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ENTRY DECISIONS AND ASYMMETRIC COMPETITION BETWEEN NON-PROFIT AND FOR-PROFIT HOMES IN THE LONG-TERM CARE MARKET*

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Demand for long-term care services is growing strongly. Using a rich administrative data set for Germany, we examine strategic interaction between nonprofit and for-profit nursing homes. The estimated competitive effects imply that competition is much stronger within type, suggesting that they provide differentiated products. Over time, the entry behavior of for-profit homes has converged to that of the more established nonprofits and between-type competition has become stronger. Counterfactual simulations of proposed changes in government policy indicate that even moderate changes have a large impact on the fraction of markets that remain unserved or only served by a single type.

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.

Nonprofits used to be the dominant service providers, but in recent years the majority of new entrants were 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 nonprofit firms. Moreover, nonprofits might 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 nonprofits impede entry of for-profit firms, there will be a loss of potential tax revenue without better access to care.[1]

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

We make three contributions in this article. 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] Own-type competition lowers profits much more, and thus deters entry more strongly, than other-type competition. In contrast with predictions from the literature, for example, Lakdawalla and Philipson (2006), entry of nonprofits is more sensitive to the presence of for-profit firms than vice versa. However, 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 (ETRs) to measure the increase in the number of consumers needed to sustain an additional entrant in the market. They show how far the industry is from the perfectly competitive benchmark, where ETRs equal one. Third, we simulate the future supply of LTC services when markets continue to grow. Tax advantages for nonprofits do not deter for-profit firms from the market. Nonprofits are predicted to cater for an increasing share of future demand. We also simulate the equilibrium market structure under three actual policy proposals: closing the remaining public homes, ending the tax advantage of nonprofits, and a single-person room mandate. These proposals have very different effects on the presence of LTC facilities in fragile markets, such as rural or low-income areas.

In order to learn how strongly incumbent competitors deter entry, we need to address a fundamental endogeneity problem because 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 nonprofit firms, their augmented objective function are positive. This allows us to explicitly solve for the market equilibrium, that is, 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. A simple theoretical model where nonprofits maximize a combination of profits and quantity provides an interpretation for the differences in the reduced-form profit parameters of both firm types. We extend comparisons of entry thresholds to the two-type setting by varying both the number of own and other-type competitors. 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 nonprofit firms in observable characteristics extends to their entry strategies. In particular, the effect of incumbents on the entry of for-profit firms increasingly resembles the pattern for the more experienced nonprofits.

We do not estimate a full dynamic model, as in Gowrisankaran and Town (1997), primarily because relatively few active homes leave this rapidly expanding market.[3] The firms primarily need to decide when a local market has expanded enough to support an additional home. Moreover, in some Bundesländer the firm identifiers are not consistent over time in a few years. We can only reliably identify net entry or exit at the market level, but that suffices to estimate the semidynamic model of Bresnahan and Reiss (1994) and Nardotto et al. (2015), which we perform as a robustness check. Sunk entry costs are positive and significant, but the main conclusions of the static model remain the same. Since the semidynamic model is not suited for counterfactual analyses, we choose the static model as our main specification.

[2] We use the German Pflegeheimstatistik, which includes information on all LTC facilities in operation between 1999 and 2013.

[3] An exception are public homes, but their exits are often due to budget constraints of the local government, not adverse market conditions. We include the number of public homes in our model as an exogenous market feature, not as strategic agents. German law specifically directs sickness funds (which administer the universal-coverage LTC public insurance program) to place new residents in private (for-profit or nonprofit) homes whenever suitable places are available (Cuellar and Wiener, 2000).

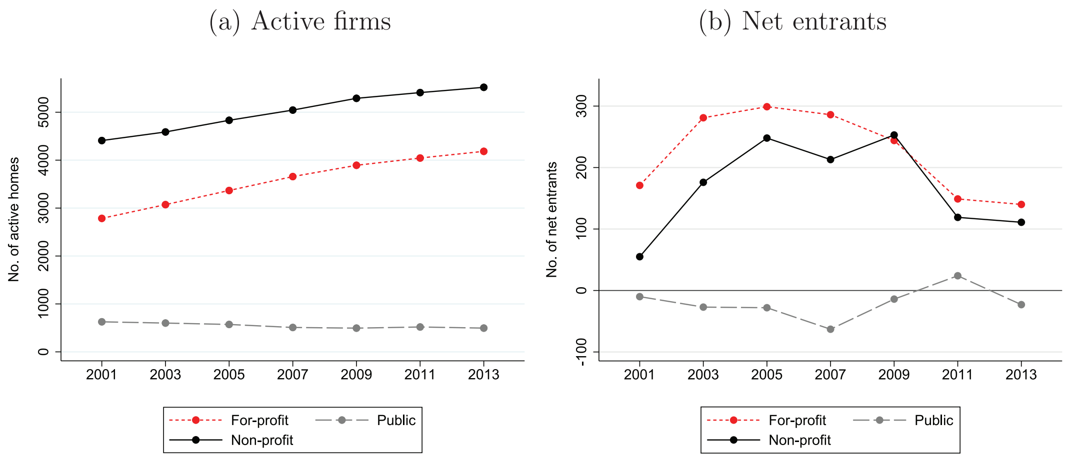
We also do not estimate a differentiated goods model of demand, the standard approach in the literature that studies quality competition. Although demand can be estimated in isolation, to study entry one needs to supplement it with a first-order condition for price or quantity setting. That allows the calculation of hypothetical profits in various market configurations and, assuming observed entry is optimal, the recovery of entry costs, see Berry et al. (2016). We prefer to be flexible regarding the nature of competition, at the cost 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 nonprofit and for-profit institutions, which often coexist in health care markets. One question is whether nonprofit 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 nonprofits 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 nonprofits 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 U.S.-centric evidence, that nonprofit 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 nonprofit hospitals vary systematically with the share of for-profits active in the local market. Grabowski and Hirth (2003) argue that the true impact of nonprofit status on outcomes is difficult to determine because competition generates spillovers. We specifically analyze the strategic entry decisions of for-profit and nonprofit 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 LTC 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 U.S. nursing homes that offer similar quality. Hackmann (2019) uses a static, structural model that assumes nonprofit homes maximize a combination of profit and output quantity 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 U.K. 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 nonprofit 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). 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. In order to quantify how competition changes with entry, Bresnahan and Reiss (1991) introduced ETRs 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 nonprofit fitness studios on market structure.

The rest of the article 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 nonprofit 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.



NOTE: Own calculations based on RDC of the Federal Statistical Office and Statistical Offices of the Federal States, Pflegestatistik, survey years 1999–2013.

FIGURE 1

NUMBER OF ACTIVE FIRMS AND NET ENTRANTS BY OWNERSHIP TYPE

2. THE LTC 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 LTC 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.[4] 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. Nonprofit 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 active firms and net entrants by ownership type and year. Net entry is 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 nonprofits in all years except for 2009. There is also a third type of public homes, but they are much less common and of declining importance, showing negative net entry in most years. By 2013 the nonprofit and for-profit sectors accounted for 54% and 42% of Germany's nursing homes, whereas 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.[5] Thus, capacity constraints are much less of an issue in Germany than in many other countries.[6] Just as nursing homes are free to enter the market, elderly people can freely choose between them. Most importantly, when moving into institutionalized LTC, the elderly prefer to stay in a local nursing home. Schmitz and 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. In

[4] Eurostat: Population on January 1 by age group and sex [demo_pjangroup, proj_15npms]. Accessed on May 16, 2017

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

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

order 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.[7]

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 nonprofit 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 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, that is, the number of active for-profit and nonprofit 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 nonprofit 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, although 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

[7] Based on the average surface area reported in Table 3, the average *Gemeinde* has an approximate diameter of only 5 km, taking only a few minutes to cross by car.

[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, p. 157).

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 nonprofit and for-profit firms to provide a microfoundation 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.

In order to keep the model tractable, we consider oligopolistic competition with all firms simultaneously choosing quantities, while facing a linear demand and constant marginal costs. Type-specific parameters and market-level variables (in caps) have a subscript f for for-profit and n for nonprofit firms or products. 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 (generic) for-profit firm f and nonprofit firm n, Q_f and Q_n the total quantities produced for both types, and S the exogenous market size. 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. Nonprofit firms may 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

$$\pi_f = (P_f - c_f)\, q_f - F_f, \tag{3}$$

$$\pi_n = (P_n - c_n)\, q_n - F_n + \delta\, q_n. \tag{4}$$

As emphasized by Lakdawalla and Philipson (2006), this objective function for nonprofits amounts to a price–cost markup of $P_n - (c_n - \delta)$. It is equivalent to assigning a reduced *effective* marginal cost to nonprofits, for example, due to a tax advantage or donor contributions that lower the user cost of capital, instead of different behavior. In the remainder of the article, we therefore refer to the objective of both types as "profits."[11]

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

$$q_n^* = S\, \frac{(a_n - c_n + \delta) b_f (N_f + 1) - d_n N_f (a_f - c_f)}{b_n b_f (N_n + 1)(N_f + 1) - d_n d_f N_f N_n}, \tag{5}$$

[11] The δ parameter enters all equilibrium expressions for prices, quantities, profits, and the number of firms as $a_n - c_n + \delta$ (see the Appendix). We do not attempt to identify the parameter itself, as this would require more assumptions on preference and cost primitives, but derive testable implications if $\delta > 0$.

(6) $$q_f^* = S\,\frac{(a_n - c_f)b_n(N_n+1) - d_f N_n(a_n - c_n + \delta)}{b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n}.$$

When both types have the same demand and cost parameters and nonprofits 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 π_n on the number of firms of either type follows directly from their dependence on optimal output quantities, given that:

(7) $$\pi_f = b_f S\left(\frac{q_f^*}{S}\right)^2 - F_f \quad\text{and}\quad \pi_n = b_n S\left(\frac{q_n^*}{S}\right)^2 - F_n.$$

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, that is, $a_n = a_f$, $b_n = b_f$, and $d_n = d_f$, and the nonprofits have a lower effective marginal cost, that is, $c_n - \delta < c_f$, then the slope of their profit function is steeper in S. In that case, a nonprofit 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 the Appendix. 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 nonprofit firms.

$$\frac{\partial \pi_f}{\partial N_t} < 0 \qquad \frac{\partial^2 \pi_f}{\partial (N_t)^2} > 0 \qquad \frac{\partial \pi_n}{\partial N_t} < 0 \qquad \frac{\partial^2 \pi_n}{\partial (N_t)^2} > 0 \qquad \text{for } t \in \{n, f\}.$$

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

$$\left|\frac{\partial \pi_f}{\partial N_f}\right| \geq \left|\frac{\partial \pi_f}{\partial N_n}\right| \qquad \left|\frac{\partial \pi_n}{\partial N_n}\right| \geq \left|\frac{\partial \pi_n}{\partial N_f}\right|.$$

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, that is, $b_n = b_f$ 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.*

$$\left|\frac{\partial \pi_f}{\partial N_f}\right| \lesseqgtr \left|\frac{\partial \pi_n}{\partial N_n}\right| \quad \Leftrightarrow \quad a_f - c_f \lesseqgtr a_n - c_n + \delta.$$

Proposition 2 states that, if consumer demand for the output of both types is symmetric, a lower effective marginal cost for nonprofits ($c_n - \delta$) 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 nonprofits 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 nonprofit and for-profit firms in a more general model, without making explicit demand and cost assumptions. Firms only enter a market if their postentry payoffs are positive. Given that the behavior of nonprofit 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.[12] For a Nash equilibrium in entry strategies to exist, the profit functions have to satisfy the following assumptions:

ASSUMPTION 1. *Firms of the same type are strategic substitutes*

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

ASSUMPTION 2. *Firms of different types are (weak) strategic substitutes*

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

ASSUMPTION 3. *Own-type effects are stronger than other-type effects*

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

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. This assumption is necessary in order for a Nash equilibrium to exist. It would be difficult to even conceive of a situation where the other-type effect were larger. The relevant range of possibilities are other-type effects that are entirely absent or other-type effects that are as large as own-type effects. 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), whereas the latter part is represented by an idiosyncratic random shock:

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

Firms only enter if it is profitable, that is, 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 Nth firm has positive profits, but the $N+1$th firm does not. The market reaches a Nash equilibrium when the last firm of either type that entered earns positive profits whereas a potential additional entrant would earn negative profits and therefore stays out of the market. It

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

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 $f(\cdot)$ 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 k number of nonprofits and l number of for-profits in the market, is given by:

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

3.4. *Empirical Identification.* If the two ownership types were strategically independent, the profit levels and entry decisions of nonprofit 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 nonprofit firms. All realizations with $\varepsilon_n \leq \pi_n(1)$ would feature a market structure with at least one nonprofit 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 entrants of each type.[13] 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 nonprofit homes always enter first.[14] There are two reasons for this assumption. First, nonprofit 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, nonprofits 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.

In the shaded areas of Figure 2 with multiple equilibria, the unique market structure that is subgame-perfect when nonprofit firms enter first is indicated in a box. It is always the one with

[13] 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.

[14] 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.

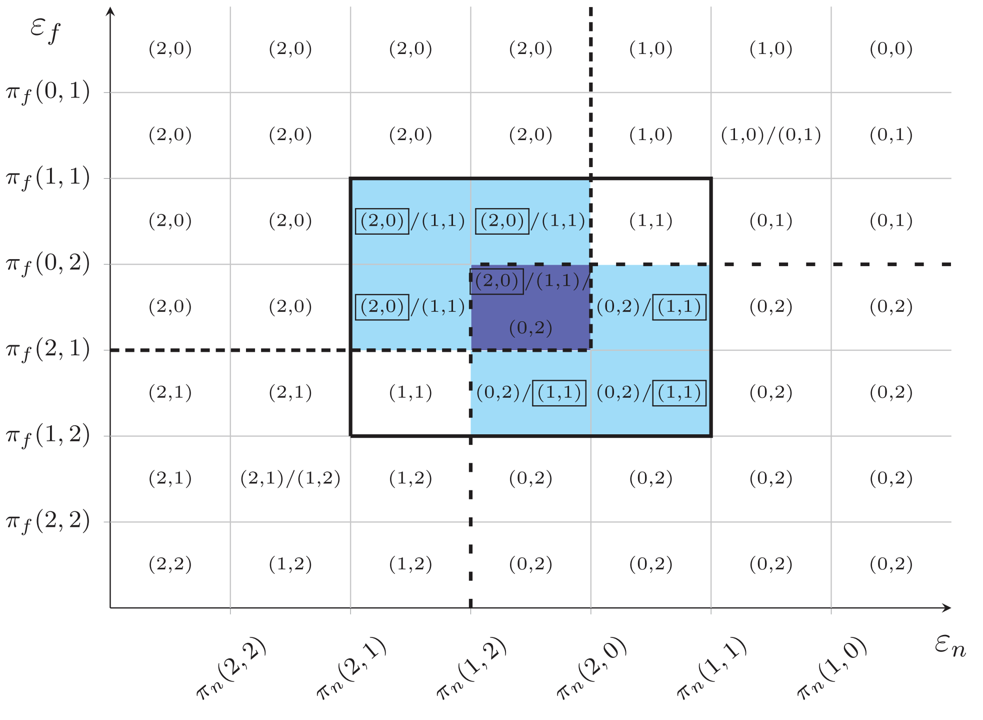


FIGURE 2

THE AREA IN ε-SPACE WHERE MARKET STRUCTURE (1,1) IS AN EQUILIBRIUM

most nonprofit firms.[15] 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. A correction term is therefore subtracted, changing the original likelihood function in (13) to[16]:

$$\begin{aligned} Pr(N_n = k, N_f = l) = &\int_{\pi_n(k+1,l)}^{\pi_n(k,l)} \int_{\pi_f(k,l+1)}^{\pi_f(k,l)} f(\varepsilon_n, \varepsilon_f, \rho)\, d\varepsilon_f\, d\varepsilon_n \\ &- \int_{\pi_n(k+1,l)}^{\pi_n(k+1,l-1)} \int_{\pi_f(k+1,l)}^{\pi_f(k,l)} f(\varepsilon_n, \varepsilon_f)\, d\varepsilon_f\, d\varepsilon_n. \end{aligned} \tag{14}$$

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 aged 75 or older, as the vast majority of LTC residents come 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

[15] Note that nonprofits 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 nonprofit firms would break-even in a (2,0) situation, but because a nonprofit firm would enter regardless, the second nonprofit stays out, even if entry is sequential.

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

receiving social assistance.

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

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 rewritten 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 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.[17] 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 $(\gamma^1, \dots, \gamma^4)$ and $(\alpha^1, \dots, \alpha^4)$ to estimate in both profit equations.[18]

In order to facilitate the interpretation and construction of the ETRs, we parameterize the competitive effects recursively as:

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

with $\Delta\gamma_n^k = \gamma_n^k - \gamma^{k-1}$, 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 nonprofit firm on a nonprofit 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 $\Delta\gamma_f^2$ if δ is sufficiently large (Proposition 2).

4. DATA AND DESCRIPTIVES

4.1. *LTC Institutions.* The national statistical office collects information on German LTC institutions in the *Pflegestatistik* micro data set.[19] All active homes are obligated to disclose information on their organizational structure, capacity, personnel, and residents. The data set contains information for odd years between 1999 and 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 nonprofit, private for-profit, or public. The summary statistics in Table 1 indicate that most characteristics are similar across homes

[17] 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.

[18] 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 nonprofit duopoly has exactly half the effect it has on a nonprofit monopoly, which can be larger or smaller than the $\gamma_n^2 - \gamma_n^1$ difference.

[19] 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; 10.21242/22412.1999.00.00.1.1.0 to 10.21242/22412.2013.00.00.1.1.0.; and 10.21242/22421.1999.00.00.1.1.0 to 10.21242/22421.2013.00.00.1.1.0.

TABLE 1
NURSING HOME CHARACTERISTICS BY OWNERSHIP TYPE FOR 2013

	Nonprofit	For-Profit	Public
Number of homes (all)	6,648	5,025	555
Number of homes (LTC)	5,520	4,184	496
Fraction care level 1	0.39	0.41	0.39
Fraction care level 2	0.41	0.41	0.40
Fraction care level 3	0.21	0.19	0.21
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	0.70	0.54	0.66

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

of all three types. In particular, the number of full-time equivalent (FTE) 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, as well as the average age of residents also show only small differences. As described in the previous section, care levels indicate the amount of care patients require and they are assessed by an independent agency. Because prices vary by care level, changes in patient composition due to entry will automatically be compensated for in the average price. Nonprofit homes are on average somewhat larger, more expensive, and have a larger share of single rooms than for-profit homes.

We report prices by care level in Table 1, but these do not reflect the full cost to the patient. They only reflect two of the three components, namely, room and board and nursing charges. The second component is heavily regulated and varies across patients of different care levels, but much less across homes. The third component is an investment charge, which amounts to a room rental rate, but it is not included in our data set, and hence excluded from the reported prices. This is particularly unfortunate as it is the part of pricing over which homes have most discretion. As a result, we cannot rely on the price information to study the strength of competition.

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, 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.

Table 2 further shows that a few attributes of nonprofits and for-profits have been converging over time. For example, whereas the size of nonprofit 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 nonprofits has decreased in this respect as well.

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. 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 and median size of 800 km^2 (taking on average 45 minutes to cross by car). The average district contains 20 homes and using them as markets would be too broad. Most municipalities (*Gemeinden*), on the other hand, are too small to contain the full set of options that people

TABLE 2
CHANGE IN NONPROFIT AND FOR-PROFIT NURSING HOME CHARACTERISTICS (1999–2013)

	Total Residents (Number)		FTE Nurses/Resident		Share Single Room	
	NP	FP	NP	FP	NP	FP
1999	79.9	50.7	0.41	0.42	0.54	0.37
2001	81.7	54.2	0.42	0.44	0.56	0.38
2003	81.5	56.4	0.43	0.44	0.59	0.41
2005	80.6	57.2	0.43	0.44	0.61	0.44
2007	79.9	58.3	0.43	0.44	0.64	0.47
2009	79.0	59.7	0.43	0.44	0.66	0.49
2011	79.1	62.0	0.43	0.44	0.68	0.52
2013	79.5	65.0	0.42	0.43	0.70	0.54

NOTE: Statistics are averages over nonprofit homes (NP) or for-profit homes (FP).

TABLE 3
SUMMARY STATISTICS OF MARKET CHARACTERISTICS IN 2013

	N	Mean	Std. Dev.	Min	Max
All markets					
Population	2,216	36,447	102,404	564	3,421,829
Surface area (km^2)	2,216	159	112	3	905
No. of Gemeinden / market	2,216	5.0	6.4	1	73
Household income (€ /month)	2,216	1,725	205	1,316	3,579
Population density	2,216	257	346	36	4,531
Old age dependency ratio	2,216	32.9	4.5	22	48
Doctors	2,216	145	36	79	407
Social assistance (share of pop.)	2,216	0.017	0.009	0.004	0.075
Markets with population < 75,000					
Population	2,054	22,973	15,865	564	74,907
Surface area (in km^2)	2,054	159	112	3	905
No. of Gemeinden/market	2,054	5.2	6.6	1	73

NOTE: Variables obtained from the *INKAR* database are defined at the district instead of the market level, but all summary statistics are computed over the markets.

are likely to consider. The median German municipality has only 1,706 inhabitants, is less than 19 km^2 in size, and can be crossed by car in only a few minutes. The average number of homes per municipality is less than one.

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.[20] 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 an LTC market. It is grouped with other units if their centers lie within a radius of 5, 7.5, or 15 km, 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 our market level. Because we cannot discern the relevant choice set for consumers in larger cities, for example, 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

[20] So Gemeinde are nested in Gemeindeverbände, which are again nested in Kreise.

TABLE 4
FREQUENCY DISTRIBUTION OF ALL OBSERVED MARKET STRUCTURES IN 2013

		Number of FPs					
		0	1	2	3	≥ 4	Total
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

2,054 markets have an average population of 22,973 and surface area of 159 km^2. The standard deviation of population is 15,865 and the large variation across markets is important for the empirical analysis.

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, as defined above, by the fraction of the population aged 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.

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 nonprofit monopoly, but also duopolies occur frequently. There are 185 unserved markets without any for-profit or nonprofit nursing home.[21]

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.

In order to control for other characteristics that can make a market more attractive for nonprofit or for-profit homes, we merge additional district-level variables from the *INKAR* database in the market-level data set. Summary statistics are in Table 3.[22]

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.[23] We therefore construct entry thresholds—the minimum market size required for an additional firm to enter the

[21] In 32 instances (one out of six), such a market will have a public home.

[22] 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. 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.

[23] 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).

TABLE 5
PARAMETER ESTIMATES FOR THE TWO TYPES' PROFIT FUNCTIONS IN 2013

	Nonprofit		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 (0.055)			
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 parentheses.

market—that provide a scale-invariant measure of competitive behavior. Finally, we simulate how the equilibrium market structure is predicted to adjust in 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 A.2.

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 LTC 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 nonprofits 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 $\Delta\gamma^k$ 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 nonprofit 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 nonprofit entry, but much less than other nonprofit incumbents. In contrast, for-profit nursing homes behave as if their profits are virtually unaffected by the presence of nonprofit homes. The point estimates of the α's in the for-profits' equation are small and statistically insignificant.[24]

The stronger impact of own-type than of other-type competitors implies that consumers perceive both firm types as imperfect substitutes.[25] Their entry patterns suggest that they operate in two different market segments. Moreover, we find a negative, albeit insignificant, correlation between the unobservable market characteristics of for-profit and nonprofit homes. Instead of some local markets having strong unobserved demand for LTC services, regardless of the type of provider, some markets are profitable for nonprofits 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 nonprofits 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 of entry to check the sensitivity of the results to this assumption. The coefficient estimates in Table A.2 in the Appendix turn out to be very similar. It implies that the area in ε-space with multiple equilibria must be 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 nonprofit 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.

Results in Table A.3 of the Appendix show the difference in predicted frequency for each possible market structure under the two alternative equilibrium selection rules. For example, averaged over 500 simulations, the (0,1) market structure appears 130.8 times (over 2,054 total markets) under the assumption that nonprofits enter first, but 134.7 times assuming for-profits enter first. The absolute difference of 3.9 is only 3% of its overall frequency, but it is the largest difference across all market structures. The average difference is only 1.2%, which underscores that situations with multiple equilibria are very rare.

The parameter estimates satisfy the three assumptions (1a–1c) necessary for a Nash equilibrium with a positive and finite number of firms.[26] Even though the own-type effects are estimated larger in absolute value for nonprofits than for-profits, in line with the predictions of Proposition 1, 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.* In order 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 solving for S. The entry threshold for N_t own-type and k

[24] Even the null hypothesis that the total effect of having four or more nonprofit 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.

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

[26] In particular, there is not a single case for either firm type in each of the eight years that any of the four α coefficients is larger than the corresponding γ coefficient (results in Table 5 and Table A.1).

other type competitors is given by:

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

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

The ETR, the ratio of entry thresholds per firm for the Nth and the $N-1$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 ETR 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 ETR declines with entry and converges to one as markups become invariant to competition as the market approaches perfect competition.

The ETR in our two-type model is the product of two factors that separately reflect own-type and other-type competition:

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

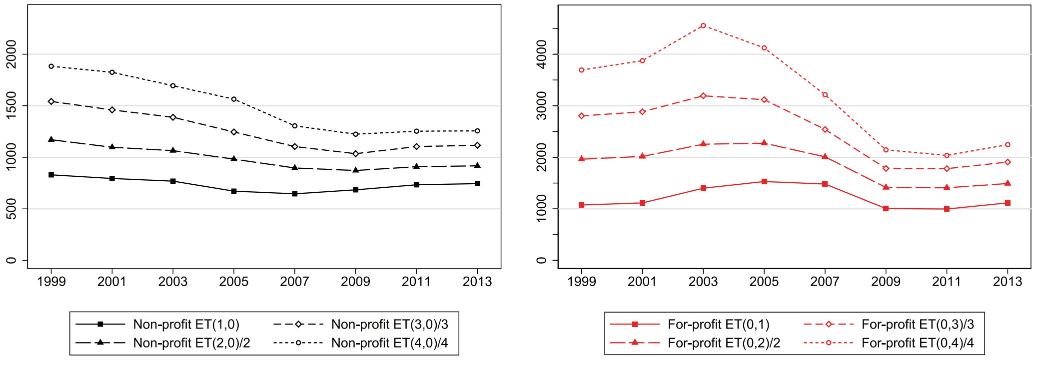
The first factor measures the usual change in the per-firm entry threshold needed for an increase from $N-1$ to N firms in the absence of other-type competition. The adjustment factor lies between 0 and 1 and reflects that a smaller percentage increase in market size is needed to support the Nth own-type 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 factor would disappear if the other-type effects in the profit equation are not divided by N_t.[27] 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 nonprofits, but not significantly different from 1.[28]

In order to zoom in on cross-type competition, we also calculate an alternative entry threshold, comparing the market size needed to support N_t firms in a market when they face 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

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

[27] Without this division, the adjustment factor would vanish and own-type entry would have the same effect on competition irrespective of the number of other-type competitors in the market. Although it is possible that the adjustment factor leads to a value of $ETR_t^{N_t,k} < 1$ even if $ETR_t^{N_t,0} > 1$, this is highly unlikely due to the exponent and to the lower estimates for the $\Delta\gamma$ than the α parameters.

[28] 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.



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

FIGURE 3

EVOLUTION OF PER-FIRM ENTRY THRESHOLDS FOR DIFFERENT LEVELS OF OWN-TYPE COMPETITION

5.2.1. *Own-type competition.* We first illustrate the entry thresholds for hypothetical markets with only one ownership type present.[29] Tables A.4 and A.5 in the Appendix report the entry thresholds and ETRs for all years, separately for nonprofit and for-profit homes. 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 both significantly above one and the difference is statistically significant.

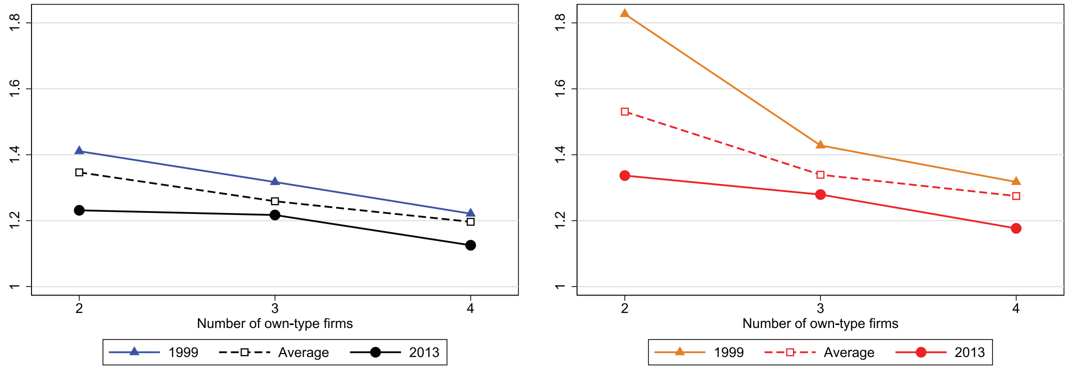
Figure 3 plots the evolution of the per-firm entry thresholds, measured as the number of local residents aged 75 or older, for nonprofit firms on the left and for-profit firms on the right. A first notable pattern, which is in line with the theoretical prediction of Proposition 2, is that the market size needed to sustain at least one firm is at least one third higher for for-profit monopolists (comparing the two solid lines). The prediction is derived assuming that nonprofits face a lower *effective* marginal cost, due to a different objective function, charity donations, or tax benefits, but alternative explanations are possible. For example, the two firm types might operate in segmented markets with fewer consumers or more price-elastic consumers preferring the services of for-profit firms.

A second pattern is that monopoly entry thresholds 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 the virtual constancy of the $ET_f^{1,0}$ threshold for viability of a for-profit monopolist. It stood at 1,075 in 1999 and, after a temporary increase between 2003 and 2007, it was 1,116 in 2013, an increase of less than 4%. It indicates that demand and costs of LTC by for-profit firms did not change over time, or that any changes had almost exactly offsetting effects. Serial correlation in the unobservable profit shocks might also contribute to the stability of the estimated pattern.

The dashed lines indicate to what extent a higher market size per firm is needed to support additional competitors. In 2013 the average nonprofit monopolist required a local market size of only 745 elderly to break even, whereas a duopoly was only viable if a market contained 1,834 elderly or 917 per firm (23% higher).[30] Without imposing more structure 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

[29] As indicated in Equation (17), we use the average values for all explanatory variables apart from the number of competitors in the calculation of the various ETs.

[30] 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.



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

FIGURE 4

ENTRY THRESHOLD RATIOS VARYING ONLY THE EXTENT OF OWN-TYPE COMPETITION

higher fixed costs. With more than 10,000 nursing homes in Germany, it is a mature market and the cost explanation is less likely.

Recall that the number of active firms increased by one third and that entry was biased toward for-profit firms. The entry thresholds to sustain multiple competitors declined for a number of years in both panels of Figure 3. The decline happened slightly later, but was more pronounced for for-profit homes. In the last four years of the sample period ETs remain virtually unchanged for both firm types and the relative differences for markets with different number of competitors have also become very similar.

Figure 4 shows the ETRs, again for nonprofits 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, that is, a 23% larger market needed to support a nonprofit 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 survive 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.[31]

The more pronounced decline in per-firm ETs for market structures with more active firms makes the ETRs shift down between 1999 and 2013. For nonprofit firms the change is relatively minor. Still, the decline in ETR_n^2 from 1.41 to 1.23 indicates that a 13% smaller market expansion is needed to accommodate a duopoly in 2013 than in 1999. The almost lateral shift in the ETR-line indicates 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; for-profit duopolists needed a per-firm market that was 83% larger than for a monopoly. The ETRs declined more rapidly with the number of active firms, the percentage decline is three times as large as in the nonprofit case. 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 is the opposite of the prediction in Proposition 2.

[31] 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.

However, the patterns for the two firm types converged almost entirely by 2013. The downward shift of the ETR-line is especially pronounced for for-profit firms and the line has flattened as well. The $ETR_f^{4,0}$ ratio is still larger than one, but the ratio is now comparable to that of nonprofits. By 2013, the entry of a second for-profit firm into a monopoly market is accommodated without a sharp reduction in variable profits, which was not the case in 1999.

This pattern can be interpreted as a weakening link between the number of active firms and the strength of competition, especially for for-profit firms. Competitors increasingly coexist without competing down markups. The change is less pronounced for nonprofit firms, which were already more established in 1999. Lower ETRs for nonprofits 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.

A number of possible challenges to this interpretation appear unlikely. The introduction of compulsory LTC insurance in 1994 that increased the attractiveness of care-at-home options could have changed the competition between homes and the outside good. We would expect it to raise entry thresholds primarily in markets with few firms, because larger markets already had competition between the inside goods. However, Figure 3 makes clear that lower ETRs are due to lower entry thresholds in markets with many firms. Moreover, market penetration for LTC homes declined only slightly, most likely due to improved health. Cost reductions are also unlikely to explain the changed patterns. In the limited price information we observe, average prices declined only slightly, by −0.4% per year for nonprofit 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. Finally, people could have gradually become less sceptical about for-profit entities providing LTC services, shifting demand toward for-profit homes. However, this is hard to reconcile with the absence of any change in ETs for markets with a single firm. There is no convergence in the behavior of monopolist entrants, consistent with the continued importance of the δ parameter that represents a difference in objective functions between types. Given that the differences between the 1999 and 2013 in per-firm ETs are concentrated in markets with more active firms, it certainly appears as if the nature of competition has changed.

A more promising alternative explanation would be increased product differentiation. By appealing to different types of consumers, homes compete less directly and can maintain higher markups. Such a strategy can increase the total market by convincing more elderly to move into a nursing home, as in Schaumans and Verboven (2015). The flatter slope in the ETRs of nonprofits would then suggest they are more successful at this. Another plausible explanation would be stronger quality competition, that is, consumers gradually putting a higher weight on quality relative to price when comparing homes. Given that quality differences tend to be more difficult to observe (Zhao, 2016), it would allow homes to sustain higher price–cost margins even when facing more competitors. Such an evolution is not unusual when product markets mature and it is plausible that the less mature for-profit homes have evolved more in this dimension.[32]

5.2.2. *Other-type competition.* The point estimates of the α parameters in the profit equation of nonprofit firms indicate that the presence of for-profit competitors also affects their profitability. In order 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 a market if there are one or more other-type competitors present. The top panel of Table 6 shows the results for various numbers of nonprofit firms.

[32] Although the estimates of the correlation coefficients are not statistically significant, they are monotonically declining over the entire sample period. This would increase the incentives for both types to adopt a product differen-

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 nonprofit 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

NOTE: The nonprofit 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 nonprofit or for-profit firms and k the number of other-type competitors.

Naturally, the increase is largest for the first (monopoly) nonprofit, shown in the first row. The estimate of 1.31 indicates that the entry threshold for a nonprofit monopolist is 31% higher in the presence of one for-profit incumbent compared to a market that is entirely unserved. Although 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 nonprofit monopolist needs a 31% larger market before it can enter, but the market then contains two firms instead of one. The 1.23 per-firm ETR corresponds to an absolute market size increase of 146% for the market to support two instead of one nonprofit 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.

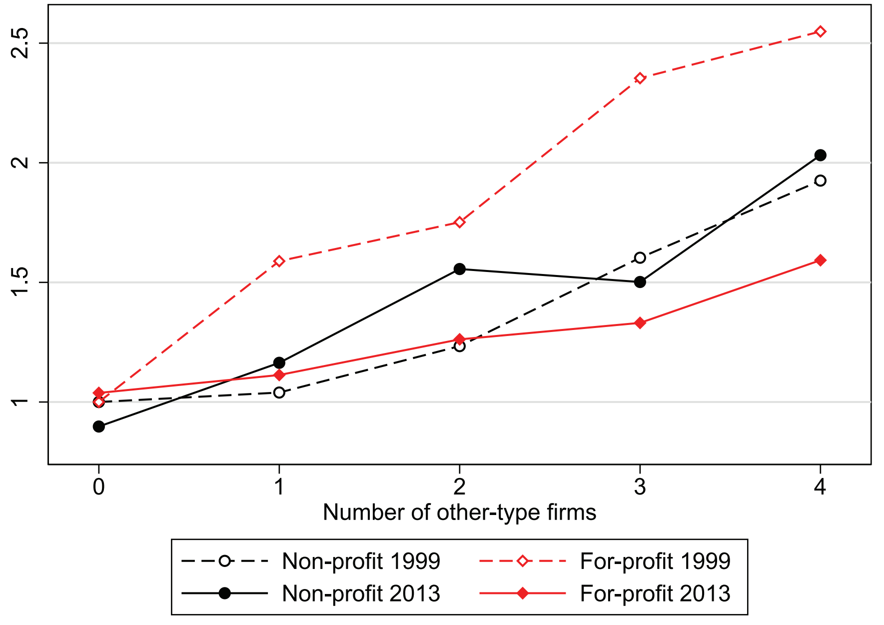
Subsequent rows of Table 6 show the corresponding increases in entry thresholds due to for-profit competition when additional nonprofits are already active. As they provide strong within-type competition, the necessary market size is already elevated and the presence of for-profit competitors is less important. The division of the α coefficients in the profit equation by N guarantees that the effect declines within each column. It imposes that the ratio in the second row equals the square root of the ratio in the first row, whereas the ratio in the third row is the third root of the first value, etc.[33]

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 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. In order 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 nonprofit 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 nonprofit competitor is much smaller than in the reverse case. Note,

tiation strategy. It could also be the case that the estimates of the correlation coefficient in our reduced-form model merely reflect increased differentiation.

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



NOTE: 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.

FIGURE 5

EVOLUTION OF THE OTHER-TYPE COMPETITIVE EFFECTS ON A MONOPOLIST'S ENTRY THRESHOLD

however, that this increase is applied to a higher baseline as for-profit monopolists already require a larger market.[34]

Figure 5 shows how these ratios have evolved for both firm types from the first to the last year in the sample period. The numbers correspond to the first rows in both panels of Table 6, showing the various numbers of other-type incumbents on the X-axis. They are thus the change in entry threshold for a monopolist entering a market with k other type competitors, relative to an unserved market (in 1999).

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 nonprofit 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 nonprofit 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 nonprofit 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 nonprofit entry to a greater extent than in the reverse case.

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

Given the many primitive parameters, even in the simple model in Subsection 3.2, convergence can have several causes. Any two parameters that became less different between the two types, for example, for the slope of demand or marginal cost, would lead to convergence in entry behavior. One particular change consistent with the results is for the other-type parameter in the nonprofit demand function d_n to increase from a low or even zero value, as target customers of nonprofit incumbents increasingly consider for-profit competitors. Initially, for-profit homes tended to target very specific market segments (e.g., the high-end segment) and competed only indirectly with many nonprofit homes. The estimates on the income quartile variables indicate that for-profit firms increasingly target markets with consumers on social assistance, bringing them in direct competition with nonprofits. The corresponding parameter in the for-profit demand function d_f could even decline (from a high level) as for-profits differentiate their offerings.

Growing importance of quality competition could also contribute to a diminished deterring effect of nonprofit incumbents on for-profit entrants. Positioning themselves as lower cost alternatives would be most effective and profitable for for-profit entrants in markets that were only lightly served, consistent with the dashed line for 1999. A sustained period of high entry rates would gradually erode the profitability of a strategy based on low prices. If competition shifted to the quality dimension, the deterring effect of incumbents is less likely to translate directly into a higher required market size.

Another potentially important feature that is missing from the model are dynamic considerations. In Appendix A.3, we introduce an extension that allows for incumbents and entrants to face different profits as entry costs might differ from the scrap value at exit. Sunk costs of entry, the difference between the two, are estimated to be sizable, but the convergence in entry behavior between for-profit and nonprofit firms remains. Figures A.1 and A.2 replicate the evolution of the own-type and other-type competitive effects shown in Figures 4 and 5 for the benchmark model and the patterns look very much alike. We consider this semidynamic model only as a robustness check as it is less suited to perform counterfactual simulations (Aguirregabiria, 2019) to which we turn next.

5.3. *Policy and Market Growth Simulations.* The above ETRs illustrate to what extent entry affects competition in a number of specific market structure situations and how this has changed over time. We can calculate the cumulative effect on competition of the observed entry between 1999 and 2013 by combining the estimated own-type and other-type effects on competition with the actual distribution of entry across all market structures. That cumulative effect is summarized in Figure A.3 in the Appendix. The main takeaway is that to break even in 2013, the marginal for-profit entrant needed a market that was on average 29% larger than in 1999. The corresponding increase for nonprofit firms is 17%.

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 German policy proposals. 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 nonprofit 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 nonprofits. We perform this simulation 500 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.

TABLE 7
SIMULATED DISTRIBUTION OF MARKET CONFIGURATIONS FOR 2013

		Number of FPs					
		0	1	2	3	≥ 4	Total
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		759.8	568.3	323.8	165.6	236.4	2054

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 nonprofits	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 nonprofits	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 1,000 people over the age of 75.
[3] Fraction of markets not served by nonprofit or for-profit homes in (1) and percentage point changes in (2)–(5).

The first column in Table 8 contains market penetration indicators in the benchmark situation. There are a total of 5,871 homes, 3,213 nonprofits, and 2,659 for-profits.[35] Of a total of 2,054 markets, 185 or 9.0% are not served by any ownership type (nonprofit, for-profit or public). Only counting nonprofit and for-profit homes, in Panel B, 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 segments, a lack of choice may also reduce consumer welfare. in the bottom panel of Table 8 we report the market penetration

[35] 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 tends to slightly underestimate changes in the number of nursing homes in those markets. With the exclusion of large markets, this explains the difference with the number of observations in Table 1.

statistics—number of homes and fractions of unserved markets—for a few subsets of markets that are of extra relevance to policymakers. 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).

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%,[36] whereas 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), and an 8% increase in real household income.

With these changes, the total number of nursing homes is predicted to increase by 11.1%. The increase in for-profit homes is 3 percentage points higher than in nonprofit homes, in line with higher observed entry rates of for-profit homes in the previous decade. The difference is due to an initial situation with fewer for-profit than nonprofit homes and stronger own-type competition effects. In addition, nonprofits are estimated to be less affected by competition from other-type entry. Entry is especially prevalent in markets that are lightly served (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 10 years. This decline is even stronger in the East and in low-income markets. The latter two markets are preferentially served by for-profit homes.

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 nonprofit and for-profit capacity—were removed from the market? This supply reduction would only be partly compensated by entry of nonprofit and for-profit homes, which numbers increase by 3.8% and 2.5%, respectively. Nonprofits 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 nonprofit 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 markets and 8 experience private entry.

Current tax policy is sometimes criticized because it exempts nonprofit homes from income tax and thus distorts market competition. In 2011 the German Fiscal Court clarified limits on nonprofit 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.

In order 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 $0.3F_nN_n = sF_n(N_n' + N_f')$, with N_t' the equilibrium numbers of firms under the new policy. It replaces the 30% tax exemption for nonprofits 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 $-\ln[1 - 0.1625]\lambda_f$.

[36] Statistisches Bundesamt (Destatis), accessed on December 03, 2019

Results in column (4) show that total market penetration declines by 3.1% in this new tax regime. Nonprofit exit exceeds for-profit entry because subsidies are now more likely to go to inframarginal firms and because nonprofits are more sensitive to for-profit competition than vice versa. In addition, nonprofit firms need lower market sizes to operate. 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 toward nonprofit 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 nonprofit 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, by as much as 50%, in the near future (Gutmann and Peters, 2021).

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 only slowly, by 1 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, which has raised concerns regarding the effects on LTC cost and accessibility (Herr and Saric, 2016).[37]

Existing homes can adjust to such a mandate by adding additional rooms or splitting existing rooms, both of which increase fixed costs. An alternative adjustment would be to simply convert double-occupancy into single-occupancy rooms, which would be cheaper, but decrease the variable profits per room. Note that both type of adjustments would change the reduced-form profit function in our model in the same way. As discussed after Equation (15), the intercept is the constant portion of $\ln(V/F)$. Both a reduction in variable profits per room or an increase in the fixed costs end up in the intercept. In the counterfactual, we assume that converting all rooms in a home from double to single use, would raise total fixed costs by half. This is an intermediate stance between the two extremes of no fixed cost increase (e.g., because there is spare capacity or most fixed costs do not scale with the number of rooms) and doubling all fixed costs (because for each double room, one additional single room has to be built).

Naturally, a single-room mandate will have less of an effect on facilities that currently already have a high share of single rooms. We observe this ratio only at the market level, but separately by ownership type. We therefore simulate an increase in fixed costs that is proportional to $x_t = (0.95 - \text{share single rooms for type } t)$, the current shortfall for each market–ownership–type combination. Raising fixed costs by one half of x_t, corresponds to lowering the intercept in the latent profit equation by $-\ln(1 + x_t/2)$.[38] If nonprofit homes in a market already have 85% single-occupancy rooms, we assume that a 95% mandate raises their fixed costs by 5% and lowers the intercept by 0.048.

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 our relatively conservative assumption on the impact the mandate has on fixed costs, it would make 20.5% of existing homes no longer viable. Especially for-profit homes, which currently tend to have a lower proportion of single rooms, would face large adjustment costs and high exit rates. As a result, the number of markets that are entirely unserved would increase by half and markets not served by any for-profit homes would increase by one fifth. Panels A and B show that rural markets and markets in the East, which currently have lower shares of single rooms, would be

[37] Our article is complementary to the analysis in Herr and Saric (2016) who estimate a demand model, but assume that the reform does not trigger entry or exit.

[38] In order 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.

especially affected. In addition to lowering available capacity, the reduction in competition is likely to drive prices up as suggested by our ETR estimates.

The counterfactual simulation is based on the 2013 parameter estimates, which are assumed to be invariant. However, it is possible that the higher estimate of the intercept for nonprofit homes ($\hat{\gamma}_n^1 > \hat{\gamma}_f^1$) is partially due to an unmodeled preference for single-occupancy rooms, which are more prevalent in nonprofit homes. If that is case, the new policy would make the intercepts of the two firm types more alike, which would diminish the (relative) exit rate of for-profit homes. Without more structure on the profit equation we cannot estimate the magnitude of this effect.

6. CONCLUSION

We have analyzed competition between nonprofit and for-profit homes in the German LTC 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 nonprofit homes as imperfect substitutes and that entry is deterred asymmetrically between different ownership types. The lower absolute entry thresholds for nonprofits could reflect stronger demand or lower marginal cost, but it is also consistent with nonprofit homes putting a positive weight (δ) on quantity in their objective function.

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 nonprofit firms also declined with the number of active firms, but the pattern was much less pronounced. By 2013, the ETRs 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, nonprofit 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 nonprofit entrant compared to markets without for-profit incumbents. For-profit entry witnessed the reverse pattern. Initially it was very sensitive to the presence of nonprofit competitors, but this sensitivity diminished over the years, in line with the diminished sensitivity to own-type competition.

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 LTC 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, nonprofit homes.

APPENDIX A

A.1. *Oligopoly Model with Competition Between Two Firm Types.*

A.1.1 *Objective functions for nonprofit and for-profit firms.* In this section we derive an expression for the objective functions of a nonprofit 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 nonprofit firms that are symmetric within each type. Let q_f and q_n denote the quantities set by for-profit firm f and nonprofit 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 have subscrips f for the for-profit and n for the nonprofit firms. The linear demand functions of a representative consumer for both types of goods are:

$$P_f = a - b_f \tfrac{Q_f}{S} - d_f \tfrac{Q_n}{S}, \tag{A.1}$$

$$P_n = a - b_n \tfrac{Q_n}{S} - d_n \tfrac{Q_f}{S}. \tag{A.2}$$

For-profit and nonprofit 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 $\sum q_n$:

$$\begin{aligned} \pi_f &= (P_f - c_f)q_f - F_f, \\ \pi_f &= \left(a - b_f \frac{(q_f + \sum q_{-f})}{S} - d_f \frac{\sum q_n}{S} - c_f\right) q_f - F_f, \end{aligned} \tag{A.3}$$

$$\begin{aligned} \frac{\partial \pi_f}{\partial q_f} &= a - c_f - 2\frac{b_f}{S} q_f - \frac{b_f}{S} \sum q_{-f} - d_f \frac{\sum q_n}{S} = 0, \\ q_f &= \frac{S}{b_f(N_f+1)} \left(a - c_f - d_f \frac{\sum q_n}{S}\right). \end{aligned} \tag{A.4}$$

For the objective function of a nonprofit firm we follow Lakdawalla and Philipson (2006) and assume that a nonprofit 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 $\sum q_f$:

$$\begin{aligned} \pi_n &= (P_n - c_n)q_f - F_n + \delta q_n, \\ \pi_n &= \left(a - b_n \frac{q_n + \sum q_{-n}}{S} - d_n \frac{\sum q_f}{S} - c_n\right) q_f - F_n + \delta q_n, \end{aligned} \tag{A.5}$$

$$\begin{aligned} \frac{\partial \pi_n}{\partial q_n} &= \left(a - c_n + \delta - 2\frac{b_n}{S} q_n - \frac{b_n}{S} \sum q_{-n} - d_n \frac{\sum q_f}{S}\right) = 0, \\ q_n &= \frac{S}{b_n(N_n+1)} \left(a - c_n + \delta - d_n \frac{\sum q_f}{S}\right). \end{aligned} \tag{A.6}$$

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 nonprofits 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:

$$q_n^* = \frac{S((a - c_n + \delta)b_f(N_f+1) - d_n N_f(a - c_f))}{b_n b_f (N_n+1)(N_f+1) - d_n d_f N_f N_n}, \tag{A.7}$$

$$q_f^* = \frac{S((a-c_f)b_n(N_n+1) - d_f N_n(a-c_n+\delta))}{b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n}. \tag{A.8}$$

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

$$P_f = \frac{ab_n b_f(N_n+1) + c_f(b_n b_f(N_n+1)N_f - d_n d_f N_f N_n) - d_f b_f N_n(a-c_n+\delta)}{b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n},$$

$$P_n = \frac{ab_n b_f(N_f+1) + (c_n-\delta)(b_n b_f(N_f+1)N_n - d_n d_f N_f N_n) - d_n b_n N_f(a-c_f)}{b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n}.$$

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:

$$\frac{(a-c_f)}{(a-c_n+\delta)}\frac{(N_n+1)}{N_n} \leq \frac{d_f}{b_n} \qquad \Rightarrow \qquad q_f^* = 0, \tag{A.9}$$

$$\frac{(a-c_n+\delta)}{(a-c_f)}\frac{(N_f+1)}{N_f} \leq \frac{d_n}{b_f} \qquad \Rightarrow \qquad q_n^* = 0. \tag{A.10}$$

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:

$$\pi_f = Sb_f\left(\frac{(a-c_f)b_n(N_n+1) - d_f N_n(a-c_n+\delta)}{b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n}\right)^2 - F_f, \tag{A.11}$$

$$\pi_n = Sb_n\left(\frac{(a-c_n+\delta)b_f(N_f+1) - d_n N_f(a-c_f)}{b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n}\right)^2 - F_n. \tag{A.12}$$

A.1.2 *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.

Proposition 1(a): Effects of own-type entry. The effect of for-profit entry on for-profit payoffs:

$$\begin{aligned}\frac{\partial \pi_f}{\partial N_f} &= -2Sb_f\frac{[(a-c_f)b_n(N_n+1) - d_f N_n(a-c_n+\delta)]^2}{[b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n]^3} \\ &\quad \times (b_n b_f(N_n+1) - d_n d_f N_n),\end{aligned} \tag{A.13}$$

$$\begin{aligned}\frac{\partial^2 \pi_f}{\partial {N_f}^2} &= 6Sb_f\frac{[(a-c_f)b_n(N_n+1) - d_f N_n(a-c_n+\delta)]^2}{[b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n]^4} \\ &\quad \times (b_n b_f(N_n+1) - d_n d_f N_n)^2.\end{aligned} \tag{A.14}$$

The effect of nonprofit entry on nonprofit payoffs:

$$\frac{\partial \pi_n}{\partial N_n} = -2Sb_n \frac{[(a-c_n+\delta)b_f(N_f+1) - d_n N_f(a-c_f)]^2}{[b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n]^3} \times (b_n b_f(N_f+1) - d_n d_f N_f), \tag{A.15}$$

$$\frac{\partial^2 \pi_n}{\partial {N_n}^2} = 6Sb_n \frac{[(a-c_n+\delta)b_f(N_f+1) - d_n N_f(a-c_f)]^2}{[b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n]^4} \times (b_n b_f(N_f+1) - d_n d_f N_f)^2. \tag{A.16}$$

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.

Proposition 1(a): Effects of other-type entry. The effect of nonprofit entry on for-profit payoffs:

$$\frac{\partial \pi_f}{\partial N_n} = 2Sb_f b_n d_f \frac{[(a-c_f)b_n(N_n+1) - d_f N_n(a-c_n+\delta)]}{[b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n]^3} \times \underbrace{[(a-c_f)d_n N_f - (a-c_n+\delta)b_f(N_f+1)]}_{<0,\text{ if no corner solution}} < 0.$$

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:

$$\frac{\partial^2 \pi_f}{\partial {N_n}^2} = 2Sb_f {b_n}^2 {d_f}^2 \frac{[(a-c_f)d_n N_f - (a-c_n+\delta)b_f(N_f+1)]^2}{[b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n]^6} > 0.$$

Since the second derivative of profit w.r.t. nonprofit 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 nonprofit payoffs can be derived similarly:

$$\frac{\partial \pi_n}{\partial N_f} = 2Sb_f b_n d_n \frac{[(a-c_n+\delta)b_f(N_f+1) - d_n N_f(a-c_f)]}{[b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n]^3} \times [(a-c_n+\delta)d_f N_n - (a-c_f)b_n(N_n+1)] < 0,$$

$$\frac{\partial^2 \pi_n}{\partial {N_f}^2} = 2Sb_n {b_f}^2 {d_n}^2 \frac{[(a-c_n+\delta)d_f N_n - (a-c_f)b_n(N_n+1)]^2}{[b_n b_f(N_n+1)(N_f+1) - d_n d_f N_f N_n]^6} > 0.$$

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:

$$\left|\frac{\partial \pi_f}{\partial N_f}\right| > \left|\frac{\partial \pi_f}{\partial N_n}\right|$$

$$\begin{aligned}\Leftrightarrow \quad & [(a-c_f)b_n(N_n+1) - d_f N_n(a-c_n+\delta)]b_n b_f \\ & +[(a-c_f)b_n(N_n+1) - d_f N_n(a-c_n+\delta)](b_n b_f N_n - d_n d_f N_n) \\ & >[(a-c_n+\delta)b_f(N_f+1) - (a-c_f)d_n N_f]b_n d_f.\end{aligned}$$

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 nonprofits objective function, $|\frac{\partial \pi_n}{\partial N_n}| \geq |\frac{\partial \pi_n}{\partial N_f}|$, can be shown in the same way.

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 nonprofits. We assume symmetric demand parameters between the two types in order to focus on the influence of the output preference component in the nonprofit'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 nonprofit firms simplifies and we find the following at $N_n = N_f = N$:

$$\begin{aligned}& \left|\frac{\partial \pi_f}{\partial N_f}\right| \lesseqgtr \left|\frac{\partial \pi_n}{\partial N_n}\right| \\ & \Leftrightarrow (a-c_f)b(N+1) - dN(a-c_n+\delta) \lesseqgtr (a-c_n+\delta)b(N+1) - (a-c_f)dN \\ & \Leftrightarrow (a-c_f)(b(N+1)+dN) \lesseqgtr (a-c_n+\delta)(b(N+1)+dN) \\ & \Leftrightarrow (a-c_f) \lesseqgtr (a-c_n+\delta) \\ & \Leftrightarrow c_n - \delta \lesseqgtr c_f.\end{aligned}$$

A.2. *Additional Results.*

A.2.1 *Results for Other Survey Years.*

TABLE A.1
PARAMETER ESTIMATES FOR BOTH FIRM TYPES IN YEARS 1999–2011

	1999	2001	2003	2005	2007	2009	2011
(a) Nonprofit 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 *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

A.2.2 *Robustness check to alternative equilibrium selection rule.* The estimates in Table 5 are based on the assumption that nonprofits always enter first if they can do so profitably, to select the unique subgame-perfect Nash equilibrium in the case of multiple equilibria. The results in Table A.2 are based on the reverse order-of-entry assumption, that is, that for-profits enter first if they can do so profitably. Most parameter estimates are very similar.

In order to illustrate that multiple equilibria are a rare occurrence in our setting, we simulate the frequency of equilibrium market configurations (for 2013) under both order-of-entry assumptions. We perform 500 simulations for both equilibrium selection rules. The average frequency of each possible market structure under the assumption that "non-profits enter first" is depicted in Table 7 in the main text. In Table A.3 we show the difference for each cell between the corresponding outcomes under the "for-profits enter first" alternative selection rule and the "non-profits enter first" rule. Panel (a) shows the absolute frequencies and Panel (b) the relative frequencies, normalized by the average frequency for each cell in both cases.

The absolute values of the numbers in Table A.3 are the differences in conditional frequencies for both selection rules. If multiple equilibria are common, the likelihood of observing some market structure, for example, (1,0) versus (0,1), should differ a lot across both

TABLE A.2
PROFIT PARAMETERS ESTIMATES FOR 2013 UNDER THE ASSUMPTION THAT FOR-PROFIT FIRMS ENTER FIRST

	Nonprofit		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		

NOTES: Significance levels $***p<0.01$, $**p<0.05$, $*p<0.1$. Standard errors between parentheses.

TABLE A.3
DIFFERENCE IN FREQUENCY OF OCCURRING FOR EACH MARKET STRUCTURE UNDER THE TWO EQUILIBRIUM SELECTION RULES

(a) Absolute frequency: number of markets out of a total of 2,054

		Number of FPs				
		0	1	2	3	≥ 4
Number of NPs	0	−1.26	3.88	1.18	−0.64	0.42
	1	−3.42	0.49	1.38	−0.76	0.36
	2	0.45	−0.04	−0.10	−0.25	−0.19
	3	−1.16	−0.28	1.24	−0.07	0.91
	≥ 4	−1.05	−1.50	−0.08	−0.17	0.66

(b) Relative frequency: relative to average occurrence of each market structure

		Number of FPs				
		0	1	2	3	≥ 4
Number of NPs	0	−0.6%	3.0%	1.4%	−1.9%	0.7%
	1	−1.3%	0.3%	1.6%	−1.8%	0.7%
	2	0.3%	−0.0%	−0.1%	−0.6%	−0.4%
	3	−1.7%	−0.5%	3.2%	−0.3%	2.8%
	≥ 4	−1.4%	−2.3%	−0.2%	−0.6%	1.5%

NOTES: Difference between the frequency of each market outcome under the equilibrium selection rule of "for-profits enter first" and the alternative rule of "non-profits enter first." In both cases, market equilibria are simulated using the same parameter estimates, that is, estimates for 2013 using the "non-profits enter first" selection rule. Results are very similar if the parameter estimates from Table A.2 are used instead. Reported statistics are the average over 500 simulations. Panel (b) is based on the same statistics as Panel (a), but expresses them as a fraction of the average number of markets taking each equilibrium configuration using either order-of-entry assumption.

TABLE A.4
ALL ENTRY THRESHOLDS IN THE ABSENCE OF OTHER-TYPE COMPETITION

	1999	2001	2003	2005	2007	2009	2011	2013
(a) Nonprofit 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 $ET^{m,0}$ are defined as in Equation (17) with m the number of own-type competitors and no other-type competitors. Standard errors in parentheses.

TABLE A.5
ALL ENTRY THRESHOLD RATIOS IN THE ABSENCE OF OTHER-TYPE COMPETITION

	1999	2001	2003	2005	2007	2009	2011	2013
(a) Nonprofit 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 $ETR^{m,0}$ are defined as in Equation (18) with m the number of own-type competitors and no other-type competitors. Standard errors in parentheses.

equilibrium selection rules. However, the difference in conditional frequencies are quite small. As comparison, in Cohen et al. (2013) the likelihood of multiple equilibria ranged from 43% to 92% over different market structures.

Positive numbers indicate a higher likelihood under the "for-profits enter first" assumption. Naturally, cells above the diagonal tend to show positive numbers and cells below the diagonal negative numbers. Switching the order-of-entry assumption from "non-profits first" to "for-profits first" will induce the equilibrium to switch in some cases from (1,0) to (0,1) or from (2,1) to (1,2), etc. There are a few instances where the numbers above the diagonal are negative, for example, for the (1,3) equilibrium. This is due to randomness in the simulations

TABLE A.6
PARAMETER ESTIMATES FOR THE SEMI-DYNAMIC EXTENSION

	2001	2003	2005	2007	2009	2011	2013
(a) Nonprofit firms							
Log population75	0.878***	0.890***	0.904***	0.985***	1.015***	0.867***	0.914***
N_{pub}	−0.125***	−0.165***	−0.150***	−0.369***	−0.259***	−0.216***	−0.509***
East	0.149	−0.051	−0.346**	−0.119	−0.080	0.221	0.108
HH income Q2	0.174	−0.089	−0.289	−0.059	−0.110	−0.183	−0.136
HH income Q3	−0.058	−0.164	−0.200	0.015	−0.140	−0.126	−0.145
HH income Q4	−0.044	−0.129	−0.205	−0.091	−0.285*	−0.247	−0.109
Log pop density	0.010	0.002	−0.003	−0.053	0.122*	0.001	−0.058
Log Doctors	0.164	0.250	0.166	0.220	0.390*	0.420*	−0.323
Social Assistance					−0.020**	−0.014*	−0.019**
γ^1	4.990***	5.670***	5.293***	6.130***	7.015***	6.136***	6.210***
$\Delta\gamma^2$	0.958***	0.670***	0.839***	0.861***	0.938***	0.747***	0.717***
$\Delta\gamma^3$	0.625***	0.512***	0.533***	0.605***	0.562***	0.637***	0.576***
$\Delta\gamma^4$	0.551***	0.468***	0.584***	0.477***	0.620***	0.370***	0.431***
α^1	0.349**	0.389***	0.503***	0.249	0.572***	0.249*	0.188
$\Delta\alpha^2$	0.025	0.080	−0.122	−0.097	−0.013	−0.040	−0.005
$\Delta\alpha^3$	−0.164	0.113	0.052	0.219	0.279*	−0.166	0.111
$\Delta\alpha^4$	0.312	−0.125	−0.162	−0.014	−0.103	0.031	0.018
Sunk (SC)	2.871***	2.704***	2.657***	2.688***	2.760***	2.846***	2.882***
(b) For-profit firms							
Log population75	0.386***	0.512***	0.554***	0.652***	0.571***	0.502***	0.646***
N_{pub}	0.013	−0.051**	−0.097***	−0.133**	−0.225***	−0.083	−0.180**
East	−0.394**	−0.442***	−0.306*	−0.286**	−0.082	−0.334	0.006
HH income Q2	−0.050	−0.059	−0.091	−0.202	0.024	−0.188	−0.102
HH income Q3	−0.192	−0.069	−0.136	−0.357***	−0.169	−0.277	0.035
HH income Q4	−0.213	−0.007	−0.348*	−0.222*	−0.133	−0.246	−0.006
Log pop density	−0.086	−0.141**	−0.222***	−0.123*	−0.029	−0.132*	−0.231***
Log Doctors	0.148	0.204	0.464**	0.195	0.046	0.064	0.194
Social Assistance					−0.018**	−0.013*	0.016**
γ^1	0.569	1.832*	2.820***	2.864***	2.028**	1.321	2.855**
$\Delta\gamma^2$	0.630***	0.696***	0.668***	0.593***	0.790***	0.529***	0.578***
$\Delta\gamma^3$	0.367***	0.483***	0.497***	0.337***	0.512***	0.427***	0.457***
$\Delta\gamma^4$	0.331***	0.454***	0.358***	0.394***	0.416***	0.311***	0.406***
α^1	0.454***	−0.123	0.605***	0.521***	0.423***	0.275**	0.158
$\Delta\alpha^2$	0.070	0.067	0.055	−0.116	0.206	0.225	0.236
$\Delta\alpha^3$	0.327	0.067	−0.393*	−0.048	−0.424**	−0.264	0.090
$\Delta\alpha^4$	0.257	0.289	0.394*	0.151	0.684***	0.200	0.024
Sunk (SC)	3.071***	2.544***	2.710***	2.731***	2.729***	2.875***	2.903***
ρ	−0.016	−0.394***	−0.423***	−0.315***	−0.279***	−0.582***	−0.503***
N	1.651	1.666	1.689	1.914	1.952	2.057	2.050

NOTE: Significance levels $***p < 0.01$, $**p < 0.05$, $*p < 0.1$.

or to switches from (1,3) to, for example, (0,4) outnumbering switches from (4,0), (3,1), or (2,2) to (1,3).

A.3. *Semidynamic Extension.* If sunk costs played an important role in the LTC market, incumbents' decisions whether to continue operating or not, would differ from potential entrants' decisions. The existence of market entry costs over and beyond fixed operating costs would drive a wedge between the profits of incumbents and entrants. The probability that a firm can operate profitable in a market will then depend on whether it was already active in the previous period or not. In order to investigate whether the existence of sunk costs would change our main conclusions, we estimate an extension to our model that was initially proposed by Bresnahan and Reiss (1994). Because firms are still not forward-looking in their decision making, Aguirregabiria (2019) calls it a semidynamic model.

In principle, we could also allow for a scrap value for firms that exit, but only the difference between the entry cost and the scrap value can be identified, see Aguirregabiria (2019). If we set the scrap value to zero, the entry costs and sunk costs (SC) coincide and our entry conditions are the two-type extension to Nardotto et al. (2015).[39] The presence of two types of firms does not really complicate the semidynamic extension, as only the thresholds that determine entry and exit for each type are modified independently. The nature of the entry game remains unchanged.

Recall the original conditions in Equation (12) that make N_n the optimal number of nonprofit firms in the market (in the presence of N_f for-profit competitors):

$$\pi_n(N_n+1, N_f) < \varepsilon_n \leq \pi_n(N_n, N_f).$$

The latent variable profit π_n already contains the nonsunk part of fixed costs. The new conditions differ slightly across three possible situations, depending on the comparison of N_n in the current and previous period. Therefore, we now need to distinguish between N_{nt} and N_{nt-1}:

$$\begin{aligned}
&\text{Case 1, net entry: } N_{nt} > N_{nt-1} \text{ if } \pi_n(N_{nt}, N_f) - \varepsilon_n \geq SC \text{ and } \pi_n(N_{nt}+1, N_f) - \varepsilon_n < SC,\\
&\text{Case 2, inaction: } N_{nt} = N_{nt-1} \text{ if } \pi_n(N_{nt}, N_f) - \varepsilon_n \geq 0 \text{ and } \pi_n(N_{nt}+1, N_f) - \varepsilon_n < SC,\\
&\text{Case 3, net exit: } N_{nt} < N_{nt-1} \text{ if } \pi_n(N_{nt}, N_f) - \varepsilon_n \geq 0 \text{ and } \pi_n(N_{nt}+1, N_f) - \varepsilon_n < 0.
\end{aligned}$$

The conditions for the optimal number of for-profit firms generalize in the same way.

The likelihood of observing $N_{nt} = k$ nonprofit firms and $N_{ft} = l$ for-profit firms in a market at time t, Equation (14) in the main text, generalizes to:

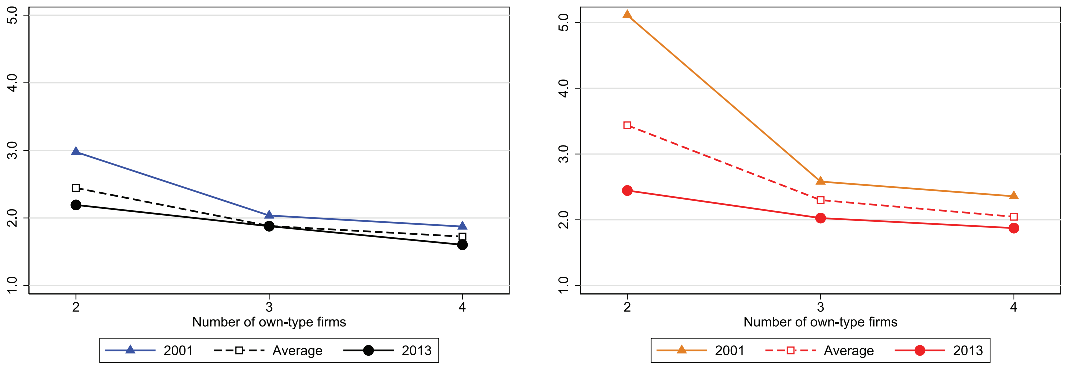
$$\begin{aligned}
Pr(N_{nt} = k, N_{ft} = l) = &\int_{\pi_n(k+1,l)-SC\cdot(I_{nt}^+ + I_{nt}^0)}^{\pi_n(k,l)-SC\cdot I_{nt}^+} \int_{\pi_f(k,l+1)-SC\cdot(I_{ft}^+ + I_{ft}^0)}^{\pi_f(k,l)-SC\cdot I_{ft}^+} f(\varepsilon_n, \varepsilon_f, \rho)\, d\varepsilon_f\, d\varepsilon_n\\
&- \int_{\pi_n(k+1,l)-SC\cdot(I_{nt}^+ + I_{nt}^0)}^{\pi_n(k+1,l-1)-SC\cdot(I_{nt}^+ + I_{nt}^0)} \int_{\pi_f(k+1,l)-SC\cdot I_{ft}^+}^{\pi_f(k,l)-SC\cdot I_{ft}^+} f(\varepsilon_n, \varepsilon_f)\, d\varepsilon_f\, d\varepsilon_n.
\end{aligned}$$

The dummy variable $I_{nt}^+ \equiv I(N_{nt} > N_{nt-1})$ indicates whether a market has experienced net entry of nonprofit firms, and the other five indicator variables are defined similarly to represent all three cases for both types. These terms adjust the intercept of the variable profit function to take changes in market structure into account.

Coefficient estimates for all years are reported in Table A.6. Because we need the lagged values to estimate the model, the first year we can estimate is now 2001. The sunk cost parameters are estimated highly stable over time and are of a relatively similar magnitude for both firm types. The lack of entry in our sample leads to very large point estimates. The parameter estimates on the own-type and other-type competitive effects show broadly similar patterns to the results in Table 5 and Table A.1 for the benchmark model.

Collard-Wexler (2014) argues that parameter estimates in the latent profit function could be biased if profit shocks are serially correlated over time. This shows up in his results as an upwardly biased estimate for the standard deviation of the profit shock. In our approach, we have normalized the standard deviation to one, but estimate λ, the sensitivity of profits to market size (which Collard-Wexler, 2014, normalizes to one). λ is then used to normalize all parameters in the construction of the ETs and ETRs. Although the benchmark model is estimated separately for each year using only cross-sectional variation, the estimates are not vulnerable to serially correlated errors, but that is not the case for the semidynamic extension.

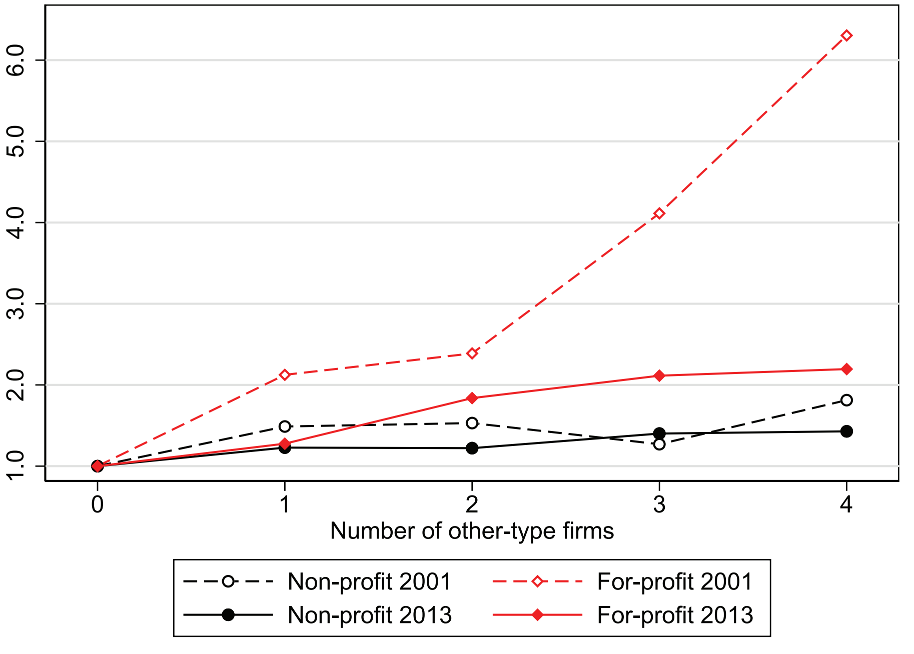
[39] With a nonzero scrap value, the zeros on the right-hand side of the profit comparisons need to be replaced by the scrap value (SV), and SC is replaced by the entry cost (EC), since SC = EC − SV.



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

FIGURE A.1

EVOLUTION OF OWN-TYPE COMPETITIVE EFFECTS IN THE SEMI-DYNAMIC EXTENSION



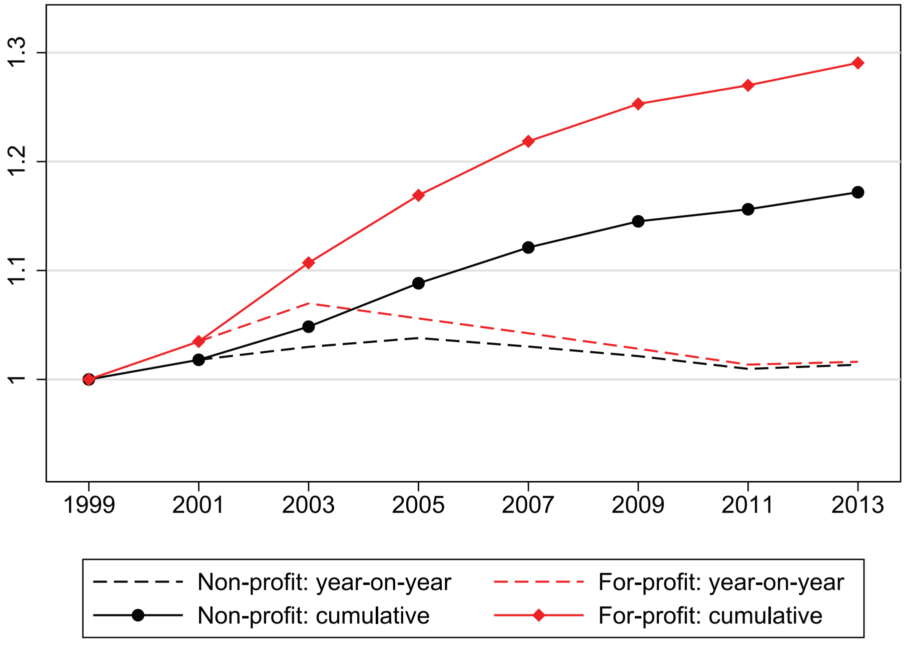
NOTES: The line of for-profit firms in 2001 is constructed by normalizing the competition parameters with market size parameter $\lambda_f = 0.55$ obtained using a constrained model (fixing the correlation coefficient ρ to its value in the static model). The λ_f estimate in the semidynamic model for 2001 was an outlier (0.39) and using this low estimate would make the line twice as steep. It would reinforce the conclusion of "convergence in entry behavior," but would make the figure harder to read.

FIGURE A.2

EVOLUTION OF OTHER-TYPE COMPETITIVE EFFECTS IN THE SEMIDYNAMIC EXTENSION

Serially correlated errors could induce a positive correlation between lagged number of firms and the residual and could help explain the uniformly lower estimates for the λ parameters in the semidynamic model. The effect on this parameter tends to be larger than the effect on the competitive parameters (γ and α), which would bias up the ET estimates.

Most importantly for our purpose, we verify to what extent the main conclusions from the article hold up if we allow for sunk costs. In Figures A.1 and A.2 we replicate the evolution of



NOTE: 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).

FIGURE A.3

EVOLUTION OF THE ENTRY THRESHOLDS OF MARGINAL ACTIVE FIRMS

the own-type and other-type competitive effects shown in Figures 4 and 5 for the benchmark model. The patterns look very similar and, most importantly, the convergence in competitive effects over the sample period between for-profit and nonprofit effects remains pronounced.

A.4. *Cumulative Effect of Historical Entry.* The ETRs in Figures 4 and 5 and Table 6 illustrate to what extent entry affects market competition. They show this for various market structures and the change over time in a few specific situations. In order to know the cumulative effect on competition, the effects of own-type and other-type entry need to be combined. Moreover, the predicted effects need to be calculated and summed over the actual distribution of entry across all observed market structures. That cumulative effect over time is summarized in Figure A.3. It illustrates to what extent entry has intensified competition by combining the behavioral effect of entry on market competition—as implied by the estimates that vary by year and by market structure—with the rate and locus of observed market entry.

Separately for each of the 2,054 markets and for both ownership types, we calculate the ratio of the following two entry thresholds, ET_t/ET_{t-2}. We use the ET that corresponds to the observed market structure in the respective years, but in both cases we use the parameter estimates and control variables for year t. As a result, only the competitive effects do not cancel out, as in Equation (18). If the market structure did not change, this ratio equals one. Given the positive point estimates for the own-type and other-type effects, most markets with an increase in the number of active firms will show a ratio above one, especially in the case of own-type entry. In the rare instances where the number of active firms decreased, the ratio is below one. The average of these ratios over all markets reflects the average increase in per-firm entry threshold for the country that is due to the observed frequency and pattern of entry. In Figure A.3 we show the year-on-year changes (dashed lines) and we also multiply them over time to obtain cumulative effects (solid lines).

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 nonprofit 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 similar magnitudes.

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