Competition and Market Structure in the Dental Industry

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Abstract

We use Survey of Dental Practice data from 1982-2012 to examine market power of dentists and hygienists in private practice. Our findings are consistent with a dental market wherein practices use hygienist services as a "loss leader" in order to steer patients into more lucrative dental services, which exhibit the ability to markup price above marginal cost. Both dental and hygienist services have similar elasticities of demand, at roughly -0.4. Another theme that emerged from our findings is the evidence for significant economies of scale in the dental market. The overall returns to scale parameter of 2.1 suggests significant increasing returns to scale are available to the typical dental practice. Given that the typical practice has 1.5 dentists, the finding is not surprising. While returns to scale diminishes with visit volume, the largest quartile of practices still has meaningful increasing returns to scale of roughly 1.6.

I. Introduction

In the United States dental care is mainly provided by dentists in private solo practice. Thus, at least on the surface, a large number of small providers could suggest a highly competitive market. However, given third-party payment as well as professional regulations, the competitiveness of the dental care market is unclear. It has long been known that dentistry in the U.S. is an internally well-organized industry in which dentists are operating in a strongly regulated environment but professional regulations are mostly made by market participants (Lipscomb and Douglass 1982). Local and state dental societies often influence local and state regulations, and ultimately impact national policy under which dentists practice their profession. Lipscomb and Douglass (1982) concluded that "the professional structure has reinforced dentistry's leverage over governmental legislation and regulations affecting the profession thereby influence the market of dental care." Such an environment could give dental practices the ability to exploit some degree of market power.

A recent 2015 judgment against the North Carolina State Board of Dental Examiners is indicative of the complex regulatory issues in dental care markets. The NC Board which is made up of six elected dentists, one hygienist and one consumer member was accused of violating antitrust laws for excluding non-dentists from the teeth-whitening services market. The main question of the case was whether a state agency involving market participants is exempt from antitrust laws. The Supreme Court decided that a state regulatory board operated by market participants is subject to federal antitrust laws unless having active state supervision (Supreme Court of the United States 2015). The Court's decision will affect state regulatory boards and could particularly change the legal environment of dental practice and dental care market. Thus, studying the competitive landscape and market structure of the dental care market is policy

relevant. Furthermore, understanding the degree of competition, which in turn affects pricing behaviors in dental care market, is important for public welfare and reimbursement policy.

In medicine, there is a rich literature with the objective of characterizing the market structure of hospitals and physicians. In some studies, researchers directly measure the degree of competition using measures of market concentration such as the Hirschman-Herfindahl Index (HHI) (Farley, 1985; Zwanziger & Melnick, 1988; Gruber, 1994; Kessler & McClellan, 2000) or the function of some structural variables such as provider density, population density, market size, or entry barriers (Joskow, 1980; Robinson & Luft, 1985; Wilson & Jadlow, 1982; Gruber, 1994). In other studies, researchers infer the market structure by giving evidence of competitive or anticompetitive conduct such as barriers to entry (Kessel 1970; Rayack 1967), advertising bans (Feldman and Begun 1978; Hass-Wilson 1986), or pricing behavior (Kessel 1958; McCarthy 1985; Gunning and Sickles 2013). Measurement of competition is useful to study its effect on prices, quality of care, and health outcomes, as well as to examining the determinants of market characteristics such as antitrust work (Baker 2001).

Empirical studies examining the structure of the dental care market are surprisingly sparse and dated. Most studies of the dental care market focused on estimating price elasticity of demand or supply, rather than identifying market structure or measuring the degree of competition. Since the 1970s, several estimates of the demand for dental care have been published by Feldstein (1973), Holtmann and Olsen (1976), Phelps and Newhouse (1973), and Maurizi (1975). However, they were criticized for methodological issues including lack of controls for price variation, environmental and personal characteristics, or under-identifying of demand curves (Manning and Phelps 1979). Later estimates of price and co-insurance elasticity

of demand by Hu (1981) and Mueller and Monheit (1988) are also questioned due to small sample size and specification errors (Grembowski et al. 1988).

