Entry and Exit in Geographic Markets

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1 Introduction

The relationship between the size of a market and the competitiveness of the market has been of long-standing interest to IO economists. Empirical studies have used the relationship between the size of a geographic market, measured as market population, and both the number of firms in the market and the average sales of the firms to indirectly draw inferences about the degree of competition in the market. A second line of inquiry has relied on dynamic models that make predictions about how the impediments to new firm entry, such as the magnitude of sunk entry costs, affect the patterns of firm turnover in order to infer the extent of competitive pressure from potential entrants. In this paper we estimate a structural model of firm entry and exit developed by Pakes, Ostrovsky, and Berry (2004) that can sort out three separate components of the competitive process. Using the model we can identify the effect of an increase in the number of firms on the average profits of firms in a market, and the magnitudes of entry costs and firm scrap values that are key determinants of the degree of firm turnover.

We use the empirical model to analyze the entry and exit patterns of establishments in two medical-related service industries, dentists and chiropractors. Using micro data collected as part of the Census of Service Industries, we measure the number of establishments and the flows of entering and exiting establishments for 754 small geographic markets in the U.S. at five-year intervals over the 1977-2002 period. In addition to measuring the entry and exit flows, we are able to measure the average revenue and average profits of establishments in each geographic market and year. We use this data to estimate a three equation model that describes establishment profits, the rate of entry, and the rate of exit across the geographic markets and time periods. The results indicate that the direct effect of an increase in the number of establishments on average profits is negative and statistically significant in the dentist industry with significant decreases in average profits as the number of establishments increases from 1 to 5. In the chiropractor industry there is no effect of an increase in the number of establishments on average profits in the market. The entry cost and scrap value parameters are statistically significant for both industries with the magnitudes being larger in the dental industry. Overall, the model provides evidence that, as a result of lower entry costs, competition from potential entrants is more substantial in the chiropractor industry than for dental practices. It results in higher turnover rates, lower average profits, and little effect of an increase in the number of competitors on average profits. In contrast, higher entry costs weaken the effect of potential entry on profits in the dental industry and, alternatively, we find an important effect of the actual number of competitors on the average profits of the incumbents.

The next section of this paper summarizes the empirical literature that focuses on the number of firms or entry/exit patterns in order to infer the degree of competition in a market. The third section summarizes the theoretical and empirical model of entry and exit developed by Pakes, Ostrovsky, and Berry (2004) that we estimate in this paper. The fourth section summarizes our data focusing on the measurement of entry and exit, profitability and the number of potential entrants in each geographic market. The fifth section reports the patterns of profitability and turnover in the dentist and chiropractor markets and econometric estimates of the profit function, entry cost distribution and scrap value distribution for each industry. The final section provides a summary.

2 Market Size, Entry, and Exit

One line of inquiry in the empirical literature on entry and exit has focused on drawing inferences about market competition from observations on the number of firms, the average size of firms, and exogenous measures of market size (such as population). In a series of papers

Bresnahan and Reiss (1987, 1991), developed the insight that, if entry of additional firms into a market compresses the average markup of all firms in operation, then the market size needed to support an additional firm will be larger than if this competitive effect was absent. Alternatively, markets with more firms would also have a larger average market size per firm. Using data on the number of firms and population for a cross-section of geographic markets in five different service and retail industries, Bresnahan and Reiss found that there was a positive correlation between the number of firms and population per firm over the range of approximately one to three firms in the market. As the number of firms increased beyond three, population per firm became constant and they interpreted this as evidence that the competitive effect of additional firms on average markups was exhausted. Campbell and Hopenhayn (2005) extended this insight, and studied the implications of increased market size on the average size of firms in the market. If larger markets are more competitive and hence have lower markups, then average firm size will be larger because the firms must sell more output to cover their fixed costs. Using cross-sectional data for geographic markets in 13 retail industries, they found that average firm size is larger in markets with larger population, which they interpret as evidence that there is a competitive effect of an increase in the number of firms. In contrast to Bresnahan and Reiss, they find that this competitive effect persists even when there are a large number of firms in the market.

Both of these papers are similar in that they focus on long-run equilibrium differences in the number of firms across markets with different populations. They also treat all firms within the market as homogeneous. Several papers have generalized the homogeneity assumption while maintaining the focus on differences in the equilibrium number of firms across markets of different size. In his study of airline markets, Berry (1992) allows for differences in fixed costs across firms and models the number of firms as a function of market and firm characteristics. He finds that average firm profits are negatively affected by an increase in the number of producers. Mazzeo (2002), Seim (2002), and Syverson (2004) allow for different degrees of product differentiation across firms within the same market. Mazzeo models the number of high-quality and low-quality firms in a market and finds significant own and cross-effects of the number of firms of each type on the average profits of each type. Seim allows firms to differ in their geographic location within the market and studies the location decision of new firms. She finds that increasing distance between firms insulates them from the competitive effects. Syverson studies a homogeneous product, ready-mix concrete, that is produced by plants with different marginal cost. Product differentiation is introduced through the spatial dispersion of customers and the presence of high transport costs. Together these make each plant's output an imperfect substitute for the output of others. An increase in demand density, the number of customers per unit of area, leads to an increase in producer density which, in turn, lowers prices and profit margins for all plants in the market. His empirical work quantifies how variation in demand density is reflected in the shape of the marginal cost distribution across geographic markets and he finds that high demand density is consistent with the increased concentration and survival of low marginal cost plants.

One common factor that characterizes these studies is that they are all two-period models. In the first period each potential entrant makes a decision to participate in the market and then profits are realized in the second period. This framework misses the dynamics of the entry and exit process, particularly the simultaneous entry and exit that characterizes firm behavior in most industries. (see Dunne, Roberts, and Samuelson (1988) and Dunne and Roberts (1991) for evidence from U.S. manufacturing and Foster, Haltiwanger, and Krizan (2001) and Jarmin, Klimek, and Miranda (2003) for nonmanufacturing. Theoretical models that focus on the entry and exit process have been developed by a number of authors including Jovanovic (1982), Lambson (1991), Hopenhayn (1992), and Ericson and Pakes (1995). These models share the feature that the participation decision for incumbent firms differs from the decision for a potential entrant. When deciding to remain in operation, incumbents compare the expected sum of discounted future profits with the scrap value they would earn by liquidating the firm. In contrast, potential entrants compare the discounted future payoff from entering with the sunk entry cost they must incur at the time of entry. This distinction, which is based on the fact that the entry cost is irrelevant for incumbent producers but not for potential entrants, has important implications for the way that market structure, particularly the number of firms, responds to exogenous factors that change profits.

The presence of the sunk entry cost, particularly when combined with uncertainty about future market conditions, gives rise to hysteresis in market structure (Dixit and Pindyck (1994)). For example, suppose there is an exogenous increase in market demand that raises profits sufficiently to induce potential entrants to pay the sunk cost and enter the market. If the market demand and profits then return to their initial levels those new firms may find it profitable to remain in operation rather than exit. The number of firms thus responds asymmetrically to changes in demand or, equivalently, the history of market structure, and not just current and future profit determinants, matters in explaining the current number of firms. This insight was incorporated into an empirical model of the number of firms by Bresnahan and Reiss (1994). Using data on the number of dentists operating in small geographic markets at two time periods, they found that market history was an important determinant of the number of firms, which is consistent with the sunk cost-hysteresis framework.[1]

Empirical models of firm entry and exit that are based on a fully dynamic framework must incorporate information on the scrap values faced by incumbents and the sunk costs of entry faced by potential entrants, as well as the profits earned by each participant in the market. There are very few empirical papers that have attempted to quantify these important variables. Das (1992) studies the closing decision of cement kilns and jointly estimates the operating profits, fixed costs, and scrap value of a kiln in a dynamic structural model of production. Her framework also allows for heterogeneity in profits at the level of the individual kiln. Das, Roberts, and Tybout (2002) estimate a dynamic, structural model of a domestic producer's decision to enter the export market. They estimate the distribution of sunk entry costs faced by potential entrants as well as the exporting profit function where the latter depends on both observed and unobserved sources of heterogeneity. They show how the entry costs affect the use of the entry/exit and quantity margins as the source of adjustment in an industry's export supply. While both of these models estimate these important dynamic parameters, they treat each firm as a price-taker in a competitive environment and do not incorporate any competitive effects of entry.

Most recently, Pesendorfer and Schmidt-Dengler (2003), Aguirregabiria and Mira (2004), Pakes, Ostrovsky, and Berry (2004), Bajari, Benkard, and Levin (2004), and Collard-Wexler (2006) have developed methodologies for estimating fully dynamic models when markets are imperfectly competitive. In this paper we utilize the model developed by Pakes, Ostrovsky, and Berry and apply it to data on the entry and exit rates of dentists and chiropractors across a large

[1]When it is also recognized that firms within an industry may be heterogenous in their underlying productivity or profitability, as the theoretical models referenced above do, then the presence of sunk costs has other implications for the size distribution of firms, the distribution of underlying productivity, and the productivity differentials between surviving and failing firms. Some of these implications of the sunk cost framework are examined empirically in Aw, Chung, and Roberts (2003).

number of geographic markets. The goal is to estimate the competitive effect of an increase in the number of firms on average profits in a market, as well as parameters describing the distribution of sunk entry costs and firm scrap values.

3 A Model of Entry, Exit, and Profit

3.1 Theoretical Model

In this section we outline the dynamic model of entry and exit developed by Pakes, Ostrovsky, and Berry (2004). Using this model we will estimate the distribution of firm-level scrap values, the distribution of firm-level entry costs, and the firm's profit function. The latter gives the average profit earned by a firm in the market as a function of the number of firms in operation and market size.

The description of the model begins with a description of an incumbent producer's decision to exit or remain in operation after the current period. The payoff from exiting is the profit earned this period $\pi(n, z; \theta)$ plus the discounted scrap value they earn by exiting next period $\delta\phi$. In this case n is the number of incumbents in the market at the beginning of the period, z is an exogenous profit shifter that evolves as a finite-state Markov process, θ is a vector of profit function parameters, δ is the discount rate, and ϕ is the scrap value of the firm, which is treated as a random draw for each firm from an underlying distribution. The incumbent compares this with the sum of current profits and the continuation value from remaining in operation next period. The payoff from the incumbent's discrete exit/continue decision can be expressed as:

$$V(n,z;\phi,\theta) = \max\{\pi(n,z;\theta) + \delta\phi, \pi(n,z,\theta) + \delta VC(n,z;\theta)\} \quad (1)$$

where *VC* is the expectation of the next period's realized value function. The expectation is taken over the possible number of exits *x*, entrants *e*, profit shifter *z*, and the scrap value ϕ. Defining $p^c(e, x|n, z, \chi = 1)$ as the incumbent's perceived probability of the number of entrants and exits given the incumbent itself is continuing $(\chi = 1)$, then *VC* can be written as:

$$VC(n,z;\theta) = \sum_{z'} \sum_{e,x} \int_{\phi'} V(n+e-x,z',\phi')p(d\phi')p^c(e,x|n,z,\chi = 1)p(z'|z) \tag{2}$$

The incumbent remains in the market if $VC(n, z; \theta) \geq \phi$.

Each potential entrant faces a decision to enter at the start of the next period. The payoff from entering is:

$$VE(n,z;\theta) = \sum_{z'} \sum_{e,x} \int_{\phi'} V(n+e-x,z',\phi')p(d\phi')p^e(e,x|n,z,\chi^e = 1)p(z'|z) \tag{3}$$

Similarly, $p^e(e,x|n,z,\chi^e = 1)$ is defined as the perceived probability of the number of entrants and exits given that the potential entrant enters $(\chi^e=1)$. The potential entrant enters if its value of entry is larger than its entry cost κ: $\delta VE(n,z;\theta) \geq \kappa$.

Under a few additional assumptions, Pakes, Ostrovsky, and Berry characterize a Markov Perfect equilibrium in this model. They assume that ex post entry profit for each firm only depends on the number of firms and the common profit shifter in the same market. Thus all firms in a market are identical in their level of profits. Profits can differ across markets as a result of additional idiosyncratic shocks as long as the shocks are *i.i.d.*. Further, the sunk costs and scrap values are *i.i.d.* over time and across markets. Incumbents and entrants know these distribution and their own realizations, but do not know the realizations of their competitors. Finally, they specify the distribution of the scrap value to be an exponential distribution with parameter σ, which equals the mean of the scrap value. They show that the continuation and entry values $VC(n, z; \theta, \sigma)$ and $VE(n, z; \theta, \sigma)$ at the state (n,z) can be written as functions of current profits, the probability of exit, and the transition matrix for future states. Specifically, in matrix form, the continuation value for a firm is:

$$VC(\theta,\sigma) = M_c[\pi(\theta) + \delta\sigma p^x] + \delta M_c VC(\theta,\sigma) \tag{4}$$

where M_c is the incumbents' perceived transition probabilities for the state variables (n, z) and p^x is the probability of exit for each state. Solving for VC gives:

$$VC(\theta,\sigma) = [I - \delta M_c]^{-1} M_c[\pi(\theta) + \delta\sigma p^x] \tag{5}$$

Notice that the value of continuation depends on both the parameter σ that characterizes the distribution of scrap values and the set of profit function parameters θ.

They derive a similar equation for the value of entering:

$$VE(\theta,\sigma) = M_e\left[\pi(\theta) + \delta VC(\theta,\sigma) + \delta\sigma p^x\right] \tag{6}$$

where M_e is the potential entrants' perceived transition probabilities for the state variables.

The assumption of an exponential distribution for the firm's scrap value is crucial to writing *VC* in this recursive form.[2] The advantage of this formulation is that, given estimates of M_c, M_e, p^x, and π we can calculate the value of continuation and entry without solving the dynamic entry/exit game. This greatly simplifies estimation of the model.

3.2 Empirical Model

The goal of the empirical model is to estimate the vector of profit function parameters θ, the parameter describing the exponential distribution of scrap values σ, and a parameter α describing the distribution of entry costs for both the dentist and chiropractor industries. We will utilize a panel data set for a cross-section of $m = 754$ geographic markets over $t = 5$ time periods, for dentists and $m = 689$ geographic markets over $t = 5$ time periods for chiropractors. In the empirical application to the dentist and chiropractor industries, for each market/year observation, there is one endogenous state variable, the number of establishments *n,* and two exogenous state variables, the level of population *pop* and the average real wage paid to employees in the industry *w*. These are the primary demand and cost shifters in these health industries. To simplify the discussion below we will often combine these two exogenous variables into the state vector $z = \{pop, w\}$. Pakes, Ostrovsky, and Berry (2004) develop several two-stage estimation methods for the scrap value and entry cost parameters, assuming that the profit function parameters are known. Our estimator is a straight-forward extension of their framework that includes a first-stage to estimate the profit function parameters as well.

[2] In the empirical application for dentists, we will generalize the assumption that the exponential scrap value distribution has the same mean across all markets and, instead, allow the mean in a market to depend on summary measures of the age distribution of dentists in the market.

Profit Function Estimation The first step of the estimation method involves the profit function parameters θ. For each market-time observation we assume that the average profit function for all firms in a market m, year t can be written as:

$$\pi_{mt} = \theta_0 + \Sigma_{k=1}^{5}\theta_k I(n_{mt} = k) + \theta_6 n_{mt} + \theta_7 n_{mt}^2 + \theta_8 pop_{mt} + \theta_9 pop_{mt}^2 + \theta_{10} w_{mt} + \theta_{11} w_{mt}^2 + \theta_{12}(pop \cdot w)_{mt} + \varepsilon_{mt} \quad (7)$$

The idiosyncratic shock ε_{mt} is *i.i.d.* both across markets and over time. We specify a profit function that is very flexible with respect to the number of firms, population, and wage rate. We include a set of dummy variables $I(n_{mt} = k)$ to distinguish markets with 1 to 5 establishments and would expect the per-establishment profits to decline with discrete increases in n. We also include linear and quadratic terms in n to allow the possibility of a diminishing effect n on average profits as the number of firms increases beyond 5. We also include linear, quadratic, and an interaction term for the two exogenous state variables, population and the wage rate.[3] Since we observe average market-level profits in our data, we are able to recover the parameters of the profit function θ.

State Variable Transitions and Exit The second step of the estimation method is to estimate the probability of exit $p^x(n, z)$ and the two transition matrices $M_c(n, z)(n', z')$ and $M_e(n, z)(n', z')$. Pakes, Ostrovsky, and Berry (2004) propose to estimate these by discretizing the values of the state variables (n, z) and calculating the empirical exit rates and transition frequencies from the market-level panel data.

[3] We do not include any interaction terms between n and z because of the way we choose to model the evolution of the joint impact of z in the next stage of estimation.

Define the set of market-year observations observed in the discrete state *(n, z)* as *T(n, z) = {mt : (n_{mt}, z_{mt}) = (n, z)}*. Consistent estimators of the three matrices can be constructed from the observed number of exits and transition patterns for each state. The exit rate from state *(n,z)* is estimated as:

$$p^{x}(n,z) = \frac{1}{\#T(n,z)} \sum_{mt \in T(n,z)} \frac{x_{mt}}{n} \tag{8}$$

The transition rate among states that is perceived by continuing incumbent firms in a market beginning in state *(n,z)* is estimated as:

$$\hat{M}_c(n,z)(n',z') = \frac{\sum_{mt \in T(n,z)} (n - x_{mt}) I[(n_{mt+1}, z_{mt+1}) = (n',z')]}{\sum_{mt \in T(n,z)} (n - x_{mt})} \tag{9}$$

In this case *I* is a dummy variable equal to one if the period *t+1* state is *(n', z')*. This equation describes an incumbent's probability of transiting from state *(n, z)* to state *(n', z')*, conditional on not exiting in state *(n, z)*. The transition rate among states that is perceived by entering firms in a market beginning in state *(n,z)* is estimated as:

$$\hat{M}_e(n,z)(n',z') = \frac{\sum_{mt \in T(n,z)} (e_{mt}) I[(n_{mt+1}, z_{mt+1}) = (n',z')]}{\sum_{mt \in T(n,z)} (e_{mt})} \tag{10}$$

This describes an potential entrant's probability of transiting from state *(n, z)* to state *(n', z')*, conditional on entering in state *(n, z)*. The three estimators in equations (8), (9), and (10) converge to the true value as the number of observations in each state $\#T(n,z) \rightarrow \infty$.

In practice, the size of the exit rate and transition matrices depends on the number of discrete categories chosen for *n* and *z*. If the maximum number of establishments observed is

n_{max} and these are combined with d_{pop} discrete cells for population and d_w cells for the wage rate, the transition matrices will have $(n_{max} \cdot d_{pop} \cdot d_w)^2$ cells. Given that in our dentist data set n_{max} is 47 for dentists and 19 for chiropractors, the number of cells exceeds the number of market observations even for small values of $d_{pop} \cdot d_w$. To make this more tractable we exploit the fact that the state variables in *z* evolve exogenously, so that the transition probability $M_c(n', z' \mid n, z) = M_n(n' \mid n, z) \cdot M_z(z' \mid z)$ and each of these smaller pieces can be estimated separately. A further simplification arises because we do not actually need the joint transition probabilities for the two exogenous state variables in *z*, but rather just the transition pattern for the nonlinear combination of *pop* and *w* that enters the second line of the profit function (7). We define a single exogenous state variable $\hat{z}_{mt} = \hat{\theta}_8\, pop_{mt} + \hat{\theta}_9\, pop_{mt}^2 + \hat{\theta}_{10}\, w_{mt} + \hat{\theta}_{11}\, w_{mt}^2 + \hat{\theta}_{12}\,(pop \cdot w)_{mt}$ that summarizes the estimated joint effect of population and wage variation on profits. We discretize the values of $\hat{z}$ into 10 cells and estimate the transition matrix for this single, composite state variable using the market-level observations.

By substituting these first- and second-stage estimators into equations (5) and (6) and fixing the discount rate δ, we can now construct estimates of the entry and continuation values $V\hat{E}$ and $V\hat{C}$, up to the value of the parameter of the scrap value distribution σ.[4]

Entry Costs and Scrap Values The final stage of the estimation method focuses on the parameters of the scrap value and entry cost distributions using the data on entry and exit flows in the market. For market *m* at time *t,* each of the n_{mt} incumbent firms makes a decision to continue or exit based

[4] To set the discount rate δ we assume a 4.0 percent annual real rate of interest. Given that our entry and exit flows correspond to 5-year intervals, we assume that, on average, entry and exit occur in year 3 of each interval and so the discount factor is $\delta = .96^3 = .885$.

on its private scrap value and $\hat{VC}_{mt} = \hat{VC}(n_{mt}, z_{mt})$. Similarly, each of the p_{mt} potential entrants makes a decision to enter or stay out based on its private entry cost and $\hat{VE}_{mt} = \hat{VE}(n_{mt}, z_{mt})$. The probability of observing x_{mt} exits and e_{mt} entrants is given by:

$$
\begin{aligned}
&l(x_{mt}, e_{mt} | \sigma, \alpha) = \\
&\qquad (n_{mt} - x_{mt}) \log(F^{\phi}(V\hat{C}_{mt}(\sigma)|\sigma) + x_{mt} \log(1 - F^{\phi}(V\hat{C}_{mt}(\sigma)|\sigma)) + \\
&\qquad e_{mt} \log(F^{\kappa}(V\hat{E}_{mt}(\sigma)|\alpha)) + (p_{mt} - e_{mt}) \log(1 - F^{\kappa}(V\hat{E}_{mt}(\sigma)|\alpha))
\end{aligned} \tag{11}
$$

The log-likelihood for the entry and exit observations is $L(\sigma, \alpha) = \Sigma_m \Sigma_t\, l(x_{mt}, e_{mt} \mid \sigma, \alpha)$.

To implement this, we need to make assumptions about the cdf's for the firm scrap value and entry cost. Consistent with the theoretical model in the last section, we assume that the firm scrap value ϕ is distributed as an exponential random variable with parameter σ. This parameter is the mean of the scrap value distribution. We have more flexibility in specifying the distribution of firm entry costs, κ. We assume that it follows a chi-square distribution with parameter α. This parameter is the degrees of freedom for the chi-square distribution and is also the mean of the distribution.[5]

Defining $\beta = (\alpha, \sigma)$ as the full parameter vector to be estimated in the final stage and $D = (x, e)$ as the data of entry and exit flows, we can define a Bayesian Markov Chain Monte Carlo (MCMC) estimator for these parameters.[6] Let $P(D|\beta)$ be the likelihood function for the data and

[5] We also attempted to estimate models where the scrap value was distributed as a normal random variable and we estimated both its mean and variance. The estimates of the mean scrap value were similar to the mean using the exponential assumption but it was not possible to estimate the variance precisely. We also explored using an exponential distribution for the entry cost and in this case the estimate of the mean entry cost was similar to the mean using the chi-square assumption. It is also possible to estimate the scrap value parameter using only the data on firm exit, and then, given the estimate of σ, to estimate bounds on the entry cost distribution nonparametrically from the entry data. We are currently pursuing this extension.

[6] See Gilks, Richardson, and Speigelhalter (1996) for details of the MCMC estimator.

$h(\beta)$ be a prior probability density of β. The posterior distribution over the parameters of interest β can then be written as the joint distribution of *D* and β divided by the marginal distribution of the data:

$$g(\beta|D) = \frac{h(\beta)P(D|\beta)}{\int h(\beta)P(D|\beta)d\beta} \tag{12}$$

It is not possible to derive this distribution analytically, but we can sample values of β from it using a Metropolis-Hastings sampling algorithm. For each draw of β, we update it using a random walk and then examine if the new value improves the posterior probability. More specifically, for the s^{th} state of the chain, β_s, the candidate point β^* is accepted as the $s+1$ state of the chain with probability:

$$\Gamma(\beta^*, \beta_s) = \min\left\{1, \frac{g(\beta^*)}{g(\beta_s)}\right\} \tag{13}$$

Otherwise, $\beta_{s+1} = \beta_s$. This can be linked to the log-likelihood function $L(\beta)$, by making a log transformation such that:

$$\begin{aligned} \log(\Gamma(\beta^*, \beta_s)) &= \min\{0, \log(g(\beta^*) - \log(g(\beta_s)\} \\ &= \min\{0, [\log(h(\beta^*)) + L(\beta^*)] - [\log(h(\beta_s)) + L(\beta_s)]\} \end{aligned} \tag{14}$$

We draw a value of *u* from a *U[0,1]* distribution and set $\beta_{s+1} = \beta^*$ if $\log(u) \leq \log(\Gamma(\beta^*, \beta_s))$ and $\beta_{s+1} = \beta_s$ otherwise. This algorithm produces a serially-correlated sequence of β*'s* that converge to the true posterior distribution $g(\beta \mid D)$.

Two Extensions of the Model Two simplifying assumptions that are made in developing the empirical model above are potentially restrictive when the model is applied to market-level panel data. First, different market observations (over time or cross-sectionally) with the same *(n, z)* can differ in the level of profits due to idiosyncratic shocks, ε_{mt} in equation (7), but there cannot be any serial correlation or geographic correlation in the profit shocks across observations. We generalize the profit function specification to include a market-specific component in the profit function error:

$$\pi_{mt} = \theta_0 + \Sigma_{k=1}^{5}\theta_k I(n_{mt} = k) + \theta_6 n_{mt} + \theta_7 n_{mt}^2 + \\ \theta_8 pop_{mt} + \theta_9 pop_{mt}^2 + \theta_{10} w_{mt} + \theta_{11} w_{mt}^2 + \theta_{12}(pop \cdot w)_{mt} + f_m + \varepsilon_{mt} \quad (15)$$

where f_m is the unobserved market fixed effect. If f_m is present in the market-level data and we ignore it, it is likely to lead to inconsistent estimates of the θ parameters because of correlation with n_{mt} . This, in turn, will result in inconsistent estimates of *VC(n, z)* and *VE(n, z)*. To avoid this endogeneity problem we include a market-specific fixed effect in the estimation of the profit function, equation (15). We then aggregate the estimated market fixed effects $\hat{f}_m$ into a small set of discrete categories f and treat it as a time-invariant state variable in addition to *(n, z)*.[7] Thus we explicitly model that $p^x(n, z, f)$ and the two transition matrices $M_c(n, z, f)(n', z', f)$ and $M_e(n, z, f)(n', z', f)$ are functions of the state f. This, in turns, means that the estimated continuation and entry values will depend on f: $VC(n, z, f)$ and $VE(n, z, f)$.[8]

A second potential restriction is that the scrap value distribution is assumed to be an identical exponential distribution across all markets with the mean value in each market equal to σ.

[7] In the empirical model we categorize the market fixed effects into three discrete categories. The first category includes the one-third of the markets with the smallest estimated fixed effects, the second category includes the one-third of the markets with the next highest fixed effects, and the final category includes the one-third of the markets with largest market effects.

[8] Ackerberg, Benkard, Berry, and Pakes (2005) discuss this as one way to correct for serial correlation in the market-level profit data that arises from a market fixed effect.

This does not allow for any heterogeneity in the outside options across markets. One potentially important factor affecting the outside option of an individual making the decision to exit the market is how close the person is to retirement age. At the market level, we would expect that, even with identical profits, markets with a larger number of older doctors would have higher exit rates. We can incorporate differences in the scrap values or outside options of the practitioners across markets by allowing the mean of the scrap value distribution to shift with observable market characteristics. Specifically, we maintain the exponential assumption on the shape of the scrap value distribution but model the mean of the distribution for market *m* in year *t* as $\sigma_0 + \sigma_1 A_{mt}$ where A_{mt} is a summary statistic of the age distribution of practitioners in the market. While allowing for more flexibility in the distribution of outside options across markets this does complicate the model by adding another state variable to the system. We treat this an exogenous state variable and use the market-level observations to estimate the transition matrix for *A* over time.[9]

4 Data

4.1 Definition of the Market

The data used in the analysis come from US Census Bureau's Longitudinal Business Database (LBD). The LBD contains panel data on all employers in the United States from 1977 through 2002. In this paper, we focus on the measurement and analysis of the entry and exit dynamics in two health care related industries, dentists (SIC 8021) and chiropractors (SIC 8041).

[9] It is possible to argue that *A* is an endogenous state variable which will respond to the entry and exit decisions of the practitioners in the market. If entry was always by young doctors and exit was always old doctors, then *A* would evolve endogenously with the entry and exit decisions. Turnover of practices in actual markets is more complex, including practices that split apart and practitioners that move to different geographic areas. This weakens any link between entry and exit flows and the age distribution in a market. To make any empirical progress on this issue would require knowing, not just the entry and exit flows in the markets, but those flows disaggregated by the age of the practitioners. That is not information that is collected in census data we utilize.

We chose these industries because they provide their services in relatively small local markets, the market demand for these services is closely tied to population, and the technologies are similar in that they combine office staff, specialized capital equipment, and the doctor's time to provide a health service. There are some differences between the two professions in the link between the level of population and the level of demand for these services that affects the level of revenue and profits, and thus number of practitioners, entry, and exit flows in the two professions. Also, the cost of establishing and operating a practice also differs between the two professions and this contributes to differences in profitability and turnover. Finally, we are also able to utilize some external data sources that allow us to construct different measures of the pool of potential entrants based on occupational and licensing data for dentists and chiropractors. The empirical issue is to see whether differences in model parameters between these two industries can help explain differences in profitability, entry, and exit.

Throughout the paper, our analysis is limited to the years in which a Census of Services is undertaken - 1977, 1982, 1987, 1992, 1997 and 2002. We restrict the data in this way because we require data on the revenue and costs of establishments and these data are only available in the years in which a Census is undertaken. All establishment-level geographic and industry coding variables used in the definition of markets are taken from the Census of Services data as well.

In order to model the entry and exit behavior of local service industries, we focus our attention on small and isolated markets. We first identified a set of relatively isolated geographic markets by examining maps and locating cities and towns that are away from large population centers. This is similar in spirit to the approach taken by Bresnahan and Reiss (1991). The original list contained roughly 1000 locations in the 46 contiguous states excluding California and Rhode Island. We then matched this list of cities and towns to census geographic codes at the place level and merged them with place-level population data from US Census Bureau. From this list, we identified a set of smaller markets (populations less than 50,000) with consistent place coding in the Census of Services over time. This resulted in a set of 754 census places. All 754 geographic areas had a dental practice present in at least one year. Because they require a larger population to sustain a practice, only 689 of the geographic areas had a chiropractor practice present. These will be the number of markets analyzed for each of the industries. The geographic markets represented here cover a much wider range of market sizes than in the studies by Bresnahan and Reiss (1991,1994). The geographic markets are small to mid-sized towns and cities that vary in population from 2,534 to 49,750 people. They are generally rural or semi-rural in nature and clearly under-represent markets in the northeast section of the US. For example, only 11 markets are identified in the New England states whereas Texas contains 57 markets.

4.2 Measuring Entry and Exit in Geographic Markets

To measure the entry and exit of establishments, we use the establishment links developed in the LBD. The LBD uses both Census Bureau establishment-level identification numbers and name and address matching algorithms to develop a panel data set that allows for the measurement of establishment entry and exit and the tracking of continuing establishments over time. Jarmin and Miranda (2002) discuss the measurement issues involved in constructing the LBD. The measure of entry used in this paper is the entry of an establishment into a geographic market. An entrant in a market is defined as an establishment that is not present in a market in period t but is producing in the market in period $t+5$ (the next Census year).[10] Similarly, an exit is defined as an

[10] Some establishments in the data switch geographic codes over time. In particular, a continuing establishment will sometimes switch between a "rest of county" place code and a place code identifying a city. We do not allow these within-county changes in geographic coding to generate entry and exit. In these cases, we always fix the place code to the code that identifies the city and the treat the establishment as continuing in that location .

establishment that is in a geographic market in period t and is not in that market in period $t+5$.[11] For each market, we construct the numbers of entering, exiting, and continuing establishments.

It is important to emphasize that we would like to eliminate the sale of an ongoing practice from the entry and exit statistics and have done this to the extent possible. This is in keeping with the assumptions of the model, which views the number of independent decision makers as the endogenous state variable affecting profits and the entry and exit decision as reflecting a change in the number of decision makers. In practice, however, the LBD is constructed based on following establishments at a specific location over time, but some of the linking relies on matching the name and address of the establishment across years. If the sale of a practice results in a name change, then it may not be recognized as an ongoing establishment and this will lead to an upward bias in the entry and exit rates we construct.[12]

The top panel of Table 1 provides an overview of the entry and exit patterns at the national level for dentist and chiropractor offices over the five inter-census periods from 1977 to 2002. Both the number of dentist offices and chiropractor offices has grown steadily over the 25 year time period. This is especially true for chiropractors where the number of offices increases by 383 percent over the period. Overall, entry rates average around .28 over the five-year periods for

[11]The vast majority of entering and exiting establishments are denovo entrants or establishments that are closing, respectively. This is not true in other industries such as manufacturing where a substantial fraction of establishments may enter and exit a market by changing their product mix. Such product mix shifts are rare in the dentist and chiropractor office data.

[12] In longitudinal Census data, errors in the linkage for an establishment over time will appear as a simultaneous entry and exit. We have compared our entry rates for dental practices with independent information on new licenses reported by the licensing boards in several states. While not comprehensive, in cases where we can make comparisons with the census markets, it suggests that the rate of entry we measure is approximately 5 percentage points higher (20 percent versus 15 percent, on average), but the cross-state patterns are similar and the 5 percentage point differential is similar across states. The higher rate in the census data could reflect errors in following existing practices over time or the movement of dentists into new geographic markets. While these two data sources have different units of measurement, establishments versus individuals, it is encouraging that the cross-sectional ranking of high and low entry states is similar.

dentists and almost .67 for chiropractors. The next column presents a measure of producer turnover. The excess turnover rate is defined as the sum of the entry and exit rate minus the absolute value of the net entry rate. The excess turnover rate attempts to control for the effect of changing market size or growth on the number of firms operating. It measures the amount of turnover in the number of producers in excess of that required to accomplish the observed net change in the number of producers. In comparison to the previous research that documents establishment entry and exit in the manufacturing sector (Dunne and Roberts (1991)), the excess turnover in dentists is significantly less than what occurs in manufacturing and excess turnover in chiropractors is of a similar magnitude.

The bottom panel of Table 1 shows the same statistics for our sample of 754 markets. Many patterns are similar to the national figures, though, they do differ in a number of important respects. Overall entry, exit and turnover rates of dentists' and chiropractors' offices are somewhat lower in the sample of local markets as compared to the national statistics. This is especially evident in the net entry statistics for dentists where net entry in the local market sample becomes essentially zero in the later periods but remains positive in the national data. Alternatively, the shifts in entry and exit patterns that occur over time in the national statistics occur in our sample of local markets. Periods with high national entry rates appear as high entry rate periods in the local market data.

4.3 Market Level Demand and Cost Variables

The dynamic model treats market demand and cost variables as exogenous state variables that shift market-level profits and thus they affect a firm’s entry or exit decision. We include two variables to capture differences in the evolution of profits across markets. To control for demand differences we include the population of the geographic market. To construct estimates of the population in each place in 1977, we utilize data from 1970 and 1980 Decennial Censuses on population by place and interpolate to get a 1977 place-level value. For 1982, we use data from the 1980 Decennial Census and the 1986 County and City Data Book to interpolate the place-level population in 1982. For 1987, we interpolate the place population using data from the 1986 County and City Data Book and the 1990 Decennial Census. For the remaining years, we use the place-level estimates produced by the US Census Bureau Population Estimates Program.

To control for cost differences we measure the average real wage paid to employees in dental or chiropractic establishments in the geographic market. It is the employment-weighted average wage over all establishments in the industry and place reported in the Census of Services. This is then deflated by the national cpi. Because we do not use local price deflators, variation in the wage variable will also reflect price-level differences across geographic markets, which is likely to be important in the cross-section dimension of the data.

4.4 Measuring Establishment Profits

In addition to measures of entry and exit, the empirical model requires a measure of the average profits earned by establishments in each geographic market and time period. We use information on revenue, payroll and legal form of organization from the Census LBD to construct a measure of establishment profitability. Unfortunately, the Census of Services does not collect data on expenses other than payroll for dentist and chiropractor offices and we rely on external data sources to estimate other expenses as a share of office revenue. For the offices of dentists, we use aggregate information from the American Dental Association (ADA) and the Census Bureau's Business Expenses Survey (BES) to estimate the share of other expenses in total revenue. These data sources report that expenses other than payroll are approximately 35% of a dentist's office revenues. For the offices of chiropractors, we rely on aggregate data from the BES for industry 804 (Offices of Other Health Practitioners) that contains chiropractors. Based on the BES data, we estimate that other expenses account for 37% of a chiropractor's office revenues.

In order to construct a measure of profit, two other important features of the industries must be accounted for. First, the tax status of a firm will affect how key data items are reported. For sole proprietors and partnerships, the owner receives compensation as net income and not as payroll. For these legal forms of organization (LFO), firm pre-tax profits (net income) are revenue minus payroll minus estimated expenses. For professional service organizations (corporations), the owning dentist(s)/chiropractors are typically paid part of their compensation as a component of payroll. We want to net out this compensation of dentists from payroll in order to have similar profit measures across firms with different LFO status. One can see clearly this difference in payroll reporting across LFO types in our data. For dentist offices in 1997, the ratio of payroll to revenue averages .25 for the sole proprietorships and partners and .49 for professional service organizations. A similar pattern holds for chiropractor offices (.18 vs .38). In order to adjust our profit measures for this feature in the data, we use aggregate tax data to measure the share of payroll going to the owners of incorporated firms. For dentist offices, we estimate the share of payroll going to officers of the corporation as 40% in the beginning of our time period, rising to 50% by the end of our time period. This rise in the dentists' share reflects the fact that dentists real compensation has risen substantially over time (American Dental Association (2003)). For chiropractor offices that file as professional service organizations, we estimate the share of payroll going to owners as 50% of total payroll across the entire time period. These adjustment to payroll make the ratio of adjusted payroll to revenue similar across LFO types.

The second issue we need to address deals with the fact that the number of owner-practitioners will vary across medical offices and thus the level of firm profits will vary with the number of owner practitioners. Based on 1997 dentist data, for sole proprietors the ratio of the number of owners to offices is one to one; for partnerships there are roughly 1.8 owner-dentists per partnership; and for professional service organizations there are roughly 1.35 dentists per practice. In order to make our profits comparable across offices of different scale, we normalize the profits per office by the average number of practitioner-owner across the LFO types. The same type of pattern occurs in offices of chiropractors and we construct a similar adjustment. Thus, our final measure of profit will be the profit per owner-practitioner.

In summary, we calculate profits per owner by using census data on establishment revenue and payroll with three adjustments. First, we estimate expenses besides payroll for each office based on aggregate tax data. Second, we adjust the payroll data for corporations to net out the compensation to the owner-practitioners. Third, we adjust the per establishment profits to account for the fact that different types of firms will have differing numbers of owner practitioners. Finally, we convert all the profit data to 1983 constant dollars by deflating by the CPI. Using this method to construct profits for each office, we construct the average profit of an establishment in a market by taking the average of all offices producing in a market. The last column in each of the panels in Table 1 report mean profit per owner practitioner in 1983 constant dollars. For dentists, there is a trend toward increasing profits. This pattern and the magnitudes of profits are consistent with ADA studies of the revenues, expenses, and net income of dentists.[13] The data on chiropractors shows overall lower profits and lower profit growth in comparison to dentists. The data that represents the sample of local markets shows similar time-series patterns in the profits

[13]Using data from the ADA on net income in 1986, we estimate that net income for dentists in private practice averaged about $67,700 in 1986 (measured in 1983 dollars) which is very close to our estimate for 1987. For 1997 we estimate the net income of dentists based on ADA sources at approximately $96,100 (in 1983 dollars). So our estimate for 1997 ($91,300) appears a little low by comparison.

compared to national markets, but overall lower profit levels.

4.5 Measuring the Number of Potential Entrants

Our empirical model requires that we measure the number of entrants relative to the pool of potential entrants in each geographic markets. There are several ways to approach measurement of the entry pool and in this project we have used two different definitions. The first definition sets the number of potential entrants into a geographic market in a time-period equal to the maximum number of different establishments that appear in the market over time minus the number of establishments already in operation. The rationale behind this definition is that in each geographic market we observe all potential entrants being active at some point in time. In each time period the pool of potential entrants is the set of establishments that are not currently active. We will refer to this as entry pool 1. This definition has the advantage that it can be constructed using only data that is present in the Census LBD. It will also tend to covary positively with the population of the geographic market and the actual number of entering firms, resulting in an entry rate that is roughly constant across market sizes (this is summarized below). The disadvantage of this measure is that it is affected by the overall growth in market size and the number of establishments over time. Since the number of establishments has increased over time due to exogenous growth in population, this measure is likely to overestimate the number of potential entrants, and thus underestimate the entry rate, in the early years of the sample.

As an alternative to this measure we exploit data from the ADA, Federation of Chiropractic Licensing Boards (FCLB) and Bureau of Health Professionals (BHP) to estimate the number of non-owner practitioners in an area that could potentially enter each geographic market. In the case of dentists, industry sources report that new dentists offices are usually established by dentists that are working in existing dental practices. Few new graduates start new practices on their own right after dental school (Weaver, Haden and Valachovic, (2001)). Using these external data sources, we measure the number of dentists that exceed the number of dental offices in the county in which each of the geographic markets is located and in the counties that are contiguous to this county. We use this number as our estimate of the pool of potential entrants in each geographic market. We will refer to the potential entry pool constructed with this ethod as entry pool 2. In the case of chiropractors, we use much cruder information from the FCLB and BHP on the ratio of the number of licensed chiropractors to the number of chiropractors' offices to construct the excess pool of entrants available to start new businesses. We also adjust the chiropractor pool for new graduates, since they are a relatively more important source of new entrants than dentists.[14]

5 Turnover in the Markets for Dentists and Chiropractors: Empirical Results

5.1 Institutional Differences in Entry and Exit Costs

Before presenting estimates of the structural parameters we discuss some sources of entry costs and scrap values for the two industries. In our framework an entry cost is any cost born by a new establishment in a geographic market that is not born by an existing establishment. In addition to the cost of renovating office space and installing capital equipment, there is also the cost of attracting a stock of patients. Further, entry costs can arise because of entry barriers, such as state licensing restrictions, that slow the geographic mobility of dentists or chiropractors from one market to another. The typical entry costs vary between the two industries for a number of

[14] The number of chiropractors in the United States increased by more than 300% over the period 1977 to 2002, based on statistics from the Bureau of Health Professionals. This reflects the relatively high growth rate in new graduates, especially as it relates to the existing pool of practitioners. To account for this growth in supply, we increase our estimate of the pool of potential entrants, based on the ratio of licensed chiropractors to chiropractor offices, by roughly 25% in each period. This basically assumes that most new graduates consider opening a chiropractor's office after graduating from school.

reasons.

The simplest difference arises from the cost of capital equipment and office construction. Dental offices generally require multiple treatment rooms with x-ray and dental equipment. The kind of physical infrastructure, electrical, plumbing, and support structures for x-ray equipment, tend to be very specialized and typical office space requires significant renovation to make it usable.[15] In contrast, the main equipment for a chiropractic office is a specialized chiropractic table in each treatment room. For both dentists and chiropractors it is possible to lease the necessary equipment which can reduce the size of the initial investment.

Another source of difference in entry conditions between the two professions involves licensing requirements.[16] In general, professionals in both fields must be licensed to practice in a state. Professional schools are typically four years in both fields, although tuition at dental schools is higher. Also, dental students typically have a bachelors degree before they enter, while a significant fraction of chiropractic students do not have a bachelors degree. At the end of schooling, national written exams are given in both fields. Dentists must also pass clinical exams that are administered regionally or by individual states. The acceptance of results across states varies by state but is not uncommon. The use of regional examining boards has grown over the last 20 years and this has made it easier for new dentists to be licensed in multiple states. For chiropractors there is a national exam that covers clinical skills, but some states require additional state exams. Besides the licensing process by examination, by which most new graduates are licensed, there is a separate licensing process for experienced practitioners that want to relocate to

[15] Osterhaus (2006) reports that the current cost of opening a new dental practice in Arizona is between $450,000 and $550,000. This includes the cost of construction, state-of-the-art equipment, and allowances for working capital and marketing.

[16] See American Dental Association (2001) and Sandefur and Coulter (1997) for further details on licensing requirements in each profession.

a new state. Referred to as licensing by credentials, this requires a dentist to show evidence of practice experience, often five or more years of continuous practice. A gap in the practice period or disciplinary actions may disqualify an experienced dentist from obtaining a license by credentials. This can help reduce mobility of dentists.[17] For chiropractors, licensing by credentials appears to be a simpler process where the required time in continuous practice is often less and waivers are more readily granted.

On the exit side, it is common for retiring dentists or chiropractors to sell their practice. The ADA reports that over the period 1995-2005 a dental practice typically sold for 60 percent of gross annual revenue, with a percentage closer to 100 for periods before 1995. A 60 percent figure is also quoted for chiropractor practices but, given the substantially lower revenues for a typical chiropractor practice, the sales prices are much less. While sales prices are useful to keep in mind, in our data the sale of a practice will, ideally, not be counted as an exit and entry. This will be viewed as a change in ownership which does not affect market structure or profitability. As discussed in section 4.2, there can be errors in matching establishments over time when ownership changes occur and thus sales of practices can enter into the entry and exit flows we measure. What we attempt to measure in the exit statistics are the establishments that actually shut down. The scrap value in this case is best viewed as the alternative earnings of the practitioner in retirement, or the alternative occupation they move into, or the alternative geographic market they move to. Thus the scrap value in this study is less likely to be a sales price for an ongoing practice and more likely to reflect the alternative earnings of a practitioner who is shutting down the

[17] The state of Ohio reports that, of the 1046 licenses issued between 1999 and 2004, only 45 were issued by credentials. In order to increase the number of dentists in the state, the Texas legislature recently passed legislation to reduce the hurdles faced by dentists using the credentials process, specifically reducing the number of years of experience required and requiring the State Board of Dental Examiners to consider the acceptance of other regional clinical exams.

practice and the value of any pieces of the practice that can be sold separately. To the extent that the dental practice has a higher stream of earnings and thus retirement income and more valuable equipment that could be sold, it is likely that the scrap value we measure will be higher in the dental industry.

5.2 Cross-sectional Patterns with Market Size

We begin the empirical analysis by summarizing the market-level patterns of entry, exit, and profitability, with particular emphasis on how the patterns differ across geographic markets of different sizes. Tables 2-5 provide summary statistics for dentists offices and chiropractors offices, respectively, across the 754 geographic markets and 5 time periods, a total of 3770 observations, used in our analysis. As the measure of market size we use the population in the geographic area and view this as the proxy for the level of market demand. We assign each of our market observations to one of 15 size categories based on market population. The market size cutoffs were chosen to give roughly equal numbers of observations per cell and the population cutoffs will tend to be further apart as the markets get larger. The same size cutoffs were used for both the dentists and chiropractors data. The average population and the number of market-year observations in each size category are reported in the second and third columns of Table 2 and 3. The remainder of Tables 2 and 3 focus on the cross-sectional patterns in the number of establishments and the level of demand, revenue, and profit per producer. Tables 4 and 5 focus on the patterns of entry, exit, and turnover.

Focusing on the summary statistics for dentists in Table 2, we see from the fourth column that, as market size increases, the number of firms also increases. More interestingly, the population per dentist office, column 5, varies between 1200 and 1600 people across the 15 market size categories. Comparing the smallest five size classes with the largest five classes, population per establishment rises from an average of 1360 to 1473, an increase of 8.3 percent. As discussed in section 2 above, Bresnahan and Reiss (1991) showed that one implication of an increase in competitiveness as markets get larger, is that the average number of customers per firm should rise. They found evidence of this pattern for dentists practices for small markets with 1-3 establishments. There is weak evidence of this pattern in our data. One explanation is that our markets tend to have more establishments than the markets examined by Bresnahan and Reiss. Even in the smallest size category, which has an average population of 3,502 people, there is an average of 2.85 establishments in our data. Our markets may have already passed the size level at which the competitive effects of entry are exhausted, but estimates of the parameters of the profit function will allow direct inferences on this effect.

The last two columns of Table 2 summarize the average revenue and average profit per establishment. Campbell and Hopenhayn (2005) have shown that an implication of increased competitiveness in larger markets is that average producer size will increase with market size and they find that average firm sales and market size are positively correlated in many of the retail industries they study. We find that both average establishment revenue and average establishment profits increase with market size. Comparing the averages over the five smallest and five largest size classes, we observe that average revenue per establishment rises 22.5 percent (from 142 to 174) and average profit per establishment rises 18.7 percent (from 59.8 to 71.0). Overall, the demand and revenue evidence is consistent with the prediction of increased competition in large markets.

Other explanations for these patterns are possible. The rise in profits and revenue could reflect an increase in product differentiation among dentists as higher-priced specialists become more common in larger markets. This differentiation would partially insulate the dentists from the competitive effects of larger numbers and be reflected in higher prices and profits for firms. Alternatively, the increase in revenue and profits with market size could also reflect higher costs in larger markets. The profit measure is the compensation earned by the dentist, and the increase with market size could reflect the need for higher compensation to compensate dentists higher living costs. The fact that average profits increase more slowly than average revenue can also reflect a combination of higher costs and more competition as markets increase in size. The profit model developed in section 3.2 will include population and average wages in the industry/market as controls when attempting to measure the direct effect of an increase in the number of firms on profits..

This same pattern of demand, revenue, and profits with market size is also evident, but the magnitudes are larger, for chiropractors. First, as seen in Table 3, there is a significant increase in the population per establishment as market size increases (column 5). It does not increase monotonically across size classes but the upward trend is clear. The average for the five smallest size categories is 4482 people per establishment, while the same number for the five largest size classes is 7254, an increase of 62 percent. This is consistent with a competitive effect of firm entry in larger markets. When compared with dentists, there are also fewer establishments per market. For half of the size categories, which covers markets with up to an average of 10,200 people, there are fewer than two chiropractors per market on average. Even the largest markets have only 5.02 chiropractors, on average, compared with 25.46 dentists. If there is a competitive effect of entry, which dies out after 4 or 5 firms are present in the market, then most of our markets will lie in the range where the effect would be present. For the chiropractors markets, it is also the case that average revenue per establishment and average profit per establishment rise with market size. The five largest size classes have average revenues that are 22.9 percent higher than the five smallest size groups and average profits that are 43 percent higher. Taken together, the substantial increases in population and revenue per establishment suggest a stronger competitive effect from the increase in the number of firms in this industry than in the dentist industry. What is inconsistent with this interpretation, is the large increase in average profits with market size. The profit function parameters will allow direct inferences about the presence of a competitive effect.

5.3 The Patterns of Market Dynamics

The cross-sectional patterns discussed in the last section summarize the relationship between market size, number of producers, and average firm profits but do not provide any direct evidence on the patterns of producer turnover. The dynamic theoretical models of industry evolution discussed above have emphasized a second pathway through which competition affects firm profits, in particular, the competition which is provided by the easy entry of new firms. A key parameter in these models is the sunk cost of entry. When this cost is low, potential entrants to a market are a significant source of competitive pressure. For example, in Hopenhayn's (1992) competitive framework, markets with high entry costs will be characterized by low rates of producer turnover. The sunk cost of entry acts as a barrier to entry that insulates the existing firms from competitive pressure. Industry profit and average firm value can also increase when entry costs are large.[18]

Tables 4 and 5 summarize the patterns of producer turnover in the dentist and chiropractor markets. The second, third, and fourth columns of Table 4 summarize the average number of

[18]There is also a selection effect which depends on the level of the entry cost. When entry costs are high, more low-profit firms will survive and this will tend to reduce industry profit and average firm value. As long as this selection effect is not too strong, the industry profitability will be positively correlated with the magnitude of sunk entry costs.

establishments, exits, and entrants in different size markets. All three variables increase monotonically with market size. Markets with larger populations have larger entry and exit flows. The next two columns express these flows as a proportion of the number of establishments in operation at the start of a time period. The market exit rate averages .20 across the size classes while the entry proportion averages .25 and these averages vary little across different size markets. A substantial amount of producer turnover occurs as the simultaneous entry and exit of establishments in the same geographic market. The excess turnover rate, reported in column 7, averages .285 across the size classes. This implies that, after controlling for the net expansion or contraction in the total number of firms in the market, the establishments undergoing a transition in or out of operation represent more than a quarter of the number of establishments in operation. The last two columns of Table 4 summarize the entry rate using two different definitions of the pool of potential entrants. The first definition, which uses the number of establishments ever observed in the market (entry pool 1), generates an average entry rate of .22. It does not vary much with market size because the pool of potential entrants is closely tied to the number of firms in the market, which in turn is highly correlated with the number of entrants. The second definition, which uses information on the number of dentists in excess of the number of practices (entry pool 2), has a similar entry rate on average, .24, but the entry rate increases significantly with market size. This occurs because, as the market size increases, the share of county population in the market rises. Thus, the number of excess dentists in the county (i.e., dentists practicing inside the county but outside the place) will have a tendency to be lower and the resulting pool of potential entrants will be smaller in larger markets.[19]

[19] While the two entry rate variables give different patterns of entry, it is difficult to argue one is more appropriate than the other. In the analysis that follows we will estimate the entry and exit model separately using each measure and examine sensitivity of the results.

The summary statistics for the entry and exit of chiropractors are reported in Table 5 and differ in some significant ways from the patterns for dentists. Most importantly, the exit rate, entry proportion, and excess turnover rate are all larger for chiropractors. While the entry proportion will reflect the overall growth in the number of chiropractors during our sample period, the other two measures are less affected by this. In particular, the excess turnover rate averages .36 across the market size classes, which is higher than the .285 observed for dentists. The higher turnover among chiropractors could reflect lower entry costs in this profession. This would also explain their lower average profits per establishment relative to dentists, which was seen in Tables 2 and 3.

Overall, the profit, entry, and exit statistics suggest that a combination of competitive and technological factors interact to produce the market-level outcomes we observe and the importance of each factor differs between the two industries. There is some evidence that an increase in market size results in an increase in competition as the number of establishments increases. To isolate this effect we will need to estimate the profit function for producers in each industry, where there is a role for both the number of firms in the market and overall market size to affect profits. The turnover statistics suggest substantial within-market turnover in both industries but a higher degree of turnover among chiropractors. One explanation for this difference is that dentists face higher sunk entry costs in establishing a business and this requires estimates of the entry costs and scrap values faced by a an establishment in each industry. Finally, the flows of simultaneous entry and exit indicate that heterogeneity exists across producers within the same market. This heterogeneity in outcomes could result from differences in the profit function, scrap value, or entry cost across producers. In the next section we report econometric results that attempt to isolate these separate effects.

5.4 Estimates of the Profit Function, Entry Costs, and Scrap Values

Estimates of the underlying structural parameters are reported in Table 6 for the dentist and Table 7 for the chiropractor markets. The profit function parameters θ were estimated two ways, first, using OLS applied to equation (7) and, second, using the fixed-effects estimator applied to equation (15). The scrap value and entry cost parameters, σ and α, were then estimated using the profit function estimates from equation (15) and the likelihood function for the entry and exit rates specified in equation (12).[20]

We focus first on the parameter estimates for the dentist practices. The first column reports estimates based on a profit-function specification without a market fixed effect, equation (7). The only coefficients in the equation that are statistically significant are related to the exogenous cost and demand shifters, wages and population, respectively. In particular, none of the coefficients related to the number of establishments are statistically significant. If there are persistent differences in profits across markets that result from omitted market effects, then we would expect the coefficient on the number of establishments to have a positive bias and the absence of any effect, rather than the expected negative effect, is consistent with this bias.

When a market fixed effect is added to the profit function (reported in column 2), we observe that all of the coefficients becomes statistically significant and reveal an important competitive effect arising from an increase in the number of establishments. The coefficients on the dummy variables for markets with 1 to 5 firms are all positive and decrease in magnitude as n increases. This implies that the average establishment profit declines monotonically as the number

[20] In the case of the entry cost and scrap value parameters, we use the Bayesian MCMC estimator described in the text and the table reports the means and standard deviations of the draws from the posterior distribution of the parameters given in equation (13). In each case we draw 50,000 observations from the distribution, eliminate the first 10,000 as a burn-in period, and then report the mean and standard deviation for the remaining 40,000 draws. The prior distribution for $log\ \sigma$ is assumed to be normal(5,100) and the prior for $log\ \alpha$ is normal(10,100). These priors guarantee that the parameter will be positive but otherwise are very diffuse and have no effect on the final parameter estimates we report.

of establishments in the market increases from 1 to 5. In addition, the coefficient on *n* is negative and statistically significant indicating further declines in average profits as the number of competitors increases. We interpret this as evidence of a competitive effect resulting from an increase in the number of establishments. Increases in market population, a measure of demand, increase average profits at a diminishing rate. The real wage rate for employees in the dental industry is also significant, but the effect is positive and diminishing. This is the opposite of what would be expected from a cost shift and probably reflects the fact that the wage rate is also a measure of price level differences across geographic markets.

The scrap value and entry cost parameters can be interpreted as the means of those variables (in millions of 1983 dollars). Focusing on the first entry pool definition, the mean of the scrap value is 0.617 million dollars and the estimate of the mean value of continuing in operation is $V\hat{C}$=0.995 million. Together, these imply that the outside option value over all *practices that remain in operation* averages 0.369 million dollars. On the entry side, the mean entry cost is 2.636 million dollars, the mean value of entering is 0.981 million and thus the average entry cost *among the establishments that enter* is 0.525 million. Both the scrap value and entry cost parameters change when the alternative definition, entry pool 2, is used. This definition results in a similar average entry rate but lower (higher) entry rates in small (large) markets than definition 1. The scrap value parameter fall slightly to .568 which implies that the surviving establishments have an average scrap value of 0.351 million dollars. The more substantial change occurs in the entry cost parameter which increases to 3.904. When compared with the average value of entry of 0.939, this implies that the average startup cost for establishments that enter is 0.598 million dollars, an increase of 75 thousand dollars from the first definition. Overall, the definition and measurement of the pool of potential entrants does impact the resulting entry and exit cost parameter estimates.

More insight can be gained by contrasting these estimates with the findings for the chiropractor industry reported in Table 7. In contrast to the dentist results, regardless of whether we control for a market fixed effect, only the profit function parameters related to population and the wage rate are statistically significant. All of the coefficients related to the number of establishments in both models are not statistically significant. Basically, despite the pattern seen in the last column of Table 3, we do not observe any systematic relationship between average profits and the number of competitors. Our interpretation is that this is most consistent with competitive outcomes in this industry regardless of the number of competitors in the market.

One factor that could contribute to this finding is a low entry cost, so that the competitive pressure comes from easy entry rather than a large number of existing practices. That is, regardless of the number of establishments in the market, low entry barriers guarantee that there are no excess profits available. In this industry, the sunk entry cost parameter is 1.858 or 1.711 depending on the potential entry pool definition used. This is always smaller than the estimates for the dentists. These parameters translate into an average setup cost of .252 and .323 million dollars for the establishments that entered. This is approximately half of the average entry cost incurred by new dental practices and is consistent with the institutional evidence that initial investments for chiropractor establishments are smaller than for dentists.

Comparing the estimates of the scrap value parameter σ for the two industries, it is clear that the scrap value is larger for dental establishments. Among the practices that remain in operation, dental practices have a mean scrap value (outside option) of .351 to .369 million dollars (depending on the entry pool used), while the corresponding figures for chiropractors are .226 to .251 million dollars. This implies that it takes a smaller value of the outside option to induce exit for chiropractors than for dentists. Taken together, the lower entry costs and scrap values should higher turnover among chiropractors than dentists and this is consistent with the entry and exit flows reported in Tables 4 and 5.

The long run value of operating in each industry is measured by *VC* and *VE*. As seen in equations (5) and (6), both a larger value of σ and a higher level of static profits, translate into a higher *VC* and *VE*. In addition to a larger value of σ, dental establishments also have higher average static profits, .062 versus .045 million dollars, than chiropractors. On average, dental establishments have a long-run operating value of .94 and 1 million dollars while chiropractor establishments lie between .58 and .72 million (depending on the entry pool definition).

One extension of the model, which we have just begun to explore, generalizes the mean of the scrap value distribution to depend on the age distribution of the dentists in the market. Specifically, we model the mean of the distribution as a linear function of the proportion of dentists in the market that are above 55 years old (A_{mt}). As individuals pass this age, retirement savings begin to become available without tax penalties and social security payments become more likely. These payments act to increase the value of the outside option (scrap value), for an older practitioner and should result in a higher probability of exit, other things equal. Given that we are using market level data, this extension will allow variation in the age of dentists across markets as well as variation in profits to affect the entry and exit rates.

Initial estimates of this model are promising. Using entry pool definition 2, we estimate the mean scrap value (standard error) to be: .126(.005) + .473 (.021) A_{mt}. Markets with a larger proportion of older dentists have a higher mean scrap value and the underlying coefficient is significant.[21] By itself, this implies that markets will older dentists will have more exit. As seen above, however, this will also result in higher continuation and entry values *VC* and *VE* in markets

[21] Using the first entry pool definition the coefficient estimates are similar: .125 (.005) + .402 (.020) A_{mt}.

with older dentists. The former will reduce exit and the latter will encourage entry. Further work is required to assess how well this model improves the overall explanation of entry and exit patterns, but the initial evidence suggests that allowing for further sources of market-level heterogeneity, both in the profit function and scrap value distribution, are important extensions when applying this model to market-level panel data..

6 Summary and Conclusion

In this paper we utilize micro data from the Census of Service Industries to measure the patterns of entry and exit for two industries, dental offices and chiropractor offices, over the period 1977 to 2002. The basic data reveal significant differences in the market structure and market performance as market size increases. In the dentist industry the population per establishment, which is a proxy for the level of demand faced by each practice, increases slightly as the market size increases, while the average revenue per establishment and average profits per establishment rise steadily. The first two patterns are consistent with a competitive effect that results in smaller markups in large markets as a result of the increased number of establishments, but the profit pattern is more consistent with an increase in product differentiation or specialization of the practices as market size increases. The same three patterns are present for the chiropractor establishments but the increases are much larger as market size rises.

We can provide some insight into the sources of these patterns by estimating the structural model of entry and exit developed by Pakes, Ostrovsky, and Berry (2004). It allows for a direct competitive effect of the number of establishments on the average profit earned by all producers in the market and allows high entry costs and/or low scrap values to insulate incumbents from pressure from potential entrants.

The estimates of the structural model parameters indicates that the direct effect of an increase in the number of establishments on average profits is negative and statistically significant in the dentist industry and not significant in the chiropractor industry. The entry cost and scrap value parameters are statistically significant for both industries with both being substantially larger for the dentists. Overall, the model provides evidence that, as a result of lower entry costs, competition from potential entrants is more substantial in the chiropractor industry than for dental practices. It can explain the pattern of higher turnover rates, lower average profits, and the finding that an increase in the number of competitors has no effect on average profits. In contrast, higher entry costs weaken the effect of potential entry on profits in the dental industry and, alternatively, provide some role for an increase in the number of dental establishments to lower average profits of the incumbents.

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Table 1. Summary Statistics for the Offices of Dentists and Chiropractors

Period	National Statistics									
	Offices of Dentists					Offices of Chiropractors				
	# of Establishments	Entry Rate	Exit Rate	Net Entry Rate	Excess Turn. Rate (a)	# of Establishments	Entry Rate	Exit Rate	Net Entry Rate	Excess Turn. Rate (a)
77-82	84,263	.375	.231	.144	.461	7,825	.946	.335	.611	.670
82-87	96,436	.294	.222	.072	.445	12,609	.873	.302	.571	.604
87-92	103,357	.237	.193	.044	.387	19,806	.615	.258	.358	.516
92-97	107,882	.228	.183	.045	.366	26,887	.426	.313	.113	.625
97-02	112,777	.262	.220	.042	.441	29,936	.495	.351	.145	.702
	Sample Statistics - Geographic Markets									
	Offices of Dentists					Offices of Chiropractors				
	# of Establishments	Entry Rate	Exit Rate	Net Entry Rate	Excess Turn. Rate (a)	# of Establishments	Entry Rate	Exit Rate	Net Entry Rate	Excess Turn. Rate (a)
77-82	6,091	.364	.229	.135	.458	922	.644	.324	.320	.649
82-87	6,912	.229	.207	.022	.414	1217	.597	.266	.330	.532
87-92	7,066	.178	.182	-.004	.355	1619	.456	.221	.235	.442
92-97	7.035	.189	.181	.009	.362	1999	.379	.261	.119	.521
97-02	7,096	.212	.211	.001	.423	2236	.427	.312	.115	.623

(a) Excess Turnover Rate is the sum of the entry and exit rates minus the absolute value of the net entry rate.

Table 2. Demand, Revenue, Profits per Establishment – Dentist Offices

Market Size Category	Average Population	Number of Markets	Mean Number of Establishments	Population per Establishment	Mean Revenue per Establishment (a)	Mean Profits per Establishment (a)
1	3,502	192	2.85	1229	125.9	52.8
2	5,109	293	3.94	1297	142.2	59.5
3	5,982	408	4.17	1433	139.8	59.7
4	6,997	384	4.99	1403	148.2	62.1
5	7,967	303	5.53	1441	155.4	64.7
6	8,950	228	6.45	1387	149.3	63.7
7	10,234	281	7.27	1407	146.9	61.8
8	11,721	259	7.93	1478	153.3	64.5
9	13,434	288	9.17	1464	161.0	66.6
10	15,933	293	11.02	1445	165.4	67.4
11	19,326	224	14.16	1365	172.7	69.7
12	23,776	206	15.82	1503	167.9	68.9
13	27,770	123	18.23	1524	165.8	69.2
14	32,220	115	23.37	1379	182.0	73.5
15	40,531	173	25.46	1592	182.2	73.9

(a) Thousands of constant (1983) dollars.

Table 3. Demand, Revenue, Profits per Establishment – Chiropractor Offices

Market Size Category	Average Population	Number of Markets	Mean Number of Establishments	Population per Establishment	Mean Revenue per Establishment (a)	Mean Profits per Establishment (a)
1	3,521	137	0.82	4268	85.7	26.9
2	5,100	238	1.10	4651	98.4	36.1
3	6,002	316	1.29	4660	91.1	33.1
4	6,996	329	1.44	4856	94.2	35.8
5	7,973	274	2.00	3979	93.3	38.5
6	8,953	217	2.06	4356	97.7	40.1
7	10,238	266	1.86	5491	94.3	36.1
8	11,710	249	2.22	5263	101.4	41.4
9	13,440	284	2.45	5476	103.0	44.1
10	15,933	293	2.63	6055	106.9	43.7
11	19,306	220	3.05	6330	121.3	50.4
12	23,805	202	3.37	7061	109.9	47.9
13	27,784	124	3.76	7393	107.3	47.4
14	32,206	118	4.36	7394	115.7	50.2
15	40,598	178	5.02	8092	114.5	47.8

(a) Thousands of constant (1983) dollars..

Table 4. Establishment Turnover by Market Size – Dentist Offices

	Average over Market-Year Observations							
Market Size Category	Number of Establishments	Number of Exits	Number of Entrants	Exit Rate	Entry Proportion	Excess Turnover Rate	Entry Rate (Pool def 1)	Entry Rate (Pool def 2)
1	2.85	.64	.69	.24	.27	.26	.23	.14
2	3.94	.81	.91	.20	.26	.23	.22	.17
3	4.17	.79	.90	.19	.23	.23	.21	.16
4	4.99	.96	1.08	.19	.24	.25	.22	.16
5	5.53	1.12	1.24	.20	.27	.26	.21	.19
6	6.45	1.67	1.41	.17	.24	.24	.24	.22
7	7.27	1.50	1.70	.21	.25	.27	.22	.22
8	7.93	1.70	1.90	.22	.25	.30	.22	.24
9	9.17	1.75	2.19	.19	.25	.29	.23	.28
10	11.02	2.19	2.68	.20	.27	.31	.23	.31
11	14.16	2.84	3.56	.21	.25	.34	.23	.29
12	15.82	3.26	3.61	.21	.24	.33	.22	.33
13	18.23	3.63	4.34	.20	.25	.32	.23	.31
14	23.37	4.62	4.93	.19	.21	.31	.22	.28
15	25.46	5.42	5.72	.22	.22	.33	.22	.35

Table 5. Establishment Turnover by Market Size – Chiropractors Offices

	Average over Market-Year Observations							
Market Size Category	Number of Establishments	Number of Exits	Number of Entrants	Exit Rate	Entry Proportion	Excess Turnover Rate	Entry Rate (Pool def 1)	Entry Rate (Pool def 2)
1	.82	.18	.35	.22	.20	.18	.26	.20
2	1.10	.29	.59	.27	.45	.36	.26	.29
3	1.29	.34	.55	.26	.40	.23	.25	.26
4	1.44	.41	.67	.29	.42	.33	.26	.29
5	2.00	.56	.83	.29	.48	.36	.26	.30
6	2.06	.50	.77	.23	.42	.29	.23	.29
7	1.86	.53	.97	.26	.49	.38	.27	.34
8	2.22	.67	1.07	.32	.55	.45	.30	.33
9	2.45	.65	1.06	.26	.52	.40	.25	.29
10	2.63	.73	1.27	.25	.53	.35	.26	.33
11	3.05	.85	1.51	.28	.66	.41	.27	.35
12	3.37	.86	1.55	.25	.57	.39	.28	.35
13	3.76	1.06	1.85	.26	.55	.43	.26	.34
14	4.36	1.25	2.30	.26	.61	.45	.26	.38
15	5.02	1.43	2.54	.28	.64	.44	.28	.38

Table 6. Estimates of Structural Parameters: Dentists
(standard errors in parentheses)

	No Market Fixed Effect	Market Fixed Effect	
		Entry Pool Def 1	Entry Pool Def 2
Profit Intercept	4.06e-02 (2.79e-03) *	-1.97e-03 (6.28e-03)	
I(n=1)	1.87e-03 (2.90e-03)	2.28e–02 (4.61e-03) *	
I(n=2)	8.98e-04 (2.07e-03)	1.19e-02 (3.35e-03) *	
I(n=3)	1.13e-03 (1.73e-03)	7.31e-03 (2.62e-03) *	
I(n=4)	8.04e-04 (1.62e-03)	4.46e-03 (2.14e-03) *	
I(n=5)	1.15e-03 (1.50e-03)	2.56e-03 (1.74e-03)	
Number of Estab *(n)*	- 3.94e-04 (2.77e-04)	- 2.45e-03 (5.04e-04) *	
n^2	1.12e-05 (6.74e-06)	3.94e-05 (1.14e-05) *	
Market Size *(pop)*	1.12e–03 (2.20e-04) *	6.32e-03 (6.17e-04) *	
pop^2	- 1.70e-05 (3.97e-06) *	- 6.37e-05 (1.13e-05) *	
Average Mkt Wage *(w)*	8.90e-04 (1.18e–03) *	7.67e-04 (1.30e-04) *	
w^2	- 4.27e-06 (1.06e-06) *	-3.62e-06 (1.06e-06) *	
*w*pop*	3.99e-06 (7.26e-06)	6.43e-06 (8.39e-06) *	
Mean Scrap Value (σ)		.617 (.0075) *	.568 (.0042) *
Mean Entry Cost (α)		2.636 (.0167) *	3.904 (.0146) *
Mean $\hat{\pi}$, $V\hat{C}$, $V\hat{E}$		.062, .995, .981	.062, .953, .939
Number of Observations	3770	3770	3770

*significant at the .01 significance level. $\hat{\pi}$, $V\hat{C}$, $V\hat{E}$ in millions of 1983 dollars.

Table 7. Estimates of Structural Parameters: Chiropractors
(standard errors in parentheses)

	No Market Fixed Effect	Market Fixed Effect	
		Entry Pool Def 1	Entry Pool Def 2
Profit Intercept	4.46e-02 (1.76e–02) *	4.36e-02 (1.87e-02) *	
I(n=1)	-1.64e-02 (1.40e-02)	-1.82e-02 (1.41e-02)	
I(n=2)	-1.22e-02 (1.09e-02)	-1.61e-02 (1.09e-02)	
I(n=3)	-9.56e-03 (8.13e-03)	-1.04e-02 (8.19e-03)	
I(n=4)	-6.34e-03 (5.85e-03)	8.65e-03 (5.86e-03)	
I(n=5)	-4.80e-03 (4.25e-03)	2.65e-03 (4.23e-03)	
Number of Estab *(n)*	5.57e-03 (3.71e-03)	-7.05e-03 (3.75e-03)	
n^2	2.99e-04 (1.78e-04)	3.08e-04 (1.82e-04)	
Market Size *(pop)*	1.15e-03 (1.92e–04) *	2.13e-03 (7.77e-04) *	
pop^2	-2.07e-05 (4.23e-06) *	-3.11e-05 (1.44e-05) *	
Average Mkt Wage *(w)*	1.41e-03 (9.82e-05) *	9.09e-04 (1.15e-04) *	
w^2	-5.25e-06 (9.36e-07) *	-1.93e-06 (1.01e-06)	
*w*pop*	-4.74e-07 (4.23e-06)	1.99e-06 (5.33e-06)	
Mean Scrap Value (σ)		.405 (.012) *	.423 (.013) *
Mean Entry Cost (α)		1.858 (.023) *	1.711 (.023) *
Mean $\hat{\pi}$, $V\hat{C}$, $V\hat{E}$		.045, .718, .710	.041, .584, .575
Number of Observations	3445	3445	3445

*significant at the .01 significance level. $\hat{\pi}$, $V\hat{C}$, $V\hat{E}$ in millions of 1983 dollars.