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ABSTRACT

The effect of licensing as a mechanism to control entry into occupations has been a neglected area of both regulation and labor market research. This study examines the role of occupational licensing for entry into dentistry, an occupation with standards that vary by state. Our research first closely replicates Freeman's previous work on labor market cobwebs by employing national data to examine purely market phenomena in the determination of training for the dental profession. We subsequently approximate the government barrier to practice in the profession by adding a weighted average state examination pass rate to the previous model. Next, we employ pooled cross-section time series analysis to explore market determinants of professional entry with state level data. Finally, these results are supplemented by measures of statutory and pass rate entry restrictiveness. Our most consistent evidence suggests that a higher state licensing failure rate deters entry into dental practice.

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Introduction

The growth of occupational licensure from approximately 3% of the labor force in 1950 to almost 18% in 1989 has been among the most dramatic changes in labor market regulation (Kleiner, 1990). Yet the impact of this institutional change on the labor market response of individuals affected by licensing, beyond wage changes and mobility, has received relatively little recent attention by economists (Rottenberg, 1981; Kleiner and Petree, 1988). This paper analyzes occupational entry in the labor market for the professional services of dentists. Unlike medical doctors, dentists must pass a separate licensing examination specific to the jurisdiction in which they wish to practice. This paper will examine the way in which licensure interacts with other variables to affect the supply of dentists both nationally and state-by-state.

The cobweb model, which has been adapted to the labor market by Richard Freeman, is the best-known approach to evaluating responsiveness of entrants to professional training (1975(a), 1975(b), 1976). The underlying rationale for the cobweb model is that future labor market conditions are so difficult for an individual to forecast that entry decisions are made on the basis of present conditions. The supply response to temporarily high earnings draws people into training for a certain line of work. These entrants, in turn, depress earnings and lower the number of entrants in subsequent periods. Just as in the classic agriculture cycle, supply lags generate cobweb responses.[1]

[1] Both logic and evidence support stable cobweb adjustments (for a discussion, see Freeman, 1971:16-32).

In his research in the 1970's, Freeman used these models to study lawyers, physicists and college graduates.[2] He was always careful to acknowledge both the theoretical and empirical limitations of this approach. In recent years, other models have rejected the assumption that supply responsiveness to immediate economic prospects provides the best possible methodology (Siow, 1984; Zarkin, 1985; and Orazem and Mattila, 1991). In particular, future demand conditions modelled through a rational expectations approach might improve upon a cobweb analysis. For example, Zarkin argues that rational expectations results obtained for primary and secondary school teachers may be particularly appropriate because future demand is so easily forecast by using straightforward demographic techniques. In the case of dentistry, however, many contrary forces have affected demand in recent decades (see Kudrle and Meskin, 1983), and forecasting the future demand for dental services, either at the state or national level, could present considerable difficulty for a potential practitioner of dentistry.[3] Moreover, a rational expectations analysis at the state level would be precluded due to data limitations. Instead, we begin with the familiar cobweb approach and modify it to take into account the fact that dentistry is a heavily regulated occupation.

This paper has two major parts and several subsections. First, it closely replicates the earlier cobweb models to make them appropriate for entering and graduating dental

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[2] In this model career decisions are made such as to maximize the functional form:

$$\underset{i}{\text{Max}} U(X_i, w_i + W)$$

where U is an indirect utility function, X_i is the job characteristic vector of occuption i, w_i is lifetime earnings in job i, and W is non-wage income (Freeman, 1971:3).

[3] The key determinants of dental demand over the past fifty years or so have been income, education, technological change (e.g., orthodontics), tastes (e.g., personal hygiene), and public policy (i.e., fluoridation). Thus, models that may be applicable for teachers would be much more problematic for this occupation.

school students at the national level. The model is then expanded to include a weighted average pass rate as an index of the additional difficulty of becoming a dentist once dental school has been completed. The next section of the paper explicitly recognizes the state level elements of the labor market by including subnational measures of economic conditions and licensing.

THE MODEL AND DATA

In this section of the paper we present the basic cobweb model and develop the rationale for our modifications to it. Freeman's initial exploration of the market for lawyers ignores that the practice of law is also a regulated profession whose "port of entry" is guarded by the states. Formally, his work therefore suffers from omitted variable bias, which could push the coefficients upward and spuriously increase the statistical significance obtained from variables in the model. More than the law, dentistry presents a strong a priori case that varying licensing restrictiveness could affect the choice of profession. Most jurisdictions give a dental exam no more than twice a year and sometimes only once. Hence, the cost of failing a dental examination and not being allowed to practice for six months or a year would be substantial. Moreover, we expect that variations in the difficulty in passing the exam will affect the flow of dentists into dental practices in various states.

The model we propose amends earlier work on occupational entry by adding a set of variables to capture various dimensions of occupational restrictiveness and their severity, thus reducing one source of potential omitted variable bias. The three major elements of restrictiveness we examined were: the pass rate on state licensing exams, whether or not the state had a citizenship requirement for practice (a dummy variable),

and the number of years since there was a major change in the state's dental practice act.

The first variable is both the most obvious and the most difficult to deal with. Put most simply, an 80 percent pass rate in California and in Wyoming may not be measuring the same thing. Hence, cross-sectional or pooled data analysis of the kind we employ may be incorrectly specified unless that problem is addressed with a selectivity bias correction (Murnane, Olson and Newstad, 1985). Citizenship is a rather blunt but obvious restriction, and stability of the states' Dental Practice Act suggests a less risky professional environment.

The cobweb model as specified by Freeman for a cohort entering professional training, revised to include licensing restrictions, can be written as:

1) $ENT(0) = a_1\lambda SAL(0) - a_2\lambda ASAL(0) - a_3\, RES(0) + (1-\lambda)\, ENT(-1) + \epsilon_1$

Where:

ENT is first year enrollees.

SAL is starting salaries in the dentist profession

ASAL is an index of starting salaries in alternative occupations

RES is a measure of restrictiveness

( ) is the time period

The model shows supply adjusting only partially to changed conditions with the speed of adjustment determined by λ.

For completion of training, the equation would be written as:

2) $GRAD(t) = b_1[SAL(t-n+1) + \ldots SAL(t-1)] - b_2[ASAL(t-n+1) + \ldots$

$ASAL(t-1)] - b_3[RES(t-n+1) + \ldots RES(t-1)] + b_3 ENT(t-n) + \epsilon_2$

Where n=years of professional training

The second equation explicitly recognizes that a person's completion of training will depend on conditions prevailing during the training period. Most of the data on current and future dentists comes from the American Dental Association. Its Survey of Dental Education, published annually, provides high-quality data gathered from the nation's approximately 70 dental schools. The data show the home addresses of all dental students with the information for all first year dental students shown separately. These data, of course, do not directly tell us about where a person ultimately intends to practice and hence where changes in state conditions -- salaries, opportunity cost, or restrictiveness -- should provide foci of concern for persons entering the profession.

In the data analysis that follows in which first year data are employed, it is assumed that each student is gearing decisions to the conditions in the state of declared residence during the first year of dental school. It could be argued that even if the student does not ultimately plan to practice in the home state, conditions in that state would be most influential in forming opinions about the general situation in dentistry. Because it is overwhelmingly likely that new dentists are concerned at least somewhat with the conditions elsewhere, we also include in our state level estimating equations measures of national remuneration from dentistry, the national opportunity cost of dental practice, and average national pass rate.

We have a completely separate set of data, also from the ADA, that provides the addresses for all new dentists (i.e., licensed or not). In the analysis employing these data we make virtually the opposite assumption from the previous case. Instead of assuming that a future dentist from Iowa, who is attending dental school in Minnesota, intends to

return to Iowa and hence views conditions in Iowa as determinative of the relevant market conditions for future dentists, we assume that the state in which the dentist actually first practices is the one that was the object of major attention during all of the previous years. The use of two separately gathered data sets serves as a check on the potential biases of using each data base separately.

In the national model, we can replicate the initial occupational entrance approach advanced by Freeman into professional training and graduation by simply adding an additional variable for licensing stringency: the weighted average pass rate.[4] In the state level analysis, the model is necessarily more complicated because of the options provided for dental practice and other employment in fifty different jurisdictions. Moreover, our data sets do not permit the examination of state-assigned cohorts as they proceed through dental school. Hence, equation (2) cannot be directly replicated. The basic partial adjustment model for the pooled cross-section time series investigation is:

$$3) \quad ENT_i(0) = a_{1i}\lambda SAL_i(0) - a_{2i}\lambda ASAL_i(0) - (1-\lambda)ENT_i(-1) + \lambda RES_i(0) + a_3\lambda SAL(0) - a_4 ASAL(0) + a_5\lambda RES(0)$$

where i indicates the state under consideration and the unsubscripted variables indicate national conditions. The alternative data set requires only a slight modification. $NEW_i(4)$ is substituted for $ENT_i(0)$ as the dependent variable and $NEW_i(3)$ replaces $ENT_i(-1)$ on the right hand side, where NEW are new dentists in the state. Also, due to

[4] Given the nature of these statutory data, the aggregation to the national level would likely lead to muddled results. Furthermore, the variables for restrictiveness variables, citizenship requirements and stability in state dental practice acts were insignificant in the individual state regressions and were not employed in the national regressions.

state level data limitations on ASAL, it is the average per capita earnings of persons in the state rather than beginning salaries.

ESTIMATES FROM THE MODEL

In this section of the paper we estimate alternative specifications of a cobweb model of labor supply for dentists when licensