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Entry decisions and asymmetric competition between non-profit and for-profit homes in the long-term care market*

Iris Grant† Iris Kesternich‡ Johannes Van Biesebroeck§

April 1, 2020

Abstract

Mostly due to population aging, the demand for long-term care (LTC) services is growing strongly. Historically, non-profit nursing homes dominated the German LTC market, but the recent entry wave was tilted towards for-profit competitors. Using a rich administrative dataset on all LTC facilities in Germany, we examine strategic interaction between these two ownership types in a static entry model. The estimates of competitive effects imply that non-profit and for-profit homes are substitutes, but competition is much stronger within-type, suggesting that they provide differentiated products. For-profit homes in particular act as if they operate in a different market segment, but over time their entry behavior has converged to that of the more established non-profits. Counterfactual simulations of proposed changes in government policy suggest a large impact on the fraction of markets that remain unserved or only served by a single type.

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1 Introduction

Due to higher life expectancy and the baby-boom generation reaching retirement age, the fraction of elderly in the population is rising. Over the last two decades, the share of the German population over age 65 has already increased by one third, from 15% in 1995 to 21% in 2015, and it is expected to increase further to 28% by 2035 (Eurostat, 2019). As a result, the number of people requiring an institutionalized form of care has expanded greatly, with a commensurate need for additional capacity. Between 1999 and 2013, the number of long-term care (LTC) facilities in Germany expanded by one third, which made it possible to avoid the long waiting lists that plague many countries.

Non-profits used to be the dominant service providers, but in recent years the majority of new entrants have been for-profit firms. As governments in many countries are considering whether and how to boost entry incentives in the LTC market, it is important to understand how entry decisions of the two types of firms differ and how they interact. In Germany, as in most industrialized countries, preferential tax treatment confers a competitive advantage to non-profit firms. Moreover, non-profits potentially pursue a different objective from straightforward profit maximization, for example maximizing a weighted sum of profits and sales or quality (Gowrisankaran et al., 2015). These differences may translate not only in asymmetric entry deterrence between the two firm types, but also lead to asymmetric preferences regarding market segments or geographic markets to enter. If tax advantages for non-profits strongly crowd out entry of for-profit firms, there will be a loss of potential tax revenue without better access to care.[1]

We make three contributions in this paper. First, using a model estimated on rich administrative data for the German LTC market, we establish that competition between the two ownership types is not symmetric.[2] The presence of own-type competitors lowers profits much more, and thus deters entry more strongly, than other-type competitors. In contrast with predictions from the literature, e.g. Lakdawalla and Philipson (2006), entry of non-profits is more sensitive to the presence of for-profit firms than vice versa. Interestingly, the entry behavior of the two types converges over time. Second, local LTC markets become more competitive with the entry of additional firms and this effect is again stronger within than between-types. We use entry threshold ratios that measure the increase in the number of consumers needed to sustain an additional entrant in the market, to quantify how far the industry is from the perfectly competitive benchmark, where entry threshold ratios equal one. Third, we simulate the future supply of LTC services as the market continues to grow. The tax advantages for non-profits do not

[1] A change in the mix of non-profit and for-profit homes could also change the availability of LTC services differentially for some types of consumers, e.g. for consumers in rural versus urban regions.

[2] We use the German Pflegeheimstatistik which includes information on all long-term care facilities in operation between 1999 and 2013.

deter for-profit firms from the market and they are predicted to cater for an increasing share of future demand. We further simulate the equilibrium market structure under three specific policy proposals that have been advanced: closing the remaining public homes, ending the tax advantage of non-profits, and a single-person room mandate. We highlight in particular that these proposals have very different effects on the presence of LTC facilities in fragile markets, such as rural or low-income areas, which are of specific policy interest.

To learn how strongly incumbent competitors deter entry, we need to address a fundamental endogeneity problem because firms' entry decisions and the local market structure are determined simultaneously. We estimate a static entry model in the spirit of Bresnahan and Reiss (1991). Firms are assumed to enter as long as expected profits or, in the case of non-profit firms, their augmented objective function are positive. This allows to explicitly solve for the market equilibrium, i.e., for the number of both types of firms that a market can sustain as a function of observable and unobservable market characteristics. Because multiple equilibria are inevitable in this situation, we follow Mazzeo (2002) and Cleeren et al. (2009) and impose an order-of-entry assumption that selects a unique subgame perfect equilibrium.

We extend the two-type static entry model and the way it is used to evaluate competition in a few ways. First, we provide an interpretation for the differences in the reduced form profit parameters of both firm types through the lens of a simple theoretical model where non-profits maximize a combination of profits and quantity. Second, we show how comparisons of entry thresholds can be extended to the two-type setting by varying both the number of own and other-type competitors in the market. Third, we estimate the model for odd years between 1999 and 2013, using only cross-sectional variation in market structures across local markets. The results indicate that the convergence between for-profit and non-profit firms in observable characteristics extends to their entry strategy. In particular, the effect of incumbents on the entry of for-profit firms increasingly resembles the pattern for the more experienced non-profits. It is consistent with firms learning how to accommodate entry and refraining from strong price competition.

We do not estimate a full dynamic model, as in Gowrisankaran and Town (1997), or a semi-dynamic model, as in Nardotto et al. (2015), primarily because relatively few homes leave this rapidly expanding market. This makes it impossible to identify the importance of sunk entry costs. In a few Bundesländer, the firm identifiers are not time consistent in several years, introducing spurious entry and exit. We can only reliably identify net entry which only ever takes on negative values for public firms. Their exits tend to be due to budget constraints of the local government, not adverse market conditions.[3] Importantly, demand by the target population is stable. The fraction of residents in the population age

[3] We include public homes in our model as exogenous market characteristics, not as strategic agents.

75 or older slowly declines over time as average health status improves with longevity.[4] The main decision market participants make is determining when the potential market has expanded enough to support an additional home. When gross and net entry coincide, the only relevant dynamic issue is the possibility of preemption. Firms might already enter before a market becomes profitable in order to deter entry by competitors, but this can also be accommodated by using a forward-looking measure of market size.

We also do not estimate a differentiated goods model of demand, as in the literature that focuses on effects of competition on quality. To study entry in such a model, one needs to know the firms' first-order conditions to derive hypothetical profits in various market configurations, as in Berry et al. (2016). We prefer to be flexible regarding the nature of competition, at the expense of some ambiguity in the interpretation of the results.

Our work relates to three strands of literature. A large body of research studies differences in behavior between non-profit and for-profit institutions which often co-exist in health care markets. One question is whether non-profit firms have different objectives or whether they are simply for-profits in disguise. Duggan (2000) studies an exogenous change in hospital financing and finds that non-profits are equally responsive to financial incentives. Gaynor and Vogt (2003) estimate a structural model of two-type competition between hospitals and find that both types are equally likely to exploit market power after a merger. Ballou (2008) predicts that non-profits will enter less profitable markets, but finds that markets served by a monopolist of either type are very similar. Nevertheless, the literature review by Hillmer et al. (2005) concludes, based on US-centric evidence, that non-profit nursing homes tend to offer higher quality of service. A related question is whether competitive pressure leads to more similar behavior. Horwitz and Nichols (2009) find that services offered by non-profit hospitals vary systematically with the share of for-profits active in the local market. Grabowski and Hirth (2003) argue that the true impact of non-profit status on outcomes is difficult to determine because competition generates spillovers. We specifically analyze the strategic entry decisions of for-profit and non-profit firms to learn whether they behave differently, whether interactions are asymmetric, and how competition has changed over time.

We also contribute to the literature on the effects of competition in the long-term care market which has primarily looked at the impact on quality. Lin (2015) shows in a dynamic model of entry, exit and quality choice that competition is strongest between US nursing homes that offer similar quality. Hackmann (2019) uses a static, structural model that assumes non-profit homes maximize a combination of profit and output quan-

[4] It declined from 10.5% in 1999 to 9.1% in 2013. The introduction of compulsory LTC insurance in 1994 had a large impact on the care-at-home market, substituting between formal and informal care, but for residents in LTC homes there always has been a well-developed social assistance subsidy system.

tity and finds that pro-competitive policies have only a small positive effect on nursing home quality. Forder and Allan (2014) even find more competition to lower quality in UK nursing homes. Zhao (2016) highlights the complementary effect of information transparency and competition in improving quality. We do not explicitly model quality and the observable quality measures in our data do not show a systematic difference between for-profit and non-profit firms. Still, unobservable quality differences could be one reason for the asymmetric effects on profits that we find.

Our study of entry in the LTC industry is related to other applications of two-type entry models in Mazzeo (2002), Cleeren et al. (2009) and Harrison and Seim (2019). Multiple equilibria are common in a discrete game setting and, like them, we impose an order-of-entry assumption to select a unique sub-game perfect Nash equilibrium. Cohen et al. (2013) study crowding out of private by public clinics in outpatient substance abuse treatment without an equilibrium selection rule, but they lose point identification. In our application, competitive effects appear to be sufficiently asymmetric to make multiple equilibria a relatively rare occurrence. To quantify how competition changes with entry, Bresnahan and Reiss (1991) introduced entry threshold ratios and they are used in health care settings by Abraham et al. (2007), Gayle et al. (2017) and Schaumans and Verboven (2008). We extend their use to a setting with two firm types. Our counterfactual simulations of the impact of current German policy proposals are similar to Harrison and Seim (2019) who study the effect of tax exemptions for non-profit fitness studios on market structure.

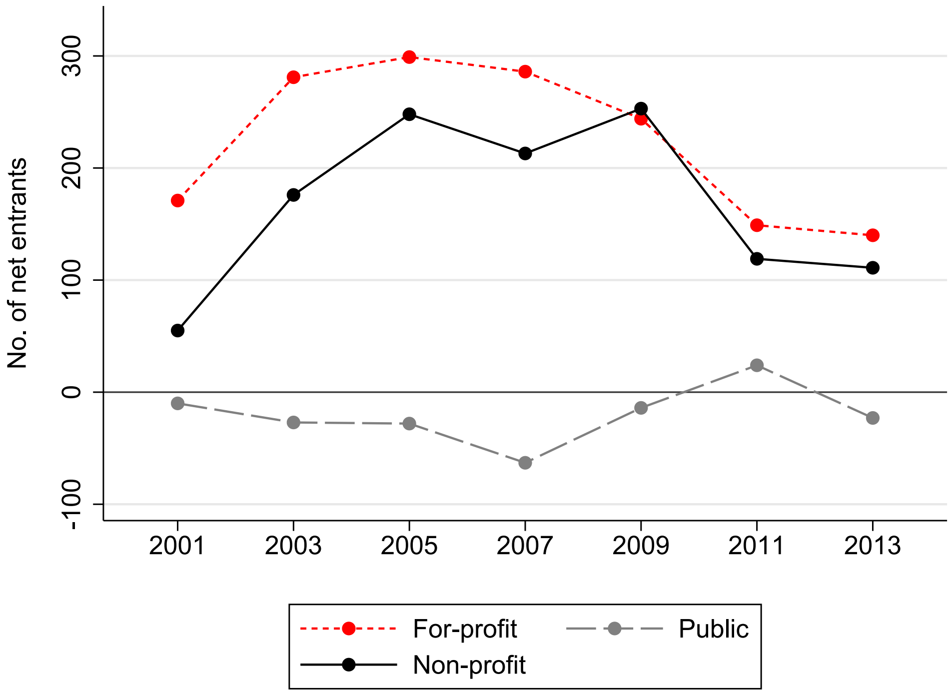
The rest of the paper is organized as follows. Section 2 provides background information on the German LTC market. In Section 3 we first describe a theoretical model of competition between non-profit and for-profit firms to motivate the reduced-form profit equations. We then show how the empirical model is constructed from the Nash equilibrium conditions and discuss identification. In Section 4 we describe the data and construction of local markets. Estimation results and simulations are in Section 5. Section 6 concludes.

2 The long-term care market in Germany

Given that the share of the elderly in Germany is one of the highest in the world, comprising almost one tenth of the population in 2013, the market for elderly long-term care is extensive. In 2013, the country counted 8.0 million people age 75 or older and this is predicted to increase to 11.5 million by 2035.[5] The number of LTC homes that provide care on a permanent basis rose by one third between 1999 and 2013, from 7,594 to 10,200.

[5]Eurostat: Population on 1 January by age group and sex [demo_pjangroup, proj_15npms]. Accessed on 16.05.2017

Figure 1: Total number of net entrants by ownership type



Source: RDC of the Federal Statistical Office and Statistical Offices of the Federal States, Pflegestatistik, survey years 1999-2013, own calculations.

Non-profit nursing homes have historically been the dominant providers of LTC, but the for-profit sector has seen stronger growth in recent years and is slowly catching up. Figure 1 shows the number of net entrants by ownership type and year, calculated as the difference in the number of LTC facilities in operation between subsequent sample years (odd years between 1999 and 2013). Net entry of for-profit homes has exceeded that of non-profits in all years except for 2009. There is also a third type of public homes, but they are clearly losing importance, showing negative net entry in most years. By 2013 the non-profit and for-profit sectors accounted for 54% and 41% of Germany's nursing homes, while the public sector had become almost negligible with only 5% of homes.

Unlike in the United States where potential entrants are subject to the *Certificate of Needs* program in many states, entry in the nursing home market is unrestricted in Germany. Facilities have to fulfill building and staffing requirements, but are otherwise free to operate.[6] Thus, capacity constraints are much less of an issue in Germany than in many other countries.[7] Just as nursing homes are free to enter the market, elderly people can freely choose between them. Most importantly, when moving into institutionalized long-term care, the elderly prefer to stay in a local nursing home. Schmitz and

[6]Building requirements: Verordnung über bauliche Mindestanforderungen für Altenheime, Altenwohnheime und Pflegeheime für Volljährige (Heimmindestbauverordnung - HeimMindBauV); Staffing requirements: Voraussetzungen für die Gründung van Pflegeeinrichtungen.

[7]On average, in a given year, the ratio of patients to available beds does not exceed 91 percent.

Stroka (2014) find that in Germany the average traveling time between the last place of residence and the new LTC home is less than 10 minutes. To account for this pattern, we constructed local markets that are often larger than municipalities (*Gemeinde*), but smaller than districts (*Kreise*), described in detail below.

Besides distance, price plays an important role in consumers' choice as it varies between nursing homes and is for a large part borne by the resident. Prices are set at the nursing home level in a bargaining process between the homes, insurance companies and the social assistance agency. The negotiations take into account past, present and expected costs of the institution and are organized at the state level (*Bundesland*). Within each nursing home, prices are the same for all residents classified into the same care level (*pflegestufe* category) by a physician.[8] LTC insurance has been compulsory in Germany since 1994 and residents of LTC homes receive a lump sum monthly payment that varies by care level.[9] This insurance covers on average about 40% of the price of institutionalized care.[10] Residents are themselves responsible for the balance, and out-of-pocket payments tend to take up a considerable part of their budget. Social assistance pays the balance for families who are unable to pay their full share of the price, around one third of nursing home residents.

3 Model

3.1 Framework

In the model that underlies the empirical analysis, entry decisions of both ownership types, and thus the equilibrium market structure, are determined simultaneously. It allows one to study the effects of non-profit and for-profit entry on the strength of competition, as well as the reverse effect, that is, to what extent own-type and other-type competitors deter entry. An alternative approach would be to regress an entry indicator for either firm type on market structure variables, but this would require instruments for the number of competitors which are clearly endogenous determinants. It is virtually impossible to find variables that are correlated with the number of competitors, but uncorrelated with unobserved market characteristics, such as land prices or the tightness of

[8]Care levels are based on the amount of time residents are expected to require assistance in their activities of daily living. Residents of care level I on average require 90 minutes of help in their activities of daily living, and this time rises to 180 and over 300 minutes for care levels II and III. The assessment of care levels is undertaken by a trained nurse or physician taking into account physical limitations and the home environment.

[9]Sozialgesetzbuch (SGB) - Elftes Buch (XI) - Soziale Pflegeversicherung (Artikel 1 des Gesetzes vom 26. Mai 1994, BGBl. I S. 1014)

[10]In 2010, nursing home residents of care levels I, II and III paid on average €81, €94 and €109 nursing home costs per day and received €33.65, €42.07 and €49.67 LTC insurance benefits per day (Schmidt and Schneekloth, 2011, p157).

the labor market.

Instead, we use a static entry model in the spirit of Bresnahan and Reiss (1991) as generalized to multiple types by Mazzeo (2002). The idea is that the observed market structure, i.e. the number of active for-profit and non-profit homes, is the equilibrium outcome of profit-maximizing entry decisions of both incumbents and potential entrants. This means that no home that chooses to remain active can make a loss and no additional home of either type can enter the market without incurring a loss. The observed market equilibria are therefore informative about the profit functions that determine firms' decision to enter or not. We recover parameters of a reduced-form profit function that depends on market size and the number of competitors by comparing market structures across isolated local markets of different size.

In a setting with both non-profit and for-profit providers, the framework needs to accommodate possible differentiation by ownership type. As in Mazzeo (2002) and Cleeren et al. (2009), we explicitly allow profits to be differentially affected by the presence of own or other-type firms. With multiple types there is often more than one Nash equilibrium, while we only observe a single outcome for each market. Like these authors we incorporate an order-of-entry assumption to select a unique subgame perfect Nash equilibrium. The model amounts to a modified bivariate ordered probit model where profits of both firm types are the two latent variables and the market-level unobservables for both firm types can be correlated. The equilibrium selection rule introduces an additional term in the likelihood function.

3.2 Benchmark theoretical model of two-type competition

We first discuss a simple theoretical model of competition between non-profit and for-profit firms to provide a micro-foundation for the reduced form profit functions used in the empirical work. The predictions on the relative magnitudes of own and other-type competitive effects that we find in Proposition 1 correspond to the assumptions one needs to impose on the reduced form profit function of a more general model for a Nash equilibrium to exist. The predictions in Proposition 2 support the order-of-entry assumption that we impose to select a unique equilibrium in the general model. All these predictions will be verified for the parameter estimates we obtain.

To keep the model tractable, we consider oligopolistic competition with all firms simultaneously choosing quantities, while facing a linear demand and constant marginal costs. Firms of the same ownership type are identical and consumers do not distinguish products within type. Let q_f and q_n be the quantities set by for-profit firm f and non-profit firm n, Q^F and Q^N the total quantities produced by each type, and S the exogenous market size. Type-specific parameters and market-level variables have a superscript F

for for-profit and N for non-profit firms or products. The linear demand curves of a representative consumer for both goods are:

$$p^F = a^F - b^F \frac{Q^F}{S} - d^F \frac{Q^N}{S} \tag{1}$$

$$p^N = a^N - b^N \frac{Q^N}{S} - d^N \frac{Q^F}{S}. \tag{2}$$

For-profit firms naturally maximize profits. Non-profit firms have a different objective function, caring directly about the services they provide. They are assumed to maximize a combination of profit and output, with the "altruism" parameter δ capturing the deviation from strict profit maximization. The respective objective functions are

$$\Pi_f = (p^F - c^F)\, q_f - F^F \tag{3}$$

$$W_n = (p^N - c^N)\, q_n - F^N + \delta\, q_n. \tag{4}$$

As emphasized by Lakdawalla and Philipson (2006), this objective function for non-profits amounts to a price-cost markup of $p^N - (c^N - \delta)$. It is equivalent to assigning a reduced *effective* marginal cost to non-profits, for example due to a tax advantage or donor contributions that lower the user cost of capital, rather than different behavior. In the remainder of the paper, we therefore refer to the objective of both types as 'profits'.

All active firms choose profit-maximizing quantities taking into account the strategies of own-type and other-type competitors. The resulting equilibrium (see Appendix A for the derivations) leads to the following optimal quantity levels for the two types of firms:

$$q_n^* = S\, \frac{(a^N - c^N + \delta) b^F (n^F + 1) - d^N n^F (a^F - c^F)}{b^N b^F (n^N + 1)(n^F + 1) - d^N d^F n^F n^N} \tag{5}$$

$$q_f^* = S\, \frac{(a^N - c^F) b^N (n^N + 1) - d^F n^N (a^N - c^N + \delta)}{b^N b^F (n^N + 1)(n^F + 1) - d^N d^F n^F n^N}. \tag{6}$$

When both types have the same demand and cost parameters and non-profits are altruistic ($\delta > 0$), they produce a higher output and charge a lower price than for-profit firms when they face the same market structure (a combination of own and other-type competitors). Because quantities are strategic substitutes, a for-profit firm's strategic response curve slopes down and its optimal output is negatively affected by δ.

The dependence of equilibrium levels Π_f and W_n on the number of firms of either type follows directly from their dependence on optimal output quantities, given that:

$$\Pi_f = b^F S \left(\frac{q_f^*}{S}\right)^2 - F^F \quad \text{and} \quad W_n = b^N S \left(\frac{q_n^*}{S}\right)^2 - F^N. \tag{7}$$

Profits of both types of firms grow linearly with market size S because q^*/S is constant for a given market structure. If demand parameters are the same for both types, i.e. $a^N = a^F$, $b^N = b^F$ and $d^N = d^F$, and the non-profits have a lower effective marginal cost, i.e. $c^N - \delta < c^F$, then the slope of their profit function is steeper in S. In that case, a non-profit will already find it profitable to enter at a smaller market size.

Differentiating the profit functions with respect to the number of own and other-type firms generates predictions about the effects of entry in a market where both ownership types compete. The results are stated formally in Propositions 1 and 2 and proofs are in Appendix A. They hold if the price elasticity of own-type and other-type demand is negative and if a unit price change has a larger effect on own-type than other-type demand.

Proposition 1. *In an oligopoly model of competition in quantities with two types of firms (symmetric within-type), constant marginal costs, and linear demands that satisfy* $b^N > d^N > 0$ *and* $b^F > d^F > 0$*:*

(a) Entry of an additional firm has a negative, but diminishing effect on the profits of for-profit incumbents and on the generalized objective function of non-profit firms.

$$\frac{\partial \Pi_f}{\partial n^T} < 0 \qquad \frac{\partial^2 \Pi_f}{\partial (n^T)^2} > 0 \qquad \frac{\partial W_n}{\partial n^T} < 0 \qquad \frac{\partial^2 W_n}{\partial (n^T)^2} > 0 \qquad \textit{for } T \in \{N, F\}$$

(b) Effects on both objective functions are larger (in absolute value) for entry by same-type firms than for entry by other-type firms.

$$\left|\frac{\partial \Pi_f}{\partial n^F}\right| \geq \left|\frac{\partial \Pi_f}{\partial n^N}\right| \qquad \left|\frac{\partial W_n}{\partial n^N}\right| \geq \left|\frac{\partial W_n}{\partial n^F}\right|$$

Proposition 1 is intuitive and not new. Own and other-type entry has a negative, but diminishing effect on profitability, with own-type effects dominating.

Proposition 2. *If consumer demand has symmetric slopes for both types, i.e.* $b^N = b^F$ *and* $d^N = d^F$*, then the relative magnitude of own-type entry effects on the two objective functions has the same ordering as the effective price-cost margin.*

$$\left|\frac{\partial \Pi_f}{\partial n^F}\right| \lesseqgtr \left|\frac{\partial W_n}{\partial n^N}\right| \quad \Leftrightarrow \quad a^F - c^F \lesseqgtr a^N - c^N + \delta$$

Proposition 2 states that, if consumer demand for the output of both types is symmetric, a lower effective marginal cost for non-profits ($c^N - \delta$) leads to a stronger effect of own-type entry on their objective function. Given that the demand intercepts cannot be separately identified from marginal costs, the condition can also be interpreted as a higher quality requirement ($a^N + \delta$) for non-profits leads to a higher own-type profit elasticity. We will not be able to estimate the δ parameter itself, but assuming it is positive, the predictions of Propositions 1 and 2 can be verified for our estimates.

3.3 Entry conditions for a Nash equilibrium

We now consider entry decisions of non-profit and for-profit firms in a more general model, without making explicit demand and cost assumptions. Firms only enter a market if their post-entry payoffs are positive. Given that the behavior of non-profit firms can be interpreted as profit-maximizing subject to an *effective* marginal cost, we call the payoffs of both firm types 'profits', and we denote them by π_n^* and π_f^* respectively. They are a function of market characteristics and the number of own-type and other-type competitors. Because the number of public homes is very small and relatively stable over time, we consider them as exogenous market participants.[11] For a Nash equilibrium in entry strategies to exist, the profit functions have to satisfy the following assumptions:

Assumption 1a: Firms of the same type are strategic substitutes

$$\pi_n^*(N_n+1, N_f) \; < \; \pi_n^*(N_n, N_f) \qquad\qquad \pi_f^*(N_n, N_f+1) \; < \; \pi_n^*(N_n, N_f) \tag{8}$$

Assumption 1b: Firms of different types are (weak) strategic substitutes

$$\pi_n^*(N_n, N_f+1) \; \leq \; \pi_n^*(N_n, N_f) \qquad\qquad \pi_f^*(N_n+1, N_f) \; \leq \; \pi_n^*(N_n, N_f) \tag{9}$$

Assumption 1c: Own-type effects are stronger than other-type effects

$$\pi_n^*(N_n+1, N_f-1) \; < \; \pi_n^*(N_n, N_f) \qquad \pi_f^*(N_n-1, N_f+1) \; < \; \pi_n^*(N_n, N_f) \tag{10}$$

According to Proposition 1, all three assumptions are satisfied in the specific model we considered earlier. Entry of an additional own-type competitor has a negative effect on profitability. Entry of an other-type competitor has a similar, but weaker effect. These assumptions restrict the coefficients on the number of competitors in the reduced form profit equations. We do not impose this, but verify that they hold in the point estimates.

We further assume that profits are composed of a deterministic part and a market-type specific unobservable. The first part is modeled as a function of observable market characteristics and the market structure (N_n, N_f), while the latter part is represented by an idiosyncratic random shock:

$$\begin{aligned} \pi_n^*(N_n, N_f) &= \pi_n(N_n, N_f) - \varepsilon_n \\ \pi_f^*(N_n, N_f) &= \pi_f(N_n, N_f) - \varepsilon_f . \end{aligned} \tag{11}$$

[11] The number of public firms in each market will be included as a control variable in the profit functions.

Firms only enter if it is profitable, i.e. when the deterministic component of profits is large enough to offset the negative shock. An equilibrium will feature N firms of one type if the N^{th} firm has positive profits, but the $N+1^{\text{th}}$ firm does not. The market reaches a Nash equilibrium when the last firm of either type that entered earns positive profits while a potential additional entrant would earn negative profits and therefore stays out of the market. It is characterized by the following four conditions:

$$\begin{aligned} \pi_n(N_n+1, N_f) < \varepsilon_n \leq \pi_n(N_n, N_f) \\ \pi_f(N_n, N_f+1) < \varepsilon_f \leq \pi_f(N_n, N_f). \end{aligned} \tag{12}$$

From these equilibrium conditions, we can construct the likelihood for each market structure to occur by integrating over the two unobservables. We assume that the vector ε is drawn from a bivariate normal distribution with correlation parameter ρ and integrate over the normal density function for values between the thresholds set by (12). The joint probability that there are n number of non-profits and m number of for-profits in the market, is given by:

$$Pr(N_n = n, N_f = m) = \int_{\pi_n(n+1,m)}^{\pi_n(n,m)} \int_{\pi_f(n,m+1)}^{\pi_f(n,m)} f_2(\varepsilon_n, \varepsilon_f, \rho)\, d\varepsilon_f\, d\varepsilon_n. \tag{13}$$

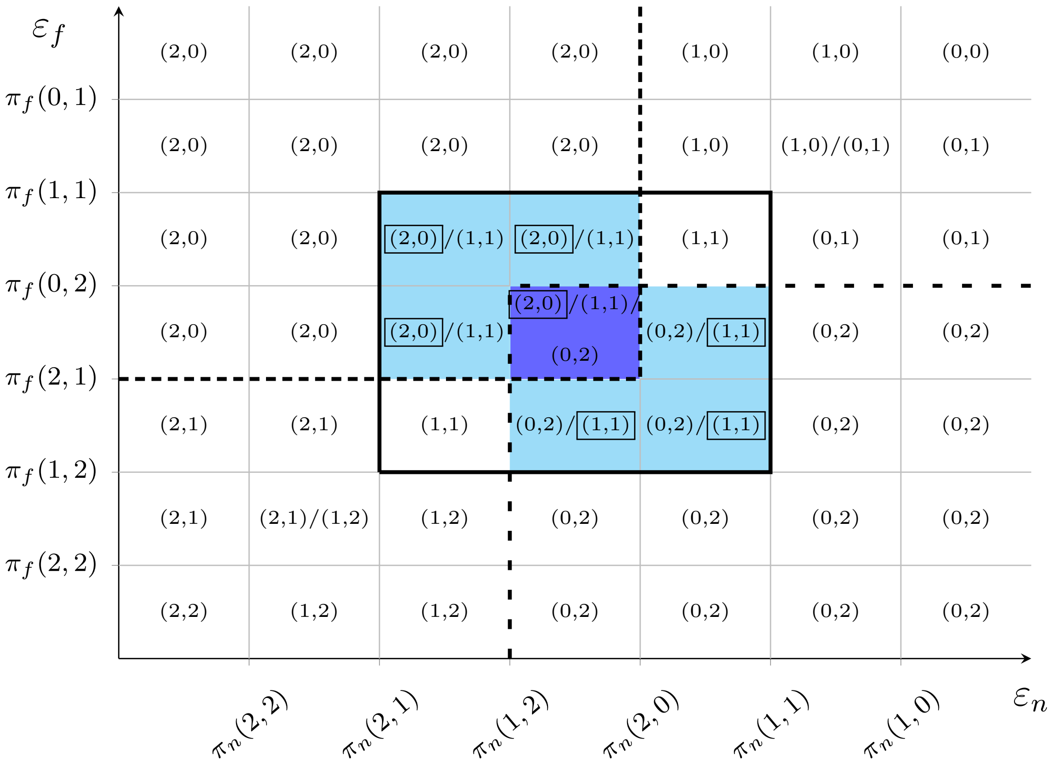
3.4 Empirical identification

If the two ownership types were strategically independent, the profit levels and entry decisions of non-profit firms would not depend on the presence of for-profits, such that $\pi_n(N_n, N_f) = \pi_n(N_n)$, and vice versa. The rectangular area in (13) would represent the probability that a particular market structure is the unique Nash equilibrium. There would be a single $\pi_n(1)$ threshold and $\varepsilon_n > \pi_n(1)$ would define a market structure without non-profit firms. All realizations with $\varepsilon_n \leq \pi_n(1)$ would feature a market structure with at least one non-profit firm, regardless of ε_f or the number of active for-profit firms.

A unique Nash equilibrium is not guaranteed when there is strategic interaction between types. In this case, some realizations of ε could support more than one market structure. The simplest example is to consider a situation where the negative cost shocks ε for the two types are relatively large, such that the market supports only a single firm, and of similar size. Either of the firm types could survive in the market on their own, but not simultaneously. Both $(1, 0)$ and $(0, 1)$ would be Nash equilibria and entry of one would preempt the other. Such a ε realization would be counted in both $Pr(N_n = 1, N_f = 0)$ and $Pr(N_n = 0, N_f = 1)$ according to (13), but only a single outcome is observed in the data.

Figure 2 illustrates the multiplicity of Nash equilibria for a market with two potential

Figure 2: The area in ε-space where market structure (1,1) is an equilibrium



entrants of each type.[12] The area within the solid line indicates all ε combinations for which market structure (1,1) is an equilibrium. The two dotted lines demarcate the areas where respectively (2,0) and (0,2) are equilibrium market structures. The light and dark-shaded areas represent realizations of ε that support two or even three market structures as Nash equilibria. The probability of observing market structure (1,1) depends on which outcome that occurs in the case of multiple equilibria.

Our solution is to impose an assumption on the entry sequence of firms, which generates a unique subgame perfect Nash equilibrium. We give the entry advantage to one type, as in Cleeren et al. (2009), and assume that non-profit homes always enter first.[13] There are two reason for this assumption. First, non-profit nursing homes have historically been more prevalent; the entry wave of for-profit homes is a more recent development. Second, it is consistent with Proposition 2 in the specific model we considered earlier. If the demand and cost parameters of the two types are sufficiently similar, non-profits will enter the market already at a lower market size. As a robustness check, we also estimate the model assuming the reverse order of entry.

[12] Note that depending on the strength of the other-type effects in the profit functions, the ordering of the $\pi_n(1,2)$ and $\pi_n(2,0)$ thresholds might be inverted, and similarly for the $\pi_f(0,2)$ and $\pi_f(2,1)$ thresholds.

[13] Alternatively, Mazzeo (2002) gives the entry advantage to the most profitable firm which complicates the calculation of the likelihood function. The boundaries that define the areas of integration are then no longer parallel to the axes in Figure 2, but depend on both error terms.

In the shaded areas of Figure 2 with multiple equilibria, the unique market structure that is subgame-perfect when non-profit firms enter first is indicated in a box. It is always the one with most non-profit firms.[14] The areas that form a Nash equilibrium, but are not subgame-perfect, need to be subtracted to avoid double counting. As can be seen in the figure, all of these areas are rectangles themselves. The following correction term is therefore subtracted from the original likelihood function in (13):[15]

$$-\int_{\pi_n(n+1,m)}^{\pi_n(n+1,m-1)} \int_{\pi_f(n+1,m)}^{\pi_f(n,m)} f_2(\varepsilon_n, \varepsilon_f)\, d\varepsilon_f\, d\varepsilon_n. \tag{14}$$

3.5 Profit functions

The deterministic part of the profit functions are assumed to be linear functions of three types of variables. Market size is denoted by S and enters the profit function in logs. It is defined as the number of people in the local market age 75 or older, as the vast majority of long-term care residents comes from this age group. The set of market characteristics X includes the following variables: number of public nursing homes, a dummy for East Germany, household income, population density, number of doctors, and the share of elderly receiving social assistance.

$$\begin{aligned} \pi_n(N_n, N_f) &= \lambda_n \ln S + X\beta_n - \gamma_n^{N_n} - \frac{1}{N_n}\alpha_n^{N_f} \\ \pi_f(N_n, N_f) &= \lambda_f \ln S + X\beta_f - \gamma_f^{N_f} - \frac{1}{N_f}\alpha_f^{N_n} \end{aligned} \tag{15}$$

The specification with market size S entering in logarithms implies a multiplicative error term (Schaumans and Verboven, 2008). The generic entry condition $\pi^* = V(N_n, N_f)S - F > 0$, with $V(\cdot)$ the variable profit per (potential) consumer, can be re-written as $S * V(N_n, N_f)/F > 0$. Taking logarithms and replacing the log-ratio of variable profits to fixed costs with $X\beta_t - \gamma^{N_t} - \alpha^{N_{-t}}/N_t + \varepsilon_t$ leads to equation (15). It implies that the parameter λ_t on $\ln S$ equals the inverse of the standard deviation σ_t of the error term.

The γ and α parameters denote competitive effects of, respectively, own and other-type firms. They enter the profit equation as a set of dummy variables to allow the impact to vary flexibly with the number of competitors. We include these coefficients with a negative sign such that positive parameter estimates indicate a negative effect of

[14] Note that non-profits still take into account that after they enter, for-profit firms also get their turn. For example, the (bottom-left) area with only market structure (1,1) is the unique equilibrium for simultaneous or sequential entry. Two non-profit firms would break-even in a (2,0) situation, but because a non-profit firm would enter regardless, the second non-profit stays out, even if entry is sequential.

[15] We refer to Cleeren et al. (2009) for details on the construction of this correction term.

competition on profit. The other-type effects α are divided by the number of own-type firms to impose a diminishing effect with the strength of existing own-type competition.[16] Instances of four and more firms are grouped into a single category because few markets contain that many homes of a single type. Hence, there are a total of eight competition parameters $(\gamma^1, ..., \gamma^4)$ and $(\alpha^1, ..., \alpha^4)$ to estimate in both profit equations.[17]

To facilitate the interpretation and construction of the entry threshold ratios, we parameterize the competitive effects recursively as:

$$\gamma_n^{N_n} = \gamma_n^1 + \Delta\gamma_n^2 + ... + \Delta\gamma_n^{N_n}, \tag{16}$$

with $\Delta\gamma^N = \gamma^N - \gamma^{N-1}$, and similarly for $\gamma_f^{N_n}$ and the two α parameters. γ^1 is the constant term of the profit function and determines the minimum market size for the first firm to enter. $\Delta\gamma_n^2$ captures the marginal effect of the second non-profit firm on a non-profit monopolist, etc. The theoretical model predicts that the $\Delta\gamma$ and $\Delta\alpha$ parameters are positive, but decrease with the number of firms. Moreover, $\Delta\gamma_n^2$ is predicted to be larger than $\Delta\gamma_f^2$.

4 Data and descriptives

4.1 Long-term care institutions

The national statistical office collects information on German long-term care institutions in the *Pflegestatistik* micro-dataset.[18] All active homes are obligated to disclose information on their organizational structure, capacity, personnel and residents. The dataset contains information for alternating years from 1999 to 2013. We drop 11% of observations which are institutions that exclusively provide short-term care or only day or night-care.

We observe each facility's ownership type: private non-profit, private for-profit, or public. The summary statistics in Table 1 indicate that most characteristics are similar across homes of all three types. In particular, the number of full-time equivalent (FTE)

[16] Otherwise, it would imply the same percentage reduction in profits regardless of the number of own-type firms in the market. Further details and a generalization of this normalization will be provided below.

[17] The two sets of additive dummies do not nest the case where both firm types produce perfect substitutes. That would require a fully flexible specification with a total of 20 parameters varying across all (N_n, N_f) combinations. For example, we now estimate the γ effects freely, but expect $\gamma_n^i - \gamma_n^{i-1} > 0$ and shrink with i because additional competitors have diminishing effects. In contrast, the effect of a for-profit competitor α_n^1 on a non-profit duopoly has exactly half the effect it has on a non-profit monopoly, which can be larger or smaller than the $\gamma_n^2 - \gamma_n^1$ difference.

[18] RDC of the Federal Statistical Office and Statistical Offices of the Federal States, Pflegestatistik, survey years [1999-2013], DOI: 10.21242/22411.1999.00.00.1.1.0 to 10.21242/22411.2013.00.00.1.1.0.

Table 1: Nursing home characteristics by ownership type for 2013

	Non-profit	For-profit	Public
Number of homes (all)	6,648	5,025	555
Number of homes (LTC)	5,520	4,184	496
% care level 1	38.6	40.7	39.3
% care level 2	40.8	40.8	40.0
% care level 3	20.6	18.5	20.7
Median age resident	85.0	84.0	85.0
Mean # residents/home	79.5	65.0	88.2
Mean price care level 1 (€/day)	69.7	63.3	71.8
Mean price care level 2 (€/day)	85.4	76.9	87.2
Mean price care level 3 (€/day)	102.3	91.2	103.2
FTE Nurses/resident	0.42	0.43	0.44
Share single room (%)	69.7	54.3	65.9

Note: Calculated for all LTC nursing homes, including homes in larger markets not used in the estimation sample.

nurses per resident, a variable often used to measure quality, averages the same for all three types. The composition of residents across the three care levels, which indicate the amount of care they require and is assessed independently, as well as the average age of residents also show only small differences. Because prices vary by care level, changes in patient composition due to entry will automatically be compensated for in the average price.

There are relatively few public homes in the sample, 496 out of a total of 10,200 in 2013 (fewer than 5%); they are the largest and, somewhat surprisingly, also the most expensive homes. In the empirical analysis, we treat the presence of public homes as exogenous and include them as a control like other market characteristics. Public homes are administered decentrally, mostly by municipalities, and local governments are gradually decreasing their direct involvement in the LTC sector. Non-profit homes are on average somewhat larger, more expensive, and have a larger share of single rooms than for-profit homes. Unfortunately, the price information in our dataset only captures two of the three components of total price. As it omits one component that homes have relatively more discretion over, we do not rely on the price information in the empirical analysis.

Table 2 further shows that a few attributes of non-profits and for-profits have been converging over time. For example, while the size of non-profit homes was relatively stable, the number of residents in the average for-profit home has increased substantially. Both types are increasing the share of single rooms they provide, but the relative advantage of non-profits has decreased in this respect as well.

Table 2: Change in non-profit and for-profit nursing home characteristics (1999-2013)

	Total residents (no.)		FTE Nurses/resident		Share single room (%)	
	NP	FP	NP	FP	NP	FP
1999	79.92	50.70	0.41	0.42	0.54	0.37
2001	81.71	54.24	0.42	0.44	0.56	0.38
2003	81.54	56.35	0.43	0.44	0.59	0.41
2005	80.63	57.22	0.43	0.44	0.61	0.44
2007	79.88	58.32	0.43	0.44	0.64	0.47
2009	79.01	59.69	0.43	0.44	0.66	0.49
2011	79.07	61.99	0.43	0.44	0.68	0.52
2013	79.48	64.99	0.42	0.43	0.70	0.54

Note: Statistics are averages over non-profit homes (NP) or for-profit homes (FP).

4.2 Markets

The unit of analysis is a geographic market which needs to capture the relevant choice set of LTC homes for potential residents. When moving into a home, proximity to the last place of residence is one of the most important determinants. In Germany, the average traveling time between the last place of residence and the chosen home is less than 10 minutes (Schmitz and Stroka, 2014). Germany has 402 districts (*Kreise*) with a median population of 148,411 in 2013. The average district contains twenty homes and using them as markets would be too broad. Municipalities (*Gemeinden*), on the other hand, are too small to contain the full set of options that people are likely to consider. The median German municipality has only 1,706 inhabitants and there is on average not even one home per municipality.

We therefore group together municipalities that lie within close proximity of each other. For a first natural grouping we make use of *Gemeindeverbände*, which are official administrative subdivisions used in 10 of 16 German states. Per district, the municipalities or Gemeindeverbände are then ranked according to urbanization level and population and combined as follows: the unit with the highest urbanization level and population serves as the center of a LTC market. It is grouped with other units if their centers lie within a radius of 5, 7.5 or 15 kilometers, with larger distances used when the level of urbanization is lower. As travel speed is higher in less urbanized areas, the relevant market area is larger there as well. After a market has been formed, the algorithm moves to the next municipality or Gemeindeverbände in the ranking and repeats the exercise until all are exhaustively allocated to a single LTC market. We end up with 2,216 markets, almost half of which consist of at most two units.

Population size at the municipality level is obtained from *Destatis*, the German Federal Statistical Office, and aggregated to the market level. Because we cannot discern the

Table 3: Summary statistics of market characteristics in 2013

	N	Mean	Std	Min	Max
All markets					
Population	2216	36,447	102,404	564	3,421,829
Surface area (km^2)	2216	159.47	111.96	3	905
No. of Gemeinden / market	2216	5.04	6.45	1	73
Household income (€/month)	2216	1724.74	205.07	1316	3579
Population density	2216	256.62	346.17	36	4531
Old age dependency ratio	2216	32.86	4.53	22	48
Doctors	2216	145.08	35.52	79	407
Social assistance (%)	2216	1.65	0.88	0.4	7.5
Markets with population < 75,000					
Population	2054	22,973	15,865	564	74,907
Surface area (in km^2)	2054	159,46	112.21	3	905
No. of Gemeinden / market	2054	5.21	6.56	1	73

Notes: Variables obtained from the *INKAR* database are defined at the district rather than the market level, but all summary statistics are computed over the markets.

relevant choice set for consumers in larger cities, e.g. the entire city of Berlin is one municipality, we exclude them from the analysis. This drops 162 markets with a population over 75,000. Summary statistics in Table 3 show that, after excluding large markets, the remaining 2,054 markets have an average population of 22,973 and surface area of 159 km^2. The standard deviation of population is equal to 15,865. The large variation in population per market will be important for the empirical analysis.

Table 4 shows the frequency distribution of the observed market structures in 2013. Half of all markets contain at most two nursing homes of any ownership type. The most common market structure is a non-profit monopoly, but also duopolies occur frequently. There are 185 unserved markets without any for-profit or non-profit nursing home.[19]

It is notable that asymmetric combinations—with many homes of one type and few of the other type—occur more frequently than symmetric combinations. For example, in markets with two homes, it is 50% more likely that there are two firms of the same type than one of each type. It could be that competition is only slightly stronger within type than between types. It is also possible that observable differences make a market more attractive for one type or that the unobservables in the two profit equations have a negative correlation. The estimates of the structural model will indicate which of these explanations is most appropriate.

To control for other characteristics that can make a market more attractive for non-profit or for-profit homes, we merge additional district-level variables from the *INKAR*

[19]In 32 instances (1 out of 6), such a market will have a public home.

Table 4: Frequency distribution of all observed market structures in 2013

		Number of FPs					Total
		0	1	2	3	≥ 4	
Number of NPs	0	185	149	87	29	56	506
	1	298	160	77	46	61	642
	2	155	133	65	33	48	434
	3	60	66	36	13	32	207
	≥ 4	69	63	51	40	42	265
	Total	767	571	316	161	239	2054

database in the market-level dataset.[20] Those summary statistics are also shown in Table 3.[21]

An important variable in the analysis is the market size S that scales the representative consumer's demand. We obtain it by multiplying the total population in each LTC market by the fraction of the population age 75 or older which is only observed at the district level. A robustness check using total population instead produced similar but less stable parameter estimates and required a re-scaling to interpret the entry thresholds.

5 Results

We report the estimation results and the implications for entry, market structure, and the strength of competition in three ways. The parameter estimates of the competitive effects directly indicate to what extent both types of nursing homes are affected by the presence of additional firms. Because the parameters are scaled by the standard deviation of their respective error terms, we cannot directly compare them across equations.[22] We therefore construct entry thresholds—the minimum market size required for an additional firm to enter the market—that provide a scale-invariant measure of competitive behavior. Finally, we simulate how the equilibrium market structure is predicted to adjust in

[20] Indicators and maps on spatial and urban development in Germany (INKAR), 2017 edition, are provided by the Federal Institute for Research on Building, Urban Affairs and Spatial Development of the Federal Office for Building and Regional Planning. The database can be accessed at `http://www.inkar.de`.

[21] Household income is average disposable income per month (€), population density is measured as inhabitants per km^2, the old age dependency ratio are the number of inhabitants aged 65+ per 100 inhabitants aged 15-65, the number of doctors is expressed per 100,000 inhabitants and the social assistance variable counts the fraction of people aged 65+ who receive social assistance.

[22] This is because the density function in equation (13) is normalized for estimation purposes. All parameters are only identified up to the standard deviation of the type-specific error. Without observables that only affect the profitability of one type, the correlation parameter ρ is only identified by functional form (Berry and Tamer, 2007).

different growth scenarios and for a number of policy changes.

5.1 Parameter estimates

The model is estimated separately for each year. The parameter estimates of the two latent profit equations for 2013, the most recent year, are reported in Table 5. Results for all other survey years are in Appendix B.

As expected, the profitability of both types is negatively affected by the presence of public nursing homes. Only for for-profit firms is it less profitable to operate in the former East German states. The estimates from the income quartile dummies show that long-term care facilities are not more likely to locate in wealthier markets. This is especially the case for for-profit nursing homes which prefer markets with more households in the lowest income quartile (the excluded category) than in the third quartile. This counterintuitive relationship between income and profitability can partly be explained by the fact that for-profits also prefer markets where a higher share of the old-age population receives social assistance payments, which guarantees on-time payment. For the non-profits there is no statistically significant effect of household income on profits.

The first γ^1 coefficient determines the intercept of the profit equation and together with the coefficient on (log) population75 it pins down the market size needed for the first firm to enter. The significant $\Delta\gamma^i$ coefficients indicate a strong negative effect of own-type competitors on profits. LTC homes are strongly deterred from entering a market where other homes of the same type are already active. This effect is largest for the second firm, the first competitor to break a monopoly, and are estimated to be gradually lower for additional competitors. For both types of firms the marginal negative impact of the second firm in the market is more than twice as large as the impact of the fourth firm.

The effects of other-type competitors, the α parameters in Table 5, are estimated to be much smaller. Profits of non-profit firms are lower when for-profit firms are active in a market, but the impact of the first other-type competitor (α_n^1) is only one third as large as the impact of the first own-type competitor ($\Delta\gamma_n^2$). For-profit incumbents will deter non-profit entry, but much less than other non-profit incumbents. In contrast, for-profit nursing homes behave as if their profits are virtually unaffected by the presence of non-profit homes. The point estimates of the α's in the for-profits' equation are small and statistically insignificant.[23]

The stronger impact of own-type than of other-type competitors imply that consumers perceive both firm types as imperfect substitutes.[24] Their entry patterns suggest that

[23]Even the null hypothesis that the total effect of having four or more non-profit firms in the market is equal to zero, that is $\alpha_f^1 + \Delta\alpha_f^2 + \Delta\alpha_f^3 + \Delta\alpha_f^4 = 0$, cannot be rejected.

[24]As mentioned before, the case of symmetric effects for both ownership types is not nested by the

Table 5: Parameter estimates for the two types' profit functions in 2013

	Non-profit		For-profit	
Log population75	1.690***	(0.068)	0.939***	(0.071)
N_{public}	−0.479***	(0.074)	−0.219***	(0.059)
East Germany	−0.042	(0.142)	−0.452***	(0.125)
HH income Q2	0.026	(0.123)	0.082	(0.112)
HH income Q3	−0.015	(0.133)	−0.232*	(0.123)
HH income Q4	−0.090	(0.143)	−0.152	(0.132)
Log pop density	−0.028	(0.054)	−0.298***	(0.053)
Log Doctors	0.489***	(0.170)	0.292*	(0.160)
Social assistance	−0.011*	(0.006)	0.025***	(0.005)
Own-type effects				
γ^1	13.190***	(0.864)	6.681***	(0.819)
$\Delta\gamma^2$	1.519***	(0.103)	0.925***	(0.111)
$\Delta\gamma^3$	1.017***	(0.047)	0.612***	(0.051)
$\Delta\gamma^4$	0.685***	(0.044)	0.422***	(0.035)
Other-type effects				
α^1	0.460**	(0.185)	0.023	(0.222)
$\Delta\alpha^2$	0.478***	(0.125)	0.095	(0.106)
$\Delta\alpha^3$	0.035	(0.165)	0.075	(0.136)
$\Delta\alpha^4$	0.487***	(0.166)	0.167	(0.143)
ρ		−0.079		
N		2,054		

Notes: The market size variable 'population75' measures the number of individuals aged 75 or older in each local LTC market. The three household income variables indicate what fraction of the local population are in the respective, nationally defined income quartiles. ***, **, and * indicate significance levels at the 1%, 5%, and 10% level. Standard errors given between brackets.

they operate in two different market segments. Moreover, we find a negative, albeit insignificant, correlation between the unobservable market characteristics of for-profit and non-profit homes. Rather than some local markets having strong unobserved demand for LTC services, regardless of the type of provider, some markets are profitable for non-profits and other markets for for-profit firms. It helps explain the pattern in Table 4 that asymmetric market structures with many homes of one type and few of the other type to be relatively common.

The results in Table 5 are based on the assumption that non-profits always enter first if they can do so profitably, to select the unique subgame-perfect Nash equilibrium in the case of multiple equilibria. We also estimate the model assuming the reverse order

functional form of the profit equations (15). However, we can test a number of conditions that need to hold if the two types exert the same deterrence on each other. For example, a Wald test strongly rejects for both types the hypothesis $H_0 : \Delta\gamma^2 = \alpha^1$, which should hold if the two types are symmetric.

of entry to check the sensitivity of the results to this assumption. The results in Table B.2 in the Appendix turn out to be very similar. It implies that the area in ε-space with multiple equilibria is relatively small. This is intuitive because the low α_f point estimates indicate that profits of for-profit firms respond only weakly to the presence of non-profit firms. In Figure 2, the horizontal thresholds $\pi_f(0,2)$ and $\pi_f(1,2)$ as well as the thresholds $\pi_f(1,1)$ and $\pi_f(2,1)$ are close together in this industry.

The parameter estimates satisfy the three assumptions (1a-1c) necessary for a Nash equilibrium with a positive and finite number of firms, in line with the predictions of Proposition 1. Even though the own-type effects are estimated larger in absolute value for non-profits than for-profits, we cannot compare them directly to learn about the relative importance of competition for both types. We next derive a metric that is invariant to the implicit normalization to evaluate the prediction of Proposition 2.

5.2 Entry thresholds

To compare the magnitudes of the competitive effects over time and between ownership types, we construct entry thresholds. They are defined as the minimum market size needed for a certain number of firms to at least break even. They are calculated by setting the profit equation (11) to zero, insert the parameter estimates and the means of market characteristics, and solve for S. The entry threshold for N_t own-type and k other type competitors is given by:

$$ET_t^{N_t,k} \quad = \quad \exp\left[\frac{-(\bar{X}\hat{\beta}_t - \hat{\gamma}_t^{N_t} - \hat{\alpha}_t^k/N_t)}{\hat{\lambda}_t}\right] \qquad \text{for } t \in \{n,f\}. \tag{17}$$

The division by λ cancels out the implicit normalization of all parameters by the standard deviation of the error term. We obtain a scale-invariant measure how the strength of competition varies with the number of active firms. I has the same units as the market size variable and can be compared across situations.

The entry threshold ratio (ETR), the ratio of entry thresholds per firm for the N^{th} and the $N-1^{\text{th}}$ firm, measures how the entry threshold evolves with the number of firms. If stronger competition puts downward pressure on markups and successive entrants face the same fixed cost, a higher demand is needed to compensate for the drop in variable profits. Such an adjustment would be reflected in an entry threshold ratio greater than one. It measures the percentage change in per-firm market size that is necessary to accommodate an additional firm in the market. The expectation is that the entry threshold ratio declines with entry and converges to one as markups become invariant to competition as the market approaches perfect competition.

The entry threshold ratio in our two-type model is the product of two factors that separately reflect own-type and other-type effects:

$$\begin{aligned} ETR_t^{N_t,k} &= \frac{ET_t^{N_t,k}/N_t}{ET_t^{N_t-1,k}/(N_t-1)} \\ &= \underbrace{\exp\left(\frac{\Delta\hat{\gamma}_t^{N_t}}{\hat{\lambda}_t}\right)\frac{N_t-1}{N_t}}_{ETR_t^{N_t,0}} \times \underbrace{\left[\exp\left(\frac{-\hat{\alpha}_t^k}{\hat{\lambda}_t}\right)\right]^{\frac{1}{N_t(N_t-1)}}}_{\text{Adjustment factor}}. \end{aligned} \tag{18}$$

The first factor measures the usual change in the per-firm entry threshold needed for an increase from $N-1$ to N firms in the absence of other-type competition. The adjustment factor lies between 0 and 1 and reflects that a smaller percentage increase in market size is needed to support the N^{th} own-type competitor if the market already counts k other-type incumbents. It decreases with N_t, as other-type competition is less important with more own-type incumbents. The adjustment only appears in (18) because of the division of other-type effects in the profit equation by N_t.[25] We also estimated a more flexible version of the model, dividing the other-type effects by N_t^{η} instead of N_t. The point estimate of η is 1.38 for non-profits, but not significantly different from 1.[26]

To zoom in on cross-type competition, we also calculate an alternative entry threshold, comparing the market size needed to support the N^{th} firm in the market when it faces k versus $k-1$ other-type competitors. Own-type competition is now held constant, but greater other-type competition is still expected to increase the market size needed to break even. This comparison depends only on the α parameters and boils down to

$$\frac{ET_t^{N_t,k}}{ET_t^{N_t,k-1}} = \left[\exp\left(\frac{\Delta\hat{\alpha}_t^k}{\hat{\lambda}_t}\right)\right]^{\frac{1}{N_t}}. \tag{19}$$

5.2.1 Own-type competition

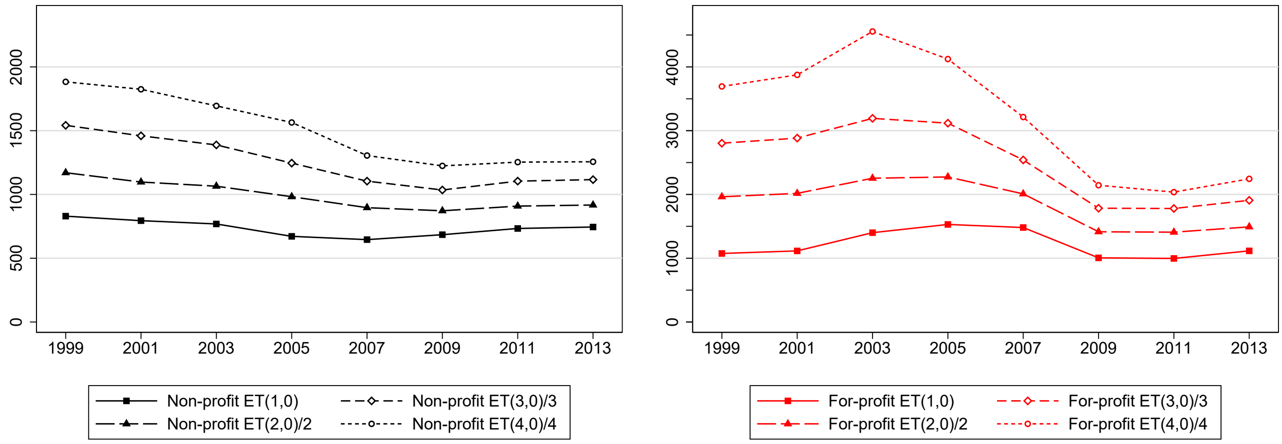
We first look at the entry thresholds in markets with only first of one ownership type. Tables B.3 and B.4 in the Appendix report the entry thresholds and entry threshold ratios for all years, separately for non-profit and for-profit homes. The standard errors are calculated using the delta method and most thresholds are very precisely estimated. For example, $ETR_n^{3,0}$ and $ETR_n^{4,0}$ are estimated at 1.22 and 1.13 for 2013; they are significantly different and even the latter is significantly higher than one.

Figure 3 plots the evolution of the per-firm entry thresholds over time, non-profits in

[25] Without this division, the adjustment factor vanishes and own-type entry would have the same effect on competition irrespective of the number of other-type competitors in the market.

[26] In the for-profit equation, η is estimated to be negative, but given the low and insignificant estimates of the α_f parameters, the η parameter cannot really be identified here.

Figure 3: Evolution of entry thresholds in markets with no other-type competition



(a) Non-profit

(b) For-profit

the left panel and for-profit firms on the right. A first notable pattern is that the market size needed to sustain at least one firm, measured as the number of local residents age 75 or older, is at least one third higher for for-profit monopolists. This pattern is in line with the theoretical prediction of Proposition 2, which is derived by assuming that non-profits face a lower *effective* marginal cost, due to different preferences, charity donations or tax benefits. Alternative explanations are possible however. For-profit and non-profit firms might operate in segmented markets with fewer consumers preferring the services of for-profit firms. Consumers who prefer for-profit homes might have a more elastic demand that lowers the optimal markup and makes it harder to recover fixed costs.

A second pattern is that monopoly entry thresholds (the solid lines) are very stable over time for both firm types, even though the coefficients from which they are calculated are estimated entirely unrestricted by year. Especially important for the discussion below is that the $ET_f^{1,0}$ threshold needed for monopoly entry of a private firm has remained virtually unchanged, apart from a temporary increase between 2003 and 2007. It stood at 1,075 in 1999 and at 1,116 in 2013, an increase of less than 4%. It indicates that demand and costs of long-term care by for-profit firms did not change over time, or that any changes had almost exactly offsetting effects.

The dashed lines lying above the solid lines indicate to what extent a higher market size per firm is needed to support additional competitors. The patterns are again very regular over time. In 2013 the average non-profit monopolist required a local market size of only 745 elderly to break even, while a duopoly of two non-profit homes was only viable if a market contained 1,834 elderly or 917 per firm (23% higher).[27] Without imposing

[27]Note that it implies an increase in the required total market size of 146% (1834/745): 100% to support a second firm if pricing and fixed costs were unchanged, and an extra increase of 23% per firm to account for changes in markups or fixed costs.

more structure on the model it is impossible to know for certain whether the increase is because competition makes monopoly pricing no longer viable and leads to lower markups, or whether second entrants systematically have higher fixed costs. With more than 10,000 nursing homes in Germany, it is a mature market and the cost explanation seems unlikely.

Recall that the number of active firms increased by one third over the sample period and that entry was biased towards for-profit firms. The thresholds reflecting break-even conditions in markets with several competitors declined for a number of years in both panels of Figure 3, and then remain virtually unchanged in the last four years of the sample period. The decline is more pronounced for for-profit firms. By 2013, their relative entry thresholds in markets with different number of competitors resemble more closely the pattern for non-profit firms.

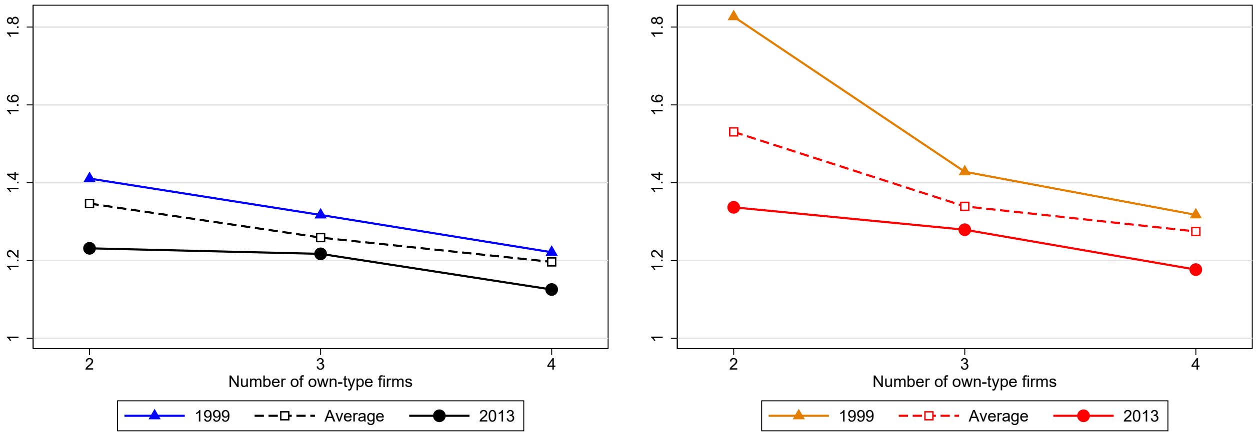
Figure 4 shows the ETRs, again for non-profits on the left and for-profits on the right, for the first and last years, as well as the average pattern over the entire period. The statistic of 1.23, i.e. the 23% larger market needed to support a non-profit duopoly versus a monopoly in 2013, now appears as the first number on the solid black line in the left panel. The next two statistics on the same line, 1.22 and 1.13, are the corresponding ratios comparing the relative market sizes needed to support three versus two firms, and four versus three firms. All three numbers are above one, indicating that firms need more potential customers to be viable in markets with more competitors.

Even with four or more competitors, the market is still not perfectly competitive as the per-firm entry threshold still increases with entry. At the same time, the rate of increase is lower for each successive entrant, e.g. the four-versus-three ratio is significantly below the three-versus-two ratio. Note that the lack of a decrease from two to three firms cannot be interpreted as no change in the strength of competition. Kesternich et al. (2020) show that ETR^2 is special, and only from ETR^3 onwards do standard oligopoly models predict a proportional relationship between the change in price-cost margins and the change in the ETR.

Because over time the per-firm entry thresholds decline more strongly for market structures with more active firms, the ETRs shift down between 1999 and 2013. For non-profit firms the change is minor and the three lines in Figure 4 are relatively similar. Still, the decline in ETR_n^2 by 13%, from 1.41 to 1.23, indicates that a smaller market expansion is needed to accommodate a duopoly entrant in 2013 than in 1999. The next two ETRs decline by a similar amount, indicating a comparable softening of competition in markets with two, three or four competitors.

The ETRs of for-profit firms showed a notably different pattern in 1999: the ETR_f^2 was much higher and fell much more rapidly with the number of active firms. For-profit duopolists needed a per-firm market that was 83% larger than for a monopoly. The ratio

Figure 4: Entry thresholds ratios in markets with no other-type competition



(a) Non-profit (b) For-profit

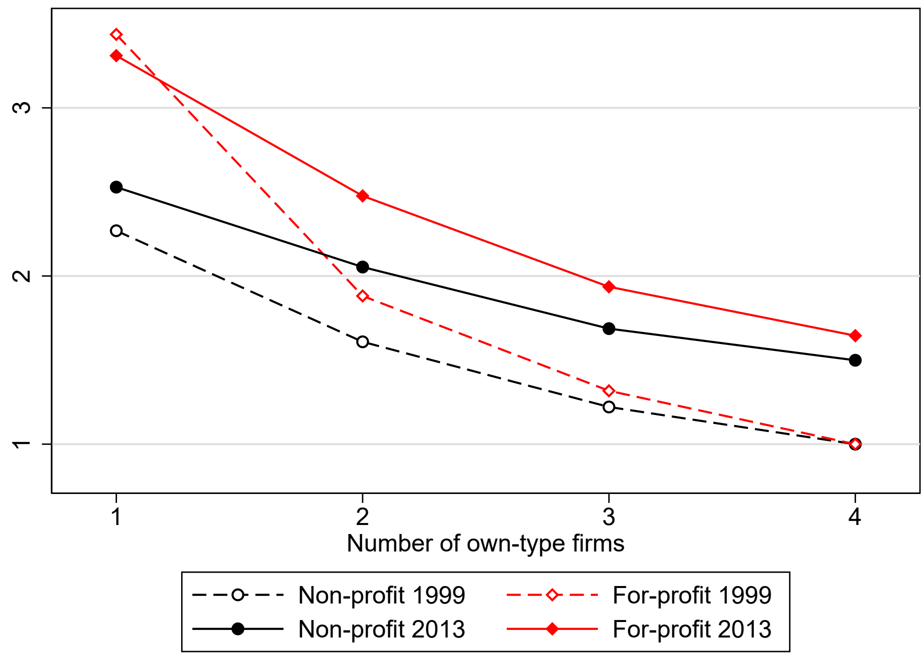
was lower for the third and fourth entrant, but even the ETR_f^4 was still 1.32. Even the fourth entrants still had a notable effect on the strength of competition. The higher ETRs for for-profit firms than for non-profit firms is the opposite of the prediction in Proposition 2.

However, the patterns for the two firm types converged almost entirely by 2013. Except for monopolists, entry thresholds at the end of the sample period are systematically lower than at the start. The downward shift of the ETR-line is especially pronounced for for-profit firms and the line has become flatter as well. The link between the number of active firms and the strength of competition has clearly diminished. The $ETR_f^{4,0}$ ratio is still larger than one, suggesting that entry strengthens competition, but the lower effect is now comparable to that of non-profits. The pattern is consistent with additional entry changing the way for-profit firms compete, in particular finding a way to accommodate more competitors while sustaining variable profits.

In Figure 5 we compare the patterns for both firm types directly. Rather than compare successive $N-1$ to N entry thresholds, we now normalize all thresholds by the market size needed to support four or more firms, which is the closest we can get to a perfectly competitive benchmark. We normalize separately by ownership type as we cannot rule out differences due to demand or cost heterogeneity. Because entry thresholds for either type of monopolists are constant over time, which suggests stable demand and cost primitives, we normalize by the $ET_t^{4,0}$ value for the same year (1999).

The dashed lines indicates how much larger the per-firm market needed to be in 1999 to support at least four competitors, compared to the number of firms on the X-axis. For a non-profit monopolist, a 2.3 times smaller market sufficed and for a for-profit monopolist even a 3.5 times smaller market. Within-type competition was clearly a lot stronger for

Figure 5: Normalized entry thresholds ratios for both ownership types



Notes: Shows $(ET_t^{4,0}/4)$ for 1999 divided by the year-specific $(ET_t^{N_t,0}/N_t)$. It is the inverse ETR normalizing each per-firm entry threshold by the corresponding value for a market structure with 4 competitors of the same ownership type in 1999.

for-profit firms.

Two things changed by 2013. First, the solid lines for both firm types converged, especially comparing markets with four firms to monopoly markets. The ratio on the left declined from 3.5 to 3.3 for for-profit firms, but increased from 2.3 to 2.5 for non-profit firms. Second, both curves became a lot less steep. The increases on the right side of the graph indicate that the market sizes needed to support several firms shrunk for both ownership types. A market approximately one third smaller already suffices to support four firms in 2013 relative to the 1999 situation (a factor of 1.6 and 1.5).

This pattern can be interpreted as firm entry strengthening competition to a lesser extent than before, especially for for-profit firms. Firms might have found a way to coexist with more competitors without competing down markups. The change is less pronounced for non-profit firms which were already more experienced in 1999. Lower ETRs for non-profits do not necessarily imply that they compete less intensely than for-profit firms. ETRs are silent on the level of competition, they only inform us how the strength of competition changes with the number of active firms. The fact that the slopes of the normalized-ETRs for both ownership types become more similar over time implies that their behavior is converging, in line with the convergence in observable characteristics we indicated earlier.

One challenge to this interpretation is that the introduction of compulsory LTC insurance in 1994 affected ETRs. The reform intended to increase the attractiveness of care-at-home options, which could change the competition between homes and the outside good. If this were an important factor it could lower the ETR, but we would expect it to work through a rising entry threshold in markets with few firms. The change in competition would be most apparent in small, monopoly markets, because larger markets already had competition between the inside goods. In contrast, it is clear from Figure 3 that the lower ETR is due to lower entry thresholds in markets with many firms. Moreover, we mentioned before that market penetration for LTC homes declined only slightly, most likely due to improved health among the elderly.

It is also unlikely that cost reductions caused the declining entry thresholds. In the limited price information we observe, average prices fell only slightly over the sample period, by -0.4% per year for non-profit homes and -0.5% for for-profit homes. We would expect cost changes to show up in prices, especially given the strong growth in the number of active firms. Another possibility is that over time people have become less sceptical about for-profit entities providing LTC services. If demand shifted towards for-profit homes, their entry threshold would decline. However, both of these explanations are hard to reconcile with the absence of any change in thresholds for monopoly markets. Given that the differences between the 1999 and 2013 normalized-ETRs are higher with more active firms, it certainly appears as if the nature of competition has changed.

A more promising alternative explanation could be that over time firms have differentiated their offerings. By appealing to different types of consumers, they compete less directly and can maintain higher markups. Such a strategy can increase the total market by convincing more potential clients to consider moving into a nursing home, as in Schaumans and Verboven (2015). The flatter slope in the ETRs of non-profits would then suggest they are more successful with this strategy. This explanation is consistent with the absence of any change in entry thresholds in monopoly markets.

5.2.2 Other-type competition

The point estimates of the α parameters in the profit equation of non-profit firms indicate that the presence of for-profit competitors also affects their profitability. To assess the magnitude of this effect, the alternative ETR in equation (19) shows the increase in market size needed to support the same number of own-type firms in markets if there is one or more other-type competitors present. The top panel of Table 6 shows the results for various numbers of non-profit firms.

Naturally, the increase is largest for the first (monopoly) non-profit, shown in the first row. The estimate of 1.31 indicates that the entry threshold for a non-profit monopolist

Table 6: Effect of other-type competition on entry thresholds

	Increase in ET_n with one additional for-profit firm			
	$k=1$	$k=2$	$k=3$	$k\geq 4$
$ET_n^{1,k}/ET_n^{1,k-1}$	1.31	1.33	1.02	1.33
$ET_n^{2,k}/ET_n^{2,k-1}$	1.15	1.16	1.01	1.15
$ET_n^{3,k}/ET_n^{3,k-1}$	1.09	1.10	1.01	1.10
$ET_n^{4,k}/ET_n^{4,k-1}$	1.07	1.07	1.01	1.07
	Increase in ET_f with one additional non-profit firm			
	$k=1$	$k=2$	$k=3$	$k\geq 4$
$ET_f^{1,k}/ET_f^{1,k-1}$	1.02	1.11	1.08	1.19
$ET_f^{2,k}/ET_f^{2,k-1}$	1.01	1.05	1.04	1.09
$ET_f^{3,k}/ET_f^{3,k-1}$	1.01	1.03	1.03	1.06
$ET_f^{4,k}/ET_f^{4,k-1}$	1.01	1.03	1.02	1.05

Notes: The non-profit and for-profit entry thresholds $ET_n^{N_n,k}$ and $ET_f^{N_f,k}$ are defined as in equation (17) with N_n and N_f the number of own-type non-profit or for-profit firms and k the number of other-type competitors.

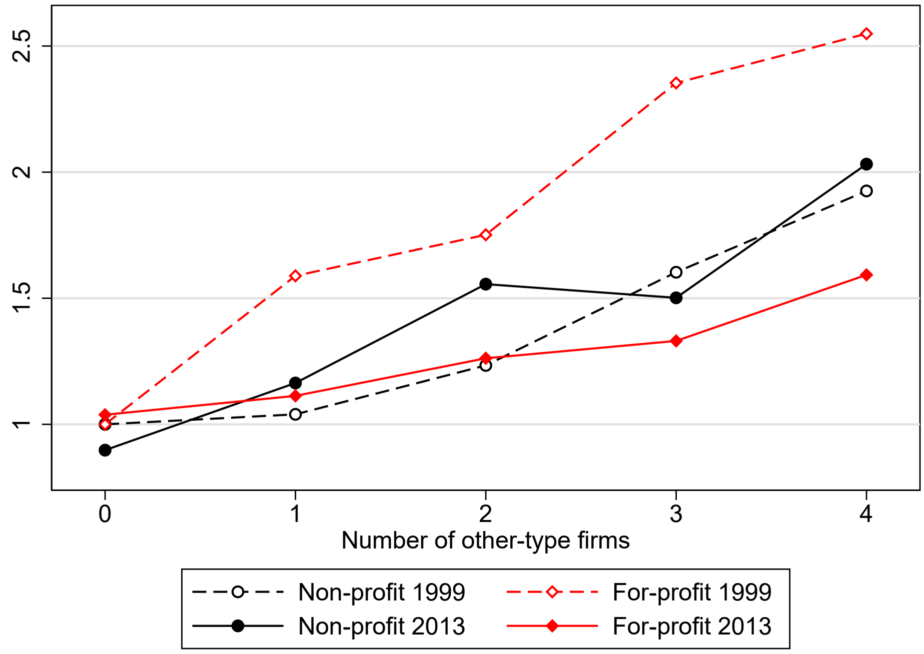
is 31% higher in the presence of one for-profit incumbent compared to a market that is entirely unserved. While this ratio is higher than the 1.23 ETR in Figure 4, it has a different interpretation because it is not calculated per firm. A monopolist non-profit needs a 31% larger market before it can enter, but the market then contains two firms rather than one. The 1.23 per-firm ETR corresponds to an absolute market size increase of 146% for the market to support two rather than one non-profit firm. It does not directly imply, however, that a (1,1) market structure is more likely than (2,0) because the for-profit firm needs a larger market size to be viable itself.

Subsequent rows of Table 6 show the corresponding increases in entry thresholds due to for-profit competition when additional non-profits are already active. As they provide strong within-type competition, the necessary market size is already elevated and the presence of for-profit competitors is less important. The division of the α coefficients in the profit equation by N guarantees a declining effect. It imposes that the ratio in the second row equals the square root of the ratio in the first row, while the ratio in the third row is the third root of the first value, etc.[28]

The relative effects for the presence of increasing numbers of other-type competitors k are estimated freely and shown in the columns. We expect these numbers to decline with k, as the marginal competitor should be less important, but this is not imposed. The estimates are surprisingly constant. The entry threshold increases by another third

[28] As discussed before, dividing by N^η instead, we find $\hat{\eta} = 1.38$, but not significantly different from 1.

Figure 6: Evolution of the other-type competitive effects on a monopolist's entry threshold



Notes: Shows $ET_t^{1,k}/ET_t^{1,0}$, the increase in the entry threshold for a monopolist of either ownership type for increasing numbers of other-type competitors normalized separately for each ownership type by the 1999 threshold for a monopolist facing no other-type competition.

if there is a second for-profit, by only 2% for the third for-profit, and by another 33% if four or more for-profit homes are present. To find the extra market size needed to enter a market with four for-profit incumbents compared to none, we simply multiply the four pairwise ratios to find an overall ratio of 2.36 or an increase of 136%.

The parameter estimates in Table 5 indicate only insignificant effects of non-profit competition on the profits of for-profit nursing homes. The bottom panel of Table 6 shows the implied magnitude of those effects. The increase in the required market size if a for-profit firm faces an additional non-profit competitor is much smaller than in the reverse case. Note, however, that this increase is applied to a higher baseline as for-profit monopolists already require a larger market.[29]

Figure 6 shows the effects for both firm types in the first and last years of the sample. The numbers correspond to the first row in Table 6, showing the various numbers of other-type incumbents on the X-axis. They always measure the change in entry threshold for a monopolist entrant relative to an unserved market, i.e. the number for $k = 2$ multiplies the ratios in the first two columns of Table 6.

[29]For example, the cumulative effect of facing four other-type competitors is approximately +136% for non-profits (multiplying the four ratios and subtracting one), but only 46% for for-profits. Given that the baseline market is only 745 for a non-profit and 1,116 for a for-profit firm, the effect in number of consumers is more similar: +1,013 for non-profits and +513 for for-profits.

Back in 1999 (dashed lines), the magnitudes of the relative effects of the two firm types on each other were reversed. For-profit firms were deterred much more strongly by non-profit firms. The difference was especially pronounced for the first other-type competitor. Similarly as for the own-type effects, the pattern for for-profit firms changed a lot in the following years. By 2013 (solid lines) both firm types are affected rather similarly by other-type competition. We already discussed that the effects for for-profit firms are not distinguishable from zero, but it is the convergence between the red and black lines that really stands out. Other-type effects diminished a lot for for-profit homes, but strengthened somewhat for non-profit homes.

These findings are not in line with the model of Lakdawalla and Philipson (2006). Assuming homogenous goods, they predict that if both types are active, the supply of non-profit firms necessarily has to be exogenously restricted. For-profit firms are the marginal providers and they alone will adjust to changed market circumstances. In contrast, our results indicate that the presence of for-profit firms deters non-profit entry to a greater extent than in the reverse case. Moreover, the large difference in the γ and α estimates suggest that non-profit and for-profit LTC homes are not perfect substitutes.

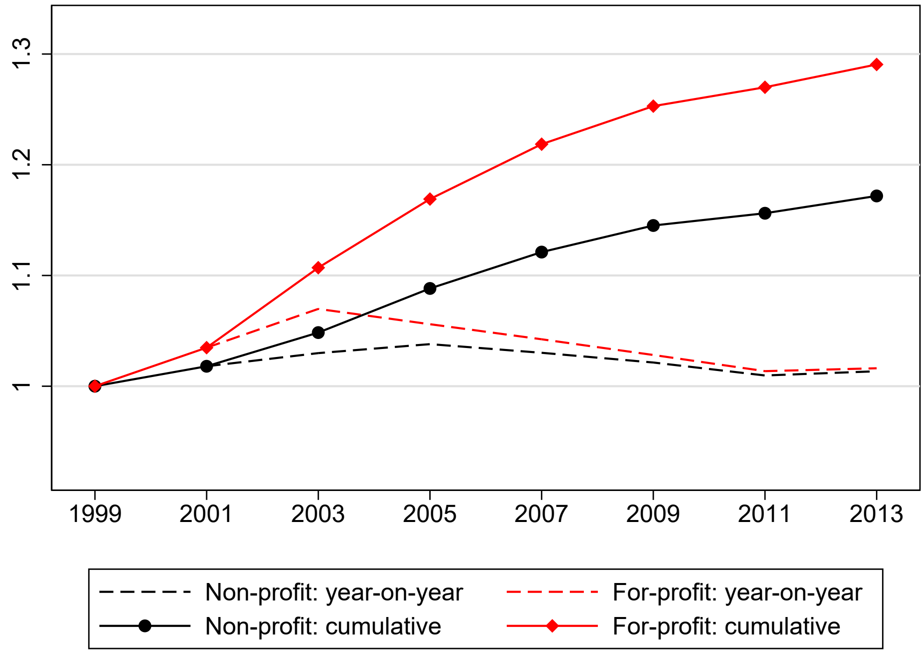
We previously mentioned that some consumers may initially have been apprehensive to buy LTC services from for-profit firms. The fraction of potential customers that consider the for-profit option might have increased over time, as more people gained experience with them, which could help explain that non-profit firms pay increasing attention to these new competitors. Initially, some for-profit homes targeted very specific market segments (e.g. the high-end segment) and competed only indirectly with many non-profit homes. The estimates for the income quartiles indicate that for-profit firms increasingly target markets with consumers on social assistance, bringing them in direct competition with non-profits.

5.2.3 Cumulative effect of historical entry

Figures 4 to 6 illustrate the magnitude of own and other-type competition in isolation. In practice, both effects interact, as illustrated by the two factors in equation (18). Additional own-type entry has a smaller impact on mark-ups and thus on the per-firm entry thresholds, if other-type competitors are present. Moreover, the impact of additional entry also depends on the prevailing local market structures which also evolved over time.

The negative point estimates on the competitive effects in both profit equations guarantee that ETRs always exceed one if the number of competitors increases. To gauge the cumulative impact of the observed entry over the sample period, we summarize its effect as follows.

Figure 7: Evolution of the entry thresholds of marginal active firms



Notes: The year-on-year statistics measure the average change in ET from $t-2$ to t across all markets that is solely due to a change in the number of active firms (using the point estimates for the competitive effects in the profit function for year t in numerator and denominator).

Separately for each market and for both ownership types, we calculate the ratio of per-firm entry thresholds for years t and $t-2$ using the observed number of non-profit and for-profit firms in the respective years. We use the parameter estimates and control variables for year t in the numerator and denominator, such that only the competitive effects do not drop out, as in equation (18). If the market structure did not change, this ratio equals one. In markets with more active firms in year t, the ratio is above one, but naturally it is higher for own-type entry. In markets with fewer firms, the ratio is below one. The average of these ratios over all markets, reflects the average increase in per-firm entry thresholds for the country that is solely due to the observed entry. In Figure 7 we show the year-on-year changes and we multiply them over time to obtain cumulative effects.

The 1.29 statistic we end up with for for-profit firms in 2013 implies that the market size required to make the marginal for-profit firm break-even was on average 29% larger in 2013 than in 1999. The corresponding increase for non-profit firms is 17%. These estimates depend both on the changes in the point estimates of the competitive effects and on the changes in the actual number of competitors in each market. Given the dominance of own-type effects and the larger increase in the number of for-profit firms, the relative size of the two effects is intuitive. Under the assumption that fixed entry costs did not change over time, these increases correspond to reductions in variable profits of

Table 7: Simulated distribution of market configurations for 2013

		Number of FPs					Total
		0	1	2	3	≥ 4	
Number of NPs	0	198.8	130.8	81.1	35.8	56.2	502.6
	1	264.2	181.5	87.4	41.8	47.8	622.7
	2	155.7	128.4	72.1	39.5	55.7	451.4
	3	68.1	62.0	37.7	21.7	32.6	222.2
	≥ 4	73.1	65.6	45.6	26.8	44.2	255.2
Total		759.84	568.3	323.8	165.6	236.4	2054

similar magnitudes.

5.3 Policy and market growth simulations

We next use the estimated model to predict how the supply of LTC services will evolve under the forecasted growth in market size and in response to three acutal policy proposals for Germany. We simulate new equilibrium market structures under each scenario, fixing the parameters at the estimated values for 2013 and changing some of the explanatory variables. We are especially interested in markets that remain unserved, lightly served, or served only by one type of firm.

As a benchmark, we first simulate the market equilibria for 2013 using the observed values and parameter estimates from Table 5. For each market we draw two errors $(\varepsilon_n, \varepsilon_f)$ from a bivariate standard normal distribution and calculate the profits of non-profit and for-profit firms in all possible market structures. If profits satisfy the entry conditions in (12), the market structure is an equilibrium. In markets with multiple Nash equilibria, we pick the one with the most non-profits. We perform this simulation one hundred times and report in Table 7 the average number of times each market configuration occurs. These simulated frequencies can be considered as the fitted values of the estimated model; most are very close to the actual frequencies reported in Table 4.

The first column in Table 8 contains market penetration indicators in the benchmark situation. There are a total of 5,871 homes, 3,213 non-profits and 2,659 for-profits.[30] Out of a total of 2,054 markets, 185 or 9.0% are not served by any ownership type (non-profit, for-profit or public). Only counting non-profit and for-profit homes, in panel B,

[30]Statistics on the total number of homes omit public homes, but we take them into account to determine whether a market is not served at all. We assign four homes to all market structures in the 'four or more firms' category, which will underestimate changes in the number of nursing homes in those markets. This as well as the exclusion of large markets explains the difference with the number of observations in Table 1.

9.7% of markets are not served and an additional 1.4% is lightly served with at least one home, but fewer than one per 1000 people over the age of 75. 42% of markets are served by only one of the two ownership types. Given that both types seem to cater to different market segments, a lack of choice may also reduce consumer welfare. The bottom panel of Table 8 shows the market penetration statistics—number of homes and fractions of unserved markets—for markets that are of extra relevance to policy makers. These are markets in the East of Germany, rural or low-income markets (lowest quartiles by population density or by income), and markets with a high share of elderly (highest old-age dependency quartile).

The results in column (2) show simulated changes in market penetration when we replace all explanatory variables in the profit equations with their predicted values for 2023, 10 years after the end of the sample period. In particular, the population over 75 is predicted to increase by 14%,[31] while other market characteristics are extrapolated using their growth rates over the preceding decade. This implies the following evolutions: a 10% increase in the share of elderly receiving old-age social assistance benefits, an 8.5% increase in the number of doctors per inhabitants, a 2% decrease in population density (recall that larger cities are omitted from the sample), and an 8% increase in real household income.

With these changes, the total number of nursing homes is expected to increase by 11.1%, but the increase in for-profit homes is 3 percentage points higher than for non-profit homes. Entry is most prevalent in markets with a population just below the entry threshold. In particular, we see the largest relative increases in the number of homes in lightly served markets (17% increase) and low-income markets (14.1% increase). The number of markets that is not served at all goes down by almost one quarter in only ten years. This decline is even stronger in the East and in low-income markets.

Column (3) contains the simulated changes in market penetration under the first policy scenario, the closure of all remaining public homes. Over the last decades, public involvement in the LTC market has gradually declined and many public homes have been privatized or closed down. What does our model predict if the remaining 308 public homes (approximately 5% of the combined non-profit and for-profit capacity) were removed from the market? This supply reduction would only be partly compensated by entry of non-profit and for-profit homes which numbers increase by 3.8% and 2.5% respectively. Non-profits are most responsive, in line with the higher estimated coefficient on the N_{public} variable in their profit equation. It is plausible that public nursing homes are more similar to private non-profit than to for-profit homes. The 0.4 percentage points reduction in the first line of panel B are instances where markets that are only served by a public home experience entry by a private home once the public home closes. There are 14 such

[31] Statistisches Bundesamt (Destatis), accessed on 12.03.2019

Table 8: Changes in market penetration for a number of policy changes and market growth scenarios

	Benchmark (1)	Predicted growth (2)	No Public[1] (3)	Redistribution tax exemptions (4)	Single room policy (5)
			All markets (2054)		
Total no. of nursing homes	5871	+11.1%	+3.2%	−3.1%	−20.5%
No. of non-profits	3213	+9.8%	+3.8%	−17.3%	−17.3%
No. of for-profits	2659	+12.6%	+2.5%	+14.0%	−24.3%
Unserved markets	185	−24.0%	+3.8%	+11.3%	+52.7%
Markets with only non-profits	561	−9.3%	−0.1%	−24.4%	+19.4%
Markets with only for-profits	304	−5.5%	−3.8%	+47.5%	+7.1%
			By type of market		
A. Total number of nursing homes (n **or** f)					
Unserved markets (185 markets)	0	+44	+0	+17	+0
Lightly served[2] (545)	1278	+17.1%	+4.0%	+0.1%	−18.6%
East (496)	1257	+14.1%	+2.9%	−3.9%	−21.0%
Rural (509)	1264	+11.7%	+2.7%	−3.3%	−22.9%
Low income (513)	1347	+14.1%	+2.8%	−3.6%	−20.7%
High elderly share (493)	1420	+11.4%	+2.6%	−3.2%	−19.8%
B. Fraction of markets not served (ignoring public homes)[3]					
Unserved markets	9.7%	−2.3	−0.4	+1.1	+5.5
Lightly served	1.4%	−0.5	−0.9	+2.8	+8.7
East	11.1%	−3.3	−0.3	+2.0	+6.5
Rural	11.5%	−2.6	−0.3	+1.4	+7.1
Low income	11.1%	−3.2	−0.3	+1.8	+6.2
High elderly share	9.7%	−2.5	−0.2	+1.3	+5.0

[1] There are on average 0.15 public homes per market or approximately 5% of the total number of LTC homes.
[2] Lightly served markets contain at least one home and fewer than one home for every 1000 people over the age of 75.
[3] Fraction of markets not served by non-profit or for-profit homes in (1) and percentage point changes in (2)-(6).

markets and 8 experience private entry.

Current tax policy is sometimes criticized because it exempts non-profit homes from income tax and thus distorts market competition. In 2011 the German Fiscal Court clarified limits on non-profit hospital tax exemptions (Harrison and Seim, 2019). Abolishing this exemption outright is unrealistic, as it would greatly reduce the number of homes. Instead, we consider a (nearly) budget-neutral policy change that redistributes the total amount currently 'spent' on tax exemptions among all active homes, irrespective of ownership type. The new policy covers a fixed share of the fixed costs of each home by a public subsidy.

To implement this policy, we exploit that our multiplicative error specification implies a linear effect of the control variables on the log-ratio of variable profits to fixed costs, as discussed with equation (15). Thus, a shift in the intercept of the latent profit equation can be interpreted as a tax exemption proportional to variable profits or a subsidy proportional to fixed cost. We find the revenue-neutral subsidy rate s of 16.25% by trial and error, such that $0.3F_nN_n = sF_n(N'_n + N'_p)$, with N'_t the equilibrium numbers of firms under the new policy. It replaces the 30% tax exemption for non-profits by a

16.25% fixed cost subsidy that is implemented by multiplying the original intercept γ_n^1 by $\ln[(1-0.1625)/(1-0.3)]\lambda_n$. The reduction in fixed costs of for-profit firms by 16.25% raises their intercept γ_f^1 by $-\ln[1-0.1625]\lambda_f$.

Results in column (4) show that total market penetration declines by 3.1% in this new tax regime. Non-profit exit exceeds for-profit entry because subsidies are now more likely to go to inframarginal firms and because non-profits are more sensitive to for-profit competition than vice versa. The changes in panels A and B indicate that this policy, even though it is budget neutral, leads to a decrease in the number of homes and thus an increase in the share of unserved markets and this change is especially pronounced in the more vulnerable markets. The current bias towards non-profit homes does seem to have desirable distributional effects across markets. Note that the predicted decline in church membership is likely to have similar distributional effects as this tax policy simulation. Existing non-profit homes benefit from explicit subsidies or charitable donations, especially from the Catholic and Protestant churches. This source of funding is also predicted to decline strongly in the near future.

Finally, we simulate how the LTC supply will adjust to the introduction of a policy mandate that at least 95% of rooms in each nursing home must be single-person rooms. Even though consumers consider the share of single rooms as the most desirable characteristic of a home (Calkins and Cassella, 2007), this share has increased by only one percentage point per year since the beginning of our sample period (see Table 2). It suggests that it is a very costly feature. Two German states have already introduced requirements on the minimum share of single rooms, sparking concerns on the effects on LTC accessibility (Herr and Saric, 2016).[32] Converting double rooms into single rooms would decrease the ratio of variable profits to fixed costs, by requiring investments to convert rooms or by lowering variable profits per room.

Evidently, the single-room mandate will have a larger effect on facilities that currently have a low share of single rooms. We observe this ratio only at the market level, but separately by ownership type. We simulate an increase in fixed costs (which can also be interpreted as a decrease in variable profits) that varies with the current average share of single rooms by market-type combination. We assume that the percentage increase in fixed costs is one half of the fraction of rooms that is affected. By doing this, we take an intermediate stance between the two extremes of incurring zero costs (for example, because there is spare capacity) and of incurring fixed costs equal to the share of single rooms (because for each double room, one additional single room has to be built). For example, if non-profit homes in a specific market already have 85% single-person rooms,

[32] Our paper is complementary to the analysis in Herr and Saric (2016) who estimate a demand model and assume that there is not entry or exit due to the reform.

we assume that increasing this share to 95% will entail a 5% increase in fixed costs.[33]

The results in column (5) indicate that a sudden implementation of the single room mandate would drive many nursing homes out of the market. Even with a relatively conservative assumption about the decrease in the ratio of variable profits to fixed costs—we assume that only half of the total fixed costs (or variable profits, respectively) are affected by the mandate—would make 20.5 percent of current homes no longer viable. Especially for-profit homes, which currently tend to have a lower proportion of single rooms, would face large transition costs and high exit rates. Panels A and B show that rural markets and markets in the East which currently have lower shares of single rooms would be especially negatively affected by this policy.

6 Conclusion

We have analyzed competition between non-profit and for-profit homes in the German long-term care market. The entry patterns of the two ownership types indicate that they operate as if in two different market segments. We find a much stronger negative impact of own-type competition than other-type competition on entry. It suggests that consumers perceive for-profit and non-profit homes as imperfect substitutes and that entry is deterred asymmetrically between different ownership types.

Over time, the behavior of the two types of firms converged, which mirrors a similar convergence in observable characteristics. In 1999, the entry threshold ratios of for-profit firms declined strongly with the number of own-type competitors. This is consistent with increased competition and lower variable profits in markets with more active firms. The ratios of non-profit firms also declined with the number of active firms, but the pattern was much less pronounced. By 2013, the entry threshold ratios were lower, especially for for-profit firms. The presence of own-type incumbents is gradually less of an entry deterrent and the deterring effect became similar for both ownership types.

The nature of competition between types also converged. Initially, non-profit entrants largely ignored for-profit competitors, but by 2013 that was no longer the case. Markets with for-profit incumbents needed to be substantially larger to sustain the first non-profit entrant compared to markets without for-profit incumbents. For-profit entry witnessed the reverse pattern. Initially it was very sensitive to the presence of non-profit competitors, but this sensitivity diminished over the years, in line with the diminished sensitivity

[33] Recall that the latent profit equation − without the $\ln S$ term − is proportional to $\ln(V(\cdot)/F_t)$ and denote the share of rooms affected by $x_t = (0.95 - \text{share single rooms for type } t)$. Raising the fixed costs by one half of x_t, corresponds to changing the intercept in the profit equation by $-\ln(1 + x_t/2)$. To make the relationship between the share of single rooms and fixed cost comparable for the two ownership types, $1 + x_f/2$ is normalized by λ_f/λ_n.

to own-type competition.

Even though the entry behavior indicates that a given number of active firms has a diminished effect on competition in later years, the number of active firms has increased a lot. We find that on balance the market environment faced by the marginal firm has become a lot more competitive.

Our analysis has ignored one new form of competition that has gained relevance in recent years. An increasing number of homes specialize in short-term rooms where residents stay for only a few months, for example to recover after a hospital procedure. We dropped homes with a majority of short-term rooms from the sample, which constituted relatively few observations prior to 2013. This segment has gained importance and such homes increasingly compete with the long-term care homes studied here. Given that for-profit firms dominate in the short-term segment, it would be interesting to study in future work whether the for-profit homes in our sample are more sensitive to short-term, for-profit competitors than to long-term, non-profit homes.

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Appendix

A Oligopoly model with competition between two firm types

A.1 Objective functions for non-profit and for-profit firms

In this section we derive an expression for the objective functions of a non-profit and for-profit firm as a function of the model parameters and the number of competitors in the market. Consider an oligopoly model with quantity competition between for-profit and non-profit firms that are symmetric within each type. Let q_f and q_n denote the quantities set by for-profit firm f and non-profit firm n, Q^F and Q^N be the total quantities produced by each type and S the exogenous market size. All firms of the same type face the same demand and cost functions. Type-specific parameters and market-level variables are superscripted F for the for-profit and N for the non-profit firms. The linear demand functions of a representative consumer for both types of goods are:

$$p^F = a - b^F \frac{Q^F}{S} - d^F \frac{Q^N}{S} \tag{A.1}$$

$$p^N = a - b^N \frac{Q^N}{S} - d^N \frac{Q^F}{S} \tag{A.2}$$

For-profit and non-profit firms differ in their objective functions. The for-profits straightforwardly maximize profit with respect to quantity, taking into account the strategic quantity response by own-type and other-type competitors. Substituting the linear demand in the objective function, differentiating with respect to q_f, and assuming that own-type firms are symmetric ($\sum q_{-f} = (n-1)q_f$) gives the best response function for q_f with respect to $\sum q_n$:

$$\begin{aligned}
\Pi_f &= (p^F - c^F)q_f - F^F \\
\Pi_f &= (a - b^F \frac{(q_f + \sum q_{-f})}{S} - d^F \frac{\sum q_n}{S} - c^F)q_f - F^F && \text{(A.3)} \\
\frac{\partial \Pi_f}{\partial q_f} &= a - c^F - 2\frac{b^F}{S} q_f - \frac{b^F}{S} \sum q_{-f} - d^F \frac{\sum q_n}{S} = 0 \\
q_f &= \frac{S}{b^F(n^F+1)}(a - c^F - d^F \frac{\sum q_n}{S}) && \text{(A.4)}
\end{aligned}$$

For the objective function of a non-profit firm we follow Lakdawalla and Philipson (2006) and assume that a non-profit maximizes a combination of profit and output. The weight attached to output is captured by "altruism" parameter δ. Following the same steps as before gives the best response function of q_n with respect to $\sum q_f$:

$$\begin{aligned}
W_n &= (p^N - c^N)q_f - F^N + \delta q_n \\
W_n &= (a - b^N \frac{q_n + \sum q_{-n}}{S} - d^N \frac{\sum q_f}{S} - c^N)q_f - F^N + \delta q_n && \text{(A.5)}
\end{aligned}$$

$$
\begin{aligned}
\frac{\partial W_n}{\partial q_n} &= (a - c^N + \delta - 2\frac{b^N}{S}q_n - \frac{b^N}{S}\sum q_{-n} - d^N \frac{\sum q_f}{S}) = 0 \\
q_n &= \frac{S}{b^N(n^N+1)}(a - c^N + \delta - d^N \frac{\sum q_f}{S}) \qquad \text{(A.6)}
\end{aligned}
$$

We exploit the symmetry within firm types, $\sum q_f = n^F q_f$ and $\sum q_n = n^N q_n$, and solve the system of two best response function (A.4) and (A.6). It leads to expressions for the optimal quantities for non-profits q_n^* and for-profits q_f^* as a function of only the demand and cost parameters and the number of competitors of both type:

$$
q_n^* = \frac{S((a - c^N + \delta)b^F(n^F+1) - d^N n^F(a - c^F))}{b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N} \qquad \text{(A.7)}
$$

$$
q_f^* = \frac{S((a - c^F)b^N(n^N+1) - d^F n^N(a - c^N + \delta))}{b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N}. \qquad \text{(A.8)}
$$

Substituting these optimal quantities into the demand functions gives the following equilibrium prices:

$$
p^F = \frac{ab^N b^F(n^N+1) + c^F\left(b^N b^F(n^N+1)n^F - d^N d^F n^F n^N\right) - d^F b^F n^N(a - c^N + \delta)}{b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N}
$$

$$
p^N = \frac{ab^N b^F(n^F+1) + (c^N - \delta)\left(b^N b^F(n^F+1)n^N - d^N d^F n^F n^N\right) - d^N b^N n^F(a - c^F)}{b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N}
$$

Since negative prices and quantities are not allowed, the following corner solutions give necessary conditions for the parameters for both types of firms to be active in the market:

$$
\frac{(a - c^F)}{(a - c^N + \delta)}\frac{(n^N+1)}{n^N} \leq \frac{d^F}{b^N} \qquad \Rightarrow \qquad q_f^* = 0 \qquad \text{(A.9)}
$$

$$
\frac{(a - c^N + \delta)}{(a - c^F)}\frac{(n^F+1)}{n^F} \leq \frac{d^N}{b^F} \qquad \Rightarrow \qquad q_n^* = 0 \qquad \text{(A.10)}
$$

Finally, to obtain the payoffs in terms of parameters and numbers of firms, we substitute the optimal quantities of both firm types (A.8) and (A.7) into the respective objective functions (A.3) and (A.5), to find:

$$
\Pi_f = Sb^F\left(\frac{(a - c^F)b^N(n^N+1) - d^F n^N(a - c^N + \delta)}{b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N}\right)^2 - F^F \qquad \text{(A.11)}
$$

$$
W_n = Sb^N\left(\frac{(a - c^N + \delta)b^F(n^F+1) - d^N n^F(a_c^F)}{b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N}\right)^2 - F^N \qquad \text{(A.12)}
$$

A.2 Entry effects

We find the effects of entry of both types of firms simply by differentiating the payoff functions (A.11) and (A.12) with respect to the number of own-type or other-type firms. Proving propositions 1 and 2 merely requires signing these derivatives.

A.2.1 Proposition 1(a): Effects of own-type entry

The effect of for-profit entry on for-profit payoffs:

$$\frac{\partial \Pi_f}{\partial n^F} = -2Sb^F \frac{[(a-c^F)b^N(n^N+1) - d^F n^N(a-c^N+\delta)]^2}{[b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N]^3} \times (b^N b^F(n^N+1) - d^N d^F n^N) \tag{A.13}$$

$$\frac{\partial^2 \Pi_f}{\partial {n^F}^2} = 6Sb^F \frac{[(a-c^F)b^N(n^N+1) - d^F n^N(a-c^N+\delta)]^2}{[b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N]^4} \times (b^N b^F(n^N+1) - d^N d^F n^N)^2 \tag{A.14}$$

The effect of non-profit entry on non-profit payoffs:

$$\frac{\partial W_n}{\partial n^N} = -2Sb^N \frac{[(a-c^N+\delta)b^F(n^F+1) - d^N n^F(a-c^F)]^2}{[b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N]^3} \times (b^N b^F(n^F+1) - d^N d^F n^F) \tag{A.15}$$

$$\frac{\partial^2 W_n}{\partial {n^N}^2} = 6Sb^N \frac{[(a-c^N+\delta)b^F(n^F+1) - d^N n^F(a-c^F)]^2}{[b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N]^4} \times (b^N b^F(n^F+1) - d^N d^F n^F)^2 \tag{A.16}$$

For the entry effects of own-type firms, (A.13) and (A.15), to be negative, it is sufficient that a unit price change has a larger effect on own-type than other-type demand, or formally, $b^N > d^N$ and $b^F > d^F$.

Since the second derivative of profit w.r.t. own-type firms is positive, the negative effect of own-type entry is decreasing in the number of own-type firms.

A.2.2 Proposition 1(a): Effects of other-type entry

The effect of non-profit entry on for-profit payoffs:

$$\frac{\partial \Pi_f}{\partial n^N} = 2Sb^F b^N d^F \frac{\left[(a-c^F)b^N(n^N+1) - d^F n^N(a-c^N+\delta)\right]}{[b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N]^3} \times \underbrace{\left[(a-c^F)d^N n^F - (a-c^N+\delta)b^F(n^F+1)\right]}_{<0,\text{ if no corner solution}} < 0$$

From the conditions in (A.9) and (A.10) we know that there is only one negative factor in the first-order derivative if quantities q_f and q_n are positive. The effect of other-type entry therefore has a negative impact on profits for both ownership types.

The second derivative is given by:

$$\frac{\partial^2 \Pi_f}{\partial {n^N}^2} = 2Sb^F {b^N}^2 {d^F}^2 \frac{\left[(a-c^F)d^N n^F - (a-c^N+\delta)b^F(n^F+1)\right]^2}{[b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N]^6} > 0$$

Since the second derivative of profit w.r.t. non-profit firms is positive, the negative effect of other-type entry is decreasing in the number of other-type firms.

The effect of for-profit entry on non-profit payoffs can be derived similarly:

$$\frac{\partial W_n}{\partial n^F} = 2Sb^F b^N d^N \frac{\left[(a-c^N+\delta)b^F(n^F+1) - d^N n^F(a-c^F)\right]}{[b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N]^3} \times \left[(a-c^N+\delta)d^F n^N - (a-c^F)b^N(n^N+1)\right] < 0$$

$$\frac{\partial^2 W_n}{\partial {n^F}^2} = 2Sb^N {b^F}^2 {d^N}^2 \frac{\left[(a-c^N+\delta)d^F n^N - (a-c^F)b^N(n^N+1)\right]^2}{[b^N b^F(n^N+1)(n^F+1) - d^N d^F n^F n^N]^6} > 0$$

A.2.3 Proposition 1(b): Comparisons of entry effects of the two types

Own-type entry has a larger impact than other-type entry in absolute values:

$$\left|\frac{\partial \Pi_f}{\partial n^F}\right| > \left|\frac{\partial \Pi_f}{\partial n^N}\right|$$

$$\begin{aligned}\Leftrightarrow\ & [(a-c^F)b^N(n^N+1) - d^F n^N(a-c^N+\delta)]b^N b^F \\ & + [(a-c^F)b^N(n^N+1) - d^F n^N(a-c^N+\delta)](b^N b^F n^N - d^N d^F n^N) \\ & > \left[(a-c^N+\delta)b^F(n^F+1) - (a-c^F)d^N n^F\right] b^N d^F\end{aligned}$$

The second term on the left-hand side of the inequality is positive for $b^N > d^N$ and $b^F > d^F$. Since $b^F > d^F$, the first term on the left-hand side is greater than the right-hand side of the equation at $n^F = n^N$ for equal (effective) marginal cost between the two types. The inequality will therefore hold as long as the difference between c^F and $c^N - \delta$ is not unreasonably high.

The inequality for the effects on the non-profits objective function, $\left|\frac{\partial W_n}{\partial n^N}\right| \geq \left|\frac{\partial W_n}{\partial n^F}\right|$, can be shown in the same way.

A.2.4 Proposition 2: Comparisons of own-type entry effects across the two types

Finally, we compare the effects of own-type entry between for-profits and non-profits. We assume symmetric demand parameters between the two types in order to focus on the influence to the output preference component in the non-profit's objective function. For $b^N = b^F$ and $d^N = d^F$, the comparison of own-type entry effects between a for-profit and non-profit firms simplify and we find the following at $n^N = n^F$:

$$
\begin{aligned}
& \left|\frac{\partial \Pi_f}{\partial n^F}\right| \lesseqgtr \left|\frac{\partial W_n}{\partial n^N}\right| \\
\Leftrightarrow \quad & (a-c^F)b(n+1) - dn(a-c^N+\delta) \lesseqgtr (a-c^N+\delta)b(n+1) - (a-c^F)dn \\
\Leftrightarrow \quad & (a-c^F)\left(b(n+1)+dn\right) \lesseqgtr (a-c^N+\delta)\left(b(n+1)+dn\right) \\
\Leftrightarrow \quad & (a-c^F) \lesseqgtr (a-c^N+\delta) \\
\Leftrightarrow \quad & c^N - \delta \lesseqgtr c^F
\end{aligned}
$$

B Additional results

B.1 Results for other survey years

Table B.1: Parameter estimates for both firm types in years 1999-2011

	1999	2001	2003	2005	2007	2009	2011
(a) Non-profit firms							
Log population75	1.430***	1.439***	1.478***	1.572***	1.619***	1.630***	1.602***
N_{pub}	−0.443***	−0.440***	−0.411***	−0.400***	−0.435***	−0.443***	−0.332***
East	0.241**	0.092	0.046	-0.031	-0.084	0.087	0.027
HH income Q2	0.141	0.093	0.055	-0.029	-0.059	0.066	0.000
HH income Q3	-0.003	-0.008	-0.082	-0.043	-0.169	-0.017	-0.047
HH income Q4	0.001	-0.033	−0.198*	-0.188	−0.211*	-0.127	-0.125
Log pop density	-0.003	-0.005	0.022	-0.014	0.004	0.013	-0.001
Log Doctors	0.283	0.341*	0.336*	0.331*	0.284	0.419**	0.366**
γ^1	10.803***	11.123***	11.506***	11.685***	11.736***	12.705***	12.303***
$\Delta\gamma^2$	1.302***	1.306***	1.319***	1.495***	1.563***	1.518***	1.432***
$\Delta\gamma^3$	0.889***	0.925***	0.926***	0.944***	0.971***	0.944***	0.997***
$\Delta\gamma^4$	0.617***	0.699***	0.691***	0.765***	0.716***	0.782***	0.710***
α^1	0.202	0.328	0.215	0.615***	0.642***	0.496***	0.333
$\Delta\alpha^2$	0.076	0.073	0.107	0.164	0.247**	0.276**	0.449***
$\Delta\alpha^3$	0.361*	0.407**	0.315*	0.174	0.182	0.013	-0.167
$\Delta\alpha^4$	0.147	0.191	0.339**	0.478***	0.322**	0.507***	0.562***
(b) For-profit firms							
Log population75	0.713***	0.739***	0.734***	0.727***	0.756***	0.836***	0.905***
N_{pub}	−0.187**	−0.188***	−0.133***	−0.161**	−0.224***	−0.286***	−0.318***
East	−0.826***	−0.726***	−0.975***	−0.691***	−0.927***	−0.845***	−0.922***
HH income Q2	-0.000	0.080	-0.069	0.195	-0.041	0.112	0.110
HH income Q3	-0.019	0.006	−0.219**	0.058	−0.244**	−0.226**	−0.214*
HH income Q4	-0.001	-0.100	−0.350***	-0.006	−0.245**	-0.182	−0.233*
Log pop density	−0.173***	−0.158***	−0.120**	−0.206***	−0.216***	−0.208***	−0.239***
Log Doctors	0.412**	0.491***	0.426***	0.624***	0.617***	0.678***	0.703***
γ^1	5.960***	6.666***	6.354***	7.210***	7.173***	7.812***	8.185***
$\Delta\gamma^2$	0.825***	0.833***	0.815***	0.731***	0.691***	0.893***	0.971***
$\Delta\gamma^3$	0.488***	0.501***	0.506***	0.498***	0.456***	0.538***	0.587***
$\Delta\gamma^4$	0.388***	0.392***	0.433***	0.379***	0.365***	0.413***	0.379***
α^1	0.119	0.014	-0.051	-0.281	-0.419	-0.022	0.131
$\Delta\alpha^2$	0.025	0.062	0.122	0.156	0.163	0.061	0.115
$\Delta\alpha^3$	0.355**	0.255*	0.134	0.065	0.118	0.241*	-0.022
$\Delta\alpha^4$	-0.007	0.190	0.122	0.130	0.080	0.103	0.234
ρ	0.064	0.070	-0.022	-0.003	-0.027	-0.044	-0.093
N	1.747	1.759	1.759	1.759	1.759	1.759	1.759

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

B.2 Robustness check on the parameter estimates

Table B.2: Profit parameters estimates for 2013 under the assumption that for-profit firms enter first

	Non-profit		For-profit	
Log population75	1.669***	(0.064)	0.971***	(0.065)
N_{public}	−0.476***	(0.073)	−0.232***	(0.057)
East Germany	−0.031	(0.140)	−0.453***	(0.125)
HH income Q2	0.025	(0.123)	0.081	(0.112)
HH income Q3	−0.011	(0.133)	−0.236*	(0.123)
HH income Q4	−0.088	(0.143)	−0.158	(0.131)
Log pop density	−0.022	(0.054)	−0.299***	(0.053)
Log Doctors	0.481***	(0.169)	0.286*	(0.160)
Social assistance	−0.011*	(0.006)	0.025***	(0.005)
Own-type effects				
$\tilde{\gamma}^1$	13.069***	(0.856)	6.787***	(0.819)
$\Delta\gamma^2$	1.496***	(0.075)	0.985***	(0.078)
$\Delta\gamma^3$	0.998***	(0.043)	0.624***	(0.037)
$\Delta\gamma^4$	0.674***	(0.042)	0.440***	(0.036)
Other-type effects				
$\tilde{\alpha}^1$	0.350**	(0.161)	0.196	(0.129)
$\Delta\alpha^2$	0.496***	(0.133)	0.013	(0.106)
$\Delta\alpha^3$	0.015	(0.173)	0.134	(0.126)
$\Delta\alpha^4$	0.506***	(0.173)	0.163	(0.139)
ρ		−0.079		
N		2,054		

Note: Significance levels *** p<0.01, ** p<0.05, * p<0.1. Standard errors between brackets.

B.3 Entry thresholds and entry threshold ratios

Table B.3: All entry thresholds in the absence of other-type competition

	1999	2001	2003	2005	2007	2009	2011	2013
(a) Non-profit firms								
$ET_n^{1,0}$	830	795	769	672	646	684	733	745
	(102)	(99)	(78)	(67)	(49)	(47)	(55)	(56)
$ET_n^{2,0}$	2341	2195	2129	1965	1793	1744	1817	1834
	(240)	(189)	(129)	(104)	(73)	(71)	(77)	(73)
$ET_n^{3,0}$	4626	4379	4165	3738	3313	3105	3313	3349
	(480)	(376)	(266)	(207)	(140)	(118)	(145)	(140)
$ET_n^{4,0}$	7532	7298	6778	6257	5220	4897	5013	5025
	(881)	(731)	(509)	(399)	(257)	(227)	(247)	(224)
(b) For-profit firms								
$ET_f^{1,0}$	1075	1115	1400	1530	1481	1006	997	1116
	(238)	(291)	(410)	(576)	(461)	(171)	(162)	(200)
$ET_f^{2,0}$	3926	4034	4508	4549	4017	2830	2817	2983
	(1075)	(1019)	(1044)	(1157)	(838)	(351)	(339)	(363)
$ET_f^{3,0}$	8411	8652	9589	9354	7622	5352	5340	5724
	(2212)	(2392)	(2393)	(2430)	(1595)	(695)	(661)	(712)
$ET_f^{4,0}$	14774	15501	18223	16494	12857	8577	8145	8980
	(4628)	(4664)	(5161)	(4691)	(2975)	(1302)	(1169)	(1251)

Notes: Entry thresholds $ET^{N,0}$ are defined as in equation (17) with N the number of own-type competitors and no other-type competitors. Standard errors in parentheses.

Table B.4: All entry threshold ratios in the absence of other-type competition

	1999	2001	2003	2005	2007	2009	2011	2013
(a) Non-profit firms								
$ETR_n^{2,0}$	1.41	1.38	1.39	1.46	1.39	1.27	1.24	1.23
	(0.07)	(0.08)	(0.08)	(0.09)	(0.07)	(0.05)	(0.06)	(0.06)
$ETR_n^{3,0}$	1.32	1.33	1.30	1.27	1.23	1.19	1.22	1.22
	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)
$ETR_n^{4,0}$	1.22	1.25	1.22	1.26	1.18	1.18	1.13	1.13
	(0.05)	(0.05)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
(b) For-profit firms								
$ETR_f^{2,0}$	1.83	1.81	1.61	1.49	1.36	1.41	1.41	1.34
	(0.17)	(0.14)	(0.16)	(0.22)	(0.17)	(0.10)	(0.10)	(0.11)
$ETR_f^{3,0}$	1.43	1.43	1.42	1.37	1.26	1.26	1.26	1.28
	(0.09)	(0.08)	(0.08)	(0.07)	(0.06)	(0.05)	(0.05)	(0.05)
$ETR_f^{4,0}$	1.32	1.34	1.43	1.32	1.27	1.20	1.14	1.18
	(0.09)	(0.08)	(0.09)	(0.07)	(0.06)	(0.05)	(0.04)	(0.04)

Notes: Entry thresholds ratios $ETR^{N,0}$ are defined as in equation (18) with N the number of own-type competitors and no other-type competitors. Standard errors in parentheses.