–972.

Smatana, M., P. Pažitný, D. Kandilaki, M. Laktišová, D. Sedláková, M. Palušková, E. Ginneken, and A. Spranger (2016). Slovakia: health system review. Technical report, World Health Organization. Regional Office for Europe.

Swait, J. (1994). A structural equation model of latent segmentation and product choice for cross-sectional revealed preference choice data. *Journal of Retailing and Consumer Services 1*(2), 77–89.

Szalay, T., P. Pažitný, A. Szalayová, S. Frisová, K. Morvay, M. Petrovič, and E. van Ginneken (2011). Slovakia: health system review. *Health Systems in Transition 13*(2), 1–200.

Train, K. E. (2008). EM algorithms for nonparametric estimation of mixing distributions. *Journal of Choice Modelling 1*(1), 40–69.

Vogler, S., D. Arts, and K. Sandberger (2012). Impact of pharmacy deregulation and regulation in European countries. Technical report, Gesundheit Österreich.

Appendix A

TABLE A1: OLS PRODUCTIVITY ESTIMATES BY EMPLOYEE TYPE

	q_j	
Technicians	12115.41	(698.32)
Pharmacists	15271.97	(378.52)
N	1,635	

Notes: Standard errors in parentheses.

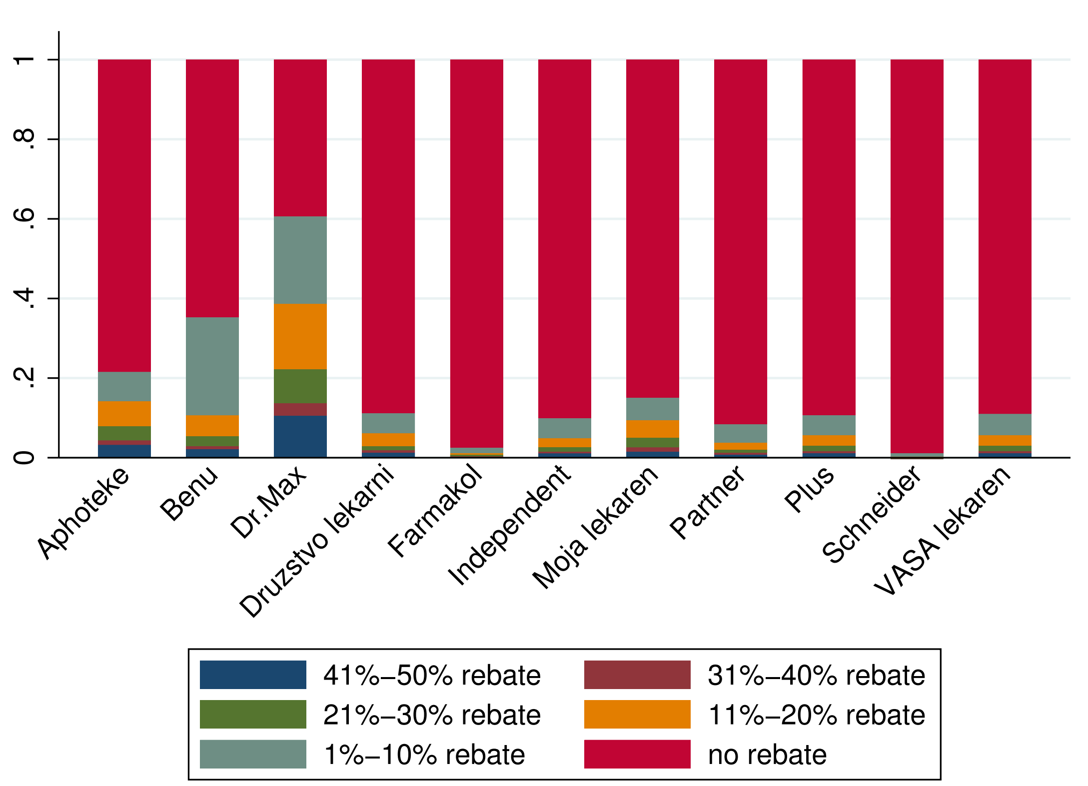

FIGURE A1: COPAYMENT DISPERSION OVER NETWORKS

Notes: Pharmacies can grant rebates to consumers. These rebates are formulated as a portion of the co-payment and have a maximum value of 50% of the maximum co-payment for a specific medication (which is established by law). The above graphic illustrates the share of sales in each pharmacy chain for which a specific level of rebates is implemented and demonstrates that the majority of sales is realized at (or close to) the regulated price ceiling. Rebates are only granted on the co-payment, the price covered by insurance companies is the same across all consumers.

Table A2: Demand Estimates: No-copayment Prescriptions

Variable	Group 1		Group 2	
Panel A. Patients below age of 65				
Distance (km)	−0.314	(0.002)	−15.372	(0.115)
Dr. Max (standard chain)	0.132	(0.010)	0.594	(0.020)
Benu (standard chain)	−0.500	(0.021)	−0.090	(0.053)
VASA lekaren (virtual chain)	−0.062	(0.012)	0.205	(0.020)
Plus (virtual chain)	0.089	(0.009)	0.201	(0.019)
Partner (virtual chain)	−0.004	(0.011)	0.303	(0.022)
Small chains	−0.242	(0.013)	0.209	(0.021)
Nonstop (open > 50 weekends)	−0.605	(0.013)	−0.722	(0.034)
Distance to hospital	0.101	(0.018)	1.162	(0.018)
No. of work days open	0.011	(0.000)	0.009	(0.000)
Population	0.001	(0.001)	0.011	(0.007)
Panel B. Patients above age of 65				
Distance (km)	−0.373	(0.002)	−15.110	(0.131)
Dr.Max (standard chain)	0.318	(0.011)	0.720	(0.022)
Benu (standard chain)	−0.668	(0.026)	−0.259	(0.060)
VASA lekaren (virtual chain)	0.044	(0.012)	−0.041	(0.022)
Plus (virtual chain)	0.144	(0.010)	0.143	(0.020)
Partner (virtual chain)	0.120	(0.011)	0.014	(0.025)
Small chains	−0.199	(0.014)	0.003	(0.024)
Nonstop (open > 50 weekends)	−0.947	(0.014)	−0.862	(0.037)
Distance to hospital	0.072	(0.002)	−1.082	(0.048)
No. of work days open	0.011	(0.000)	0.010	(0.000)
Population	0.005	(0.001)	0.008	(0.008)
ϕ_1	0.508 (0.001)			
ϕ_2	0.492 (0.001)			

Notes: Standard errors in parentheses. Based on 22,450,974 observations.