The number of studies on the supply side is even smaller and they provided mixed results. One study used a multi-equation supply and demand system and concluded dentists' behavior could be characterized as monopolistic (Kushman and Scheffler 1978), while in another paper using the marginal product and wage approach they found that dentists' behavior was consistent with competitive profit-maximizing (Kushman et al. 1978). As a result, Kushman (1981) suggested that there should be a model including some characteristics of both market structure extremes. The answer to the question of how competitive the dental care market is remains unclear based on the prior evidence. Additionally, most studies used cross-sectional data from decades ago. Hence there is a need for research on the structure of dental care market using more recent data. As data on market shares of dental practices are unavailable, we cannot directly measure competition using HHI or practice density. Instead, we characterize the market structure by estimating the market power of dental practices in pricing in relative to their marginal costs. The method is from Bresnahan (1989) and will be described in the next section. The research objective is to estimate the amount of market power in the private dental practice market, as well as the extent of any economies of scale in the provision of dental services. The use of the repeat cross-section data allows for describing trends over a three-decade period.

II. Theoretical Model

Economic theory predicts that profit-maximization in a competitive market with costless entry and exit implies cost-minimization. The equilibrium output level y is chosen such that the

marginal revenue equals the marginal cost. In the perfectly competitive market, firms are price-takers that produce at the output level *y* such that the marginal cost equals the equilibrium price. In non-perfectly competitive markets, the familiar Lerner index allows us to measure the extent of market power (Lerner 1934): $(P - MC)/P$, which can be rewritten as $1/|e_D|$, where e_D represents the elasticity of demand. The index implies that the extent to which a monopolist sets the price above the marginal cost depends on the inverse of the price elasticity of demand. Firms in markets between the two extremes, perfect competition and monopoly, also have some market power to set the price above the marginal cost. If the market is highly inelastic, a small increase in price would not significantly change the quantity demanded, which allows firms to markup more. The extent of the markup implies the degree of market competition and the elasticity of demand.

To characterize the market for dental services we use the theoretical framework as described in Bresnahan (1989) to measure market power, the ability of providers to markup price above marginal cost, given the elasticity of demand for dental care services. We define for private dental practice *i* with quantity of output y_i the cost function and resulting marginal cost function as:

$$C_i = C(y_i, w_i, Z_i, \Gamma, \varepsilon_{ci}) \quad [1]$$

$$MC_i = \partial C_i/\partial y_i = C_1(y_i, w_i, Z_i, \Gamma, \varepsilon_{ci}) \quad [2]$$

where w_i is a vector of factor prices, Z_i are exogenous variables that shift cost, Γ are parameters to be estimated, and ε_{ci} is an idiosyncratic term.

The demand function is given by the derivative of the output function, $y_i = D(P_i, X_i, \Lambda, \varepsilon_{di})$ with respect to price:

$$\partial y_i/\partial P_i = D_1(P_i, X_i, \Lambda, \varepsilon_{di}), \quad [3]$$

where X_i are exogenous demand shifters, Λ are parameters to be estimated, and ε_{di} is the error term. The marginal revenue is:

$$MR_i = P_i + y_i\, \theta\, (\partial C/\partial y_i) = P_i + \theta\, (y_i/D_1). \quad [4]$$

Combining [2] and [4] we have the condition for profit-maximizing or cost-minimizing equilibrium:

$$\theta = D_1\, (C_1 - P_i)/y_i. \quad [5]$$

Equation [5] illustrates the relationship between the marginal cost incurred by a firm and the price it sets. In perfect competition, price equals marginal cost and thus $\theta = 0$, and in familiar fashion in equation [4], marginal revenue equals price. The marginal revenue for a monopolist is $MR = P + y/D_1$ which implies $\theta = 1$. The parameter θ is therefore an index of the market competition, measuring the ability of a firm to markup the price above the marginal cost, occurring in market structures departing from perfect competition. Obtaining a credible estimate of the parameter θ for dental services is the primary purpose of our research. Returns to scale for multiple-output production can be computed using the modified formula developed by Panzar and Willig (1977): $SCALE = C / \Sigma_{i=d,h}\, y_i\, (\partial C/\partial y_i)$, where a value of greater than, less than, or equal to unity indicates increasing, decreasing, or constant returns to scale, respectively.

III. Empirical specification

We estimate the market power index θ in the dental care market by employing the common generalized translog production function (Christensen, Jorgenson, and Lau 1973;

Caves, Christensen, and Tretheway 1980). There are several advantages to the translog function. First is that it accommodates multi-product firms. For example, it has been commonly used in empirical healthcare work to estimate the costs of hospital and physician practice production with multiple outputs (Escarce and Pauly 1998 and Gunning and Sickles 2013). The two outputs in our context are dentist visits and hygienist visits. Second, the translog function imposes no *a priori* restrictions on factor substitution elasticities and allows us to measure economies of scale and scope in a multi-product firm. Third, the translog offers ease of interpretability of coefficients and has a manageable number of parameters to be estimated compared to alternatives. The translog cost function has the form:

$$\ln C = \alpha_0 + \alpha_d \ln y_d + \alpha_h \ln y_h + .5\,\beta_d (\ln y_d)^2 + .5\,\beta_h (\ln y_h)^2 + \beta_{dh} \ln y_d \ln y_h + \Sigma^3_{j=1}\beta_{dj} \ln y_d \ln w_j +$$

$$\Sigma^3_{j=1}\beta_{hj} \ln y_h \ln w_j + \Sigma^3_{j=1}\alpha_j \ln w_j + .5\,\Sigma^3_{j,k=1}\beta_{jk} \ln w_j \ln w_k + \Theta Z + \gamma T + \varepsilon_1, \qquad [6]$$

where w_i are input factor prices including wage of dentists (w_1), wage of hygienists (w_2), and office price (w_3), corresponding to the three inputs in our model, dentists, hygienists, and office space; T is a vector of year indicators; Z is a vector of non-input cost shifters including practice location (urban or rural area), corporate structure (incorporated or unincorporated), and an indicator of public program participation; and ε is the error term. From the cost function given by equation [6], we derive the marginal cost functions:

$$MC_d = \partial C/\partial y_d = (C/y_d)(\partial \ln C/\partial \ln y_d) = (C/y_d)(\alpha_d + \beta_d \ln y_d + \beta_{dh} \ln y_h + \Sigma^3_{j=1}\beta_{dj} \ln w_j) \qquad [7]$$

$$MC_h = \partial C/\partial y_h = (C/y_h)(\partial \ln C/\partial \ln y_h) = (C/y_h)(\alpha_h + \beta_h \ln y_h + \beta_{dh} \ln y_d + \Sigma^3_{j=1}\beta_{hj} \ln w_j). \qquad [8]$$

It is common to add the factor demand functions into the system to increase efficiency (as the factor demand functions are the derivative of the cost function with respect to the factor prices, the parameters of the factor demand functions are restricted to be identical to the

corresponding parameters in the cost function). Differentiating the cost function with respect to input prices (and applying Sheppard's Lemma) yields the input factor share demand equations for dentists and hygienists, respectively:

$$\partial \ln C/\partial \ln w_1 = (w_1/C)(\partial C/\partial w_1) = (w_1/C) X_d = \alpha_1 + \beta_{d1} \ln y_d + \beta_{h1} \ln y_h + \beta_{11} \ln w_1 + \beta_{12} \ln w_2 + \beta_{13} \ln w_3 \quad [9]$$

$$\partial \ln C/\partial \ln w_2 = (w_2/C)(\partial C/\partial w_2) = (w_2/C) X_h = \alpha_2 + \beta_{d2} \ln y_d + \beta_{h2} \ln y_h + \beta_{21} \ln w_1 + \beta_{22} \ln w_2 + \beta_{23} \ln w_3. \quad [10]$$

Note that the factor shares sum to 1 so no information is gained by including the third input, office space.

We estimate the translog cost function parameters simultaneously by the seemingly unrelated regression of three equations [6], [9], and [10], imposing the following cross-equation restrictions for the cost function to be homogeneous of degree one and symmetric in factor prices:

$$\Sigma^3_{j=1}\alpha_j = 1$$

$$\Sigma^3_{j,k=1}\beta_{jk} = 0$$

$$\Sigma^3_{j=1}\beta_{dj} = 0$$

$$\Sigma^3_{j=1}\beta_{hj} = 0$$

Because of our use of imputed variables (described in the next section), we apply the bootstrap for all standard errors in our regression models.

To complete the estimation procedure, we require estimates of the demand curve for both dental visits and hygienist visits. We estimate models of the form:

$$y_i = \gamma_0 + \gamma_i P_i + \Lambda X_i + \tau + \varepsilon_i, \quad [11]$$

where *i* represents dentist or hygienist visits, *P* is the market price for each type of visit, X represents a vector of demand shifters, τ is a set of year dummies, and ε is an error term.

IV. Data

We use data from the American Dental Association (ADA) Survey of Dental Practice (SDP) for the years 1982 to 2012. The SDP is an annual survey conducted by the ADA sent to a random sample of general practitioners and specialists in private practice across the U.S. The sample is drawn with a simple random probability method, from the ADA Sampling Frame which includes all active dentists who graduated from an accredited dental school in the U.S. and work in private practice (regardless of ADA membership). The response rates vary from 30 to 50 percent (Vujicic, Lazar, Wall, & Munson, 2012). The questionnaire includes a core set of questions that remain roughly unchanged over the years (with some important exceptions described below) and other questions that vary depending on whether a short form or long form version of the survey was administered in the given year.

The survey contains both individual dentist questions and practice-level questions. For estimation of the cost model the practice-level questions are most relevant. Practice characteristics include practice expenses, gross income (annual billing), staffing, location, ownership, office space, patient visits, and participation in public programs (e.g. Medicare, Medicaid, and other public insurance).

The variables needed to estimate the cost function are the practice cost (total expenses), outputs (dentist visits and hygienist visits), input factor prices (dentist wage, hygienist wage, and office price), and two of the three input factors demand (number of dentists and hygienists). Output variables are calculated from weekly dentist visits (combining scheduled visits and emergency/walk-in visits) and hygienist visits both multiplied by 52 to annualize. Dentist and hygienist wages are reported, while office price is calculated from the expenses for rent and/or mortgage divided by the number of office square feet.

Unfortunately, not all years provide the necessary data fields to estimate our cost function; moreover, missing practice-level variables is also a concern. Information to construct office price data is not collected in 11 of the 31 years and is missing in other instances; we are thus missing measures of office price in 70% of cases. Dentist and hygienist wage variables, although administered in all years of data, have high missing rate (30% and 67%, respectively). Hygienist variables are missing in instances when the practice does not employ a hygienist. We impute the office price variable by using predicted prices based on the regression of observed price on state indicator and year. For the dentist and hygienist wage variables, we impute the missing values by using a nearest neighbor approach controlling practice size and year. The nearest dental offices for each observation is set by using latitude and longitude obtained from ZIP Code. Using imputed input prices increases the number of observations that can be included in the estimation from 9,860 to 24,611.

The demand function requires including the dentist and hygienist visit prices, which are available in the survey in selected years. In nearly half of the years of available data, the survey contains information on fees charged by a practice for procedures such as periodic oral examination, prophylaxis, amalgam restoration, and other common dental procedures. We use

the fee variables to construct weighted price measures for dentist and hygienist visits. The weights are created based on survey questions on the percentage of time devoted to each procedure. To account for missing values of dentist and hygienist prices, we use the 14 years of available visit price data to create a regression model to obtain predicted dentist and hygienist visit prices for the whole data set.

Control variables for the cost and demand function include indicators of urban location, corporate practice, public programs participation, and practice size. We create the urban location indicator based on reported zip code of the practice and the Rural-Urban Commuting Area Codes.

Missing data is a concern in our data. Observations with missing data tend to represent larger practices on average: they have more dentists and dentist visits, higher dentist and hygienist wage, are more likely to locate in urban areas, and are more likely to be incorporated and accept public insurance patients. Missing observations also tend to have higher prices for dentist visit and hygienist visit. The differences between included and excluded observations can potentially lead to bias. As the SDP asks sampled individual dentists about the entire practice, owner dentists may not want to report all their business details and employed dentists may leave the questions of entire practice unfilled. Despite the potential limitations, the SDP is a unique resource for studies of the dental market and remains the best data source available to address our research questions.

V. Results

Table 1 reports descriptive statistics of practice characteristics. All dollar values have been converted to 2011 real dollars. Total practice cost averages just under $600,000. Practices averaged just under 4,000 dentist visits and about 2,700 hygienist visits. The average number of dentists and hygienists per practiced both averaged 1.5, but the trend over time has been towards larger practices (see Figure 1). Dentist and hygienist wages averaged $217,000 and $39,000, respectively, and have generally risen over time in real terms (see Figure 2). Half of practices are incorporated and the large majority in the sample are located in urban areas. Dentist prices averaged $363 and hygienist prices averaged $47.

Table 2 presents the results of cost function estimated using the translog function. Note that simultaneous estimation was conducted for equations [6], [9], and [10], representing the cost function itself plus two input factor demand functions (derivatives), in a three-equation seemingly unrelated regression that imposed the relevant cross-equation restrictions. The translog cost function parameters are somewhat difficult to interpret in isolation, particularly given the host of interaction terms. We will use the estimates, however, to derive key measures related to the dental market below. The results also show that urban area location and being incorporated were associated with higher practice cost.

Table 3 reports the parameters estimated from the dentist and hygienist visit demand functions. The result shows that the demand function is non-increasing in prices. Incorporated practices, larger size practices, and practices that accept public insurance have significantly more dentist and hygienist visits than their counterparts. Interestingly, practices located in urban areas have more hygienist visits and fewer dentist visits than practices located in rural areas, though

the urban effect for dentists is not statistically significant. Though not displayed in the table, the demand for dentist visit decreases over time especially from 1993, while the demand for hygienist visit keeps increasing starting from 1988.

Table 4 displays summary results computed from the coefficients in the cost function and demand functions. We use the coefficients estimated from the cost functions to calculate the marginal cost of dentist and hygienist visits for each observation using equation [8]. Next, we use the marginal cost estimates, the average price of dentist or hygienist visit, the derivative of the demand function with respect to price, and the number of dentist or hygienist visit to compute equation [5] to estimate the market power index θ for each observation. We derive two separate market power indices, one for dentists and one for hygienists. Using the results of the cost function, we can compute returns to scale using the formula above. For returns to scale, we compute them by quartile of visits to examine the heterogeneity of returns to scale by the size of the practice. Finally, we bootstrap the whole system of estimations to obtain appropriate standard errors for the marginal costs, the first derivative of the demand functions, the market power indexes, and returns to scale.

On average, the marginal cost of a dentist visit is $30 estimated by the translog function; the marginal cost of a hygienist visit is $67. We use the results to calculate the price elasticity of demand at the mean of prices and quantities using the formula: $Elasticity = \frac{P_i}{y_i} \times \frac{dy_i}{dP_i} = \frac{P_i}{y_i \times D_{1i}}$.

The price elasticity of demand for dentist visits and hygienist visits are nearly identical at -0.38 and -0.39, respectively; both estimates suggest inelastic demand for dental services. The price elasticity of roughly -0.4 is at the somewhat higher end of elasticity range of -0.04 to -0.75 (generally centers around -0.2) found in general medical care by the RAND HIE (Newhouse

1993) and other studies (Ringel et al. 2002). The elasticity of -0.4 is also higher than the range of -0.03 to -0.19 elasticity of demand for dental visits found in New York and Pennsylvania household data in 1971-1972 (A. G. Holtmann and Olsen 1976).

The computed market power index for dentist services is 0.54, which is significantly above 0 (the benchmark for perfect competition). While significantly less than 1 (the benchmark for monopoly), the index suggests considerable market power for dentists. The index implies that the dentists have some degree of market power to markup price above marginal cost. By contrast, the market power index for hygienist services is negative (-0.28), suggesting that dental practices are pricing hygienist services below marginal cost. Moreover, the negative power index for hygienist services seems contradict to the inelastic demand for hygienist visits found above. However, if dental services and hygienist services are bundled and hygienists are not authorized to directly bill their services as in some states, the dental practices may intentionally lower the hygienist visit price to attract more patients to their practice. The observed relationship would be consistent with a policy dental practices using hygienist services as a "loss leader" in order to attract customers to more lucrative dental services.

The overall returns to scale parameter of 2.1 suggests significant increasing returns to scale are available to the typical dental practice. Given that the typical practice has 1.5 dentists, this is perhaps not surprising. Table 4 also displays results stratifying returns to scale by quartile of dental visits. While the smallest quartile of practices has large returns to scale, not surprisingly returns to scale decreases with size. The highest quartile of practices still has meaningful increasing returns to scale at roughly 1.6.

VI. Conclusion

The study brings together over three decades of dentist survey data to examine market power of dentists and hygienists in private practice via their pricing behavior given the practice cost structure and the demand for their services. We find two different structures in the dental care market: while the hygienist market exhibits pricing below marginal cost, the dentist market has a monopolistically competitive structure where practices have some market power to price above marginal cost. However, both dental and hygienist services have similar elasticities of demand, at roughly -0.4, which is in line with previous research. Given that dental practices are multiproduct firms, it could be that hygienist services are used as loss leaders to create an opportunity to provide more lucrative dental services. Further investigation especially on the demand side using more precise price information is needed for better understanding of any structural change in the market that affect competition and pricing behavior. Moreover, future work that marries explicit measures of patient dentist choice with measures of dental firm structure would be highly fruitful in this space.

Another theme that emerged from our findings is the evidence for significant economies of scale available in the dental market. Group size is increasing over time, yet even the top quartile of practices has a returns to scale parameter of 1.6. The question is why do such scale opportunities appear to persist. It could be that dentists have limited access to capital markets given Corporate Practice of Dentistry laws that limit ownership (and investment) in dental firms to other dentists. Such restrictions may serve to keep dental firms smaller than they otherwise would be. Alternatively, it could be that dentists have a preference for small independent practice organization, in which case practices might be smaller than what would otherwise appear to be optimal. However, recent trends suggest that dental practice size is on the rise (Wall and Guay

2015). Thus it could be the case that market forces are driving the dental market to follow the medical market with consolidation and increasing practice sizes.

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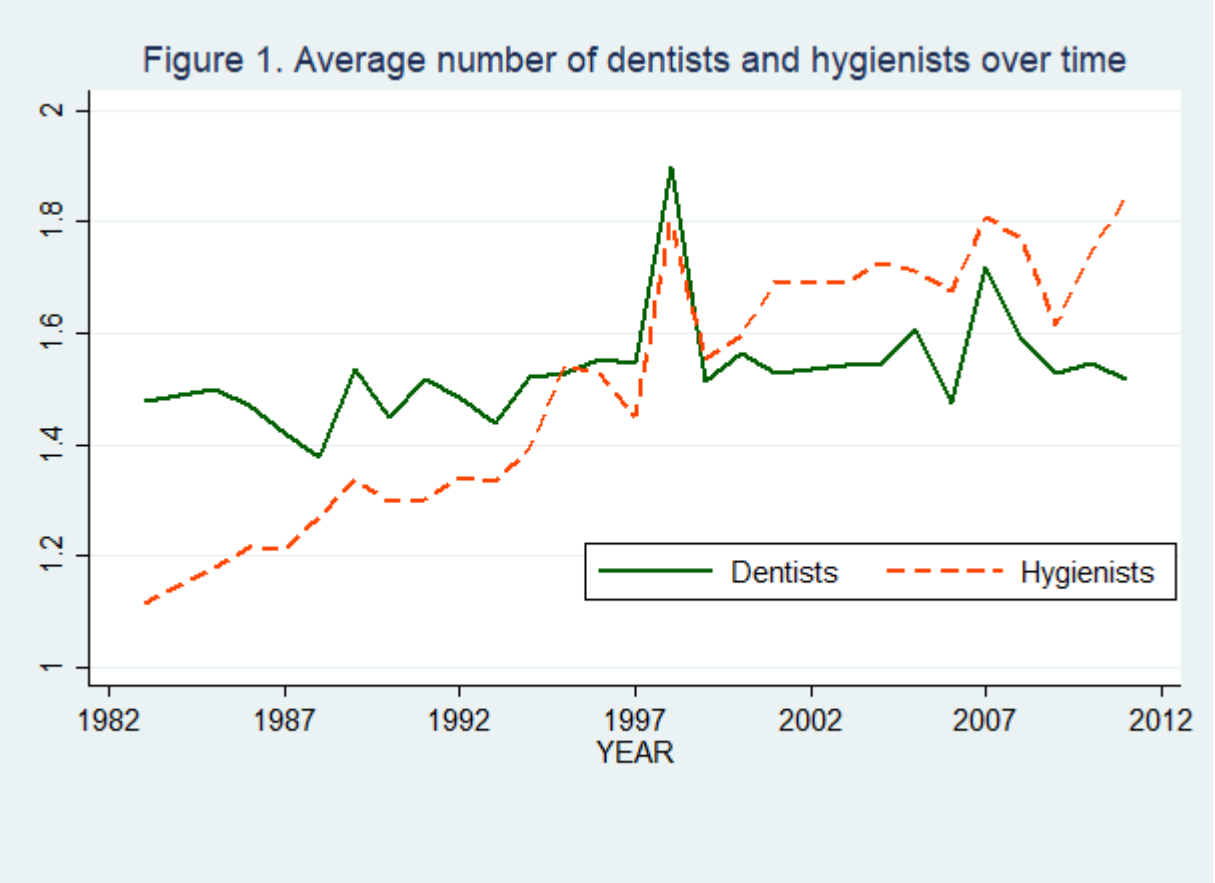
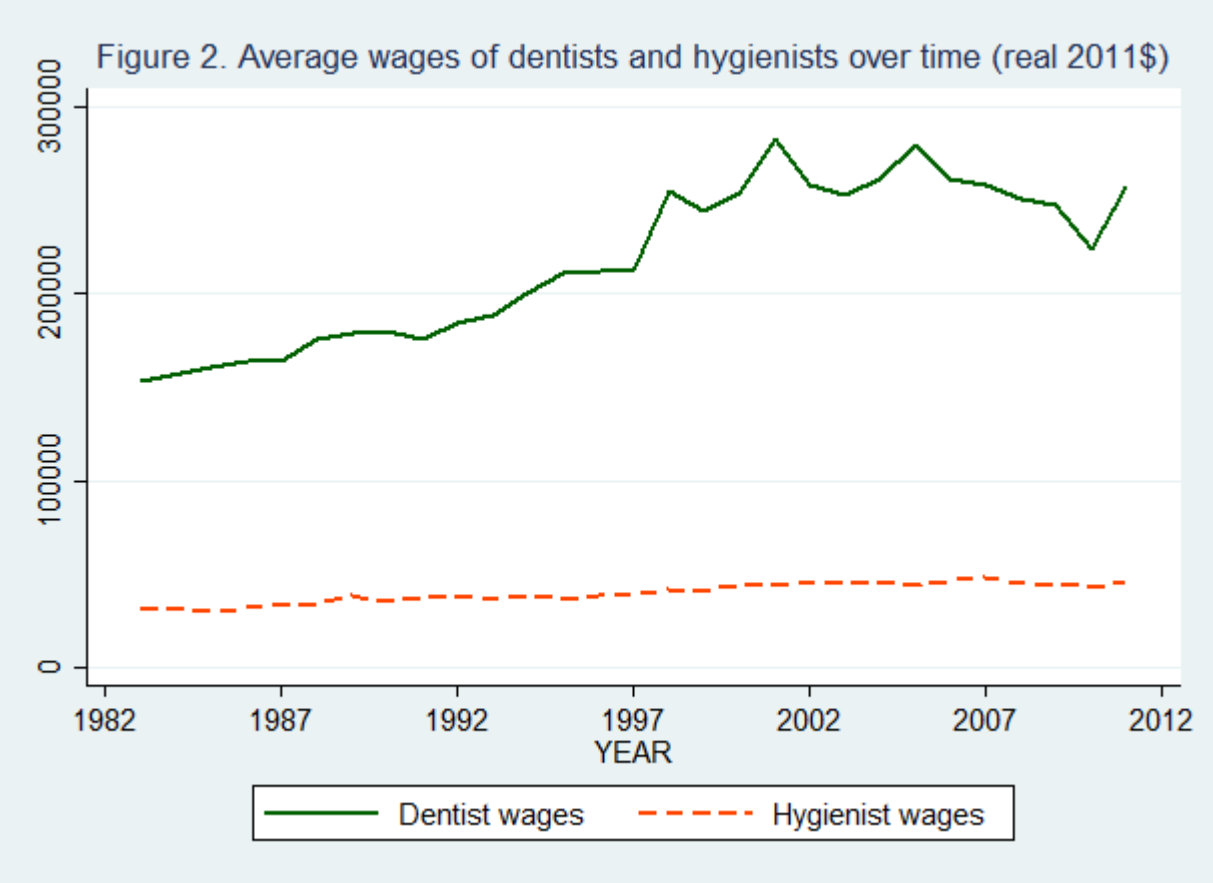


Notes: N=19,354. Estimates from Survey of Dental Practice, 1982-2012.



Notes: N=19,354. Estimates from Survey of Dental Practice, 1982-2012.

Table 1: Descriptive statistics

Variable	Mean	SD	Min	Max
Total cost (C)	588,214.40	598,950.70	2.23	18,800,000.00
Dentist visits (Yd)	3,988.32	3,910.77	52.00	163,800.00
Hygienist visits (Yh)	2,741.46	2,864.08	52.00	104,000.00
Dentist wage (W1)	217,083.30	132,798.40	12,826.17	797,824.90
Hygienist wage (W2)	39,308.53	17,693.00	5,045.36	89,308.77
Office price (W3)	630.03	242.61	235.00	1,940.00
Number of dentists (Xd)	1.53	1.31	1.00	45.00
Number of hygienists (Xh)	1.49	1.14	0.50	38.00
Urban	0.82	0.38	0.00	1.00
Incorporated	0.49	0.50	0.00	1.00
Public insurance	0.39	0.49	0.00	1.00
Dentist visit price (DPi)	362.55	71.86	163.90	724.48
Hygienist visit price (HPi)	47.11	11.59	27.88	93.49

Notes: N=19,354. Estimates from Survey of Dental Practice, 1982-2012.

Table 2: Translog cost function estimates

Variable	Definition	Coefficients	SE
lnYd	Natural log of dentist output (visits)	-0.601***	(0.125)
lnYh	Natural log of hygienist output (visits)	-0.347**	(0.123)
lnYd2	lnYd squared	0.0819***	(0.00583)
lnYh2	lnYh squared	0.0157	(0.00905)
lnYdlnYh	lnYd*lnYh	-0.0169	(0.0146)
lnW1	Natural log of dentist wage	0.301**	(0.113)
lnW2	Natural log of hygienist wage	-0.129	(0.167)
lnW3	Natural log of office price	0.828***	(0.185)
lnYdlnW1	lnYd*lnW1	-0.0473**	(0.0180)
lnYdlnW2	lnYd*lnW2	-0.0194	(0.0163)
lnYdlnW3	lnYd*lnW3	0.0667**	(0.0227)
lnYhlnW1	lnYh*lnW1	0.00156	(0.0147)
lnYhlnW2	lnYh*lnW2	0.125***	(0.0184)
lnYhlnW3	lnYh*lnW3	-0.126***	(0.0215)
lnW12	lnW1 squared	0.0646***	(0.0105)
lnW22	lnW2 squared	0.00532	(0.0121)
lnW32	lnW3 squared	-0.0210	(0.0158)
lnW1lnW2	lnW1* lnW2	-0.0910***	(0.0180)
lnW1lnW3	lnW1* lnW3	-0.0383*	(0.0189)
lnW2lnW3	lnW2* lnW3	0.0803***	(0.0220)
Urban	Urban/rural	-0.0197	(0.0108)
Incorporate	Incorporated/Non-incorporated	0.397***	(0.00883)
Constant		6.348***	(0.665)

Notes: N=19,354. Bootstrapped standard errors in parentheses. Estimates from Survey of Dental Practice, 1982-2012. Model includes year dummies [not displayed]. Cost function estimated jointly via SUR with implied input factor demand equations for dentists and hygienists, with appropriate cross-equation restrictions imposed [not displayed].

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Dental and hygienist visit demand function results

Variable	Coefficients	Standard Errors	Coefficients	Standard Errors
	Dentist visit		Hygienist visit	
Dentist visit price	-7.260	(3.937)	--	--
Dentist visit price squared	0.0122*	(0.00561)	--	--
Hygienist visit price	--	--	-10.29	(14.57)
Hygienist visit price squared	--	--	-0.0533	(0.136)
Urban/rural	95.71	(57.79)	274.2***	(43.31)
Incorporated/Non-incorporate	1220.6***	(44.57)	821.1***	(45.92)
Public insurance participation	997.3***	(60.69)	401.2***	(51.83)
Constant	4074.8***	(671.8)	1700.5***	(353.5)

Notes: N=19,354. Bootstrapped standard errors in parentheses. Estimates from Survey of Dental Practice, 1982-2012. Model includes year dummies [not displayed].

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Estimates derived from translog cost function

Definition	Coefficients	Standard Errors
Marginal cost of dentist visit	30.2158	(1.0527)
Marginal cost of hygienist visit	67.0299	(0.4965)
1st derivative of dentist visit demand	-2.8443	(0.0063)
1st derivative of hygienist visit demand	-12.7976	(0.0044)
Dentist market power index	0.5376	(0.0505)
Hygienist market power index	-0.2811	(0.0532)
Dentist visit elasticity	-0.3810	(0.0044)
Hygienist visit elasticity	-0.3882	(0.0036)
Returns to scale (overall)	2.1401	(0.0615)
By quartile of visits:		
Q1	3.1445	(0.3559)
Q2	2.2067	(0.0129)
Q3	1.9426	(0.0074)
Q4	1.6200	(0.0185)
Sample size	19,354	

Notes: Values computed based on estimates contained in Tables 2 and 3. Bootstrapped standard errors in parentheses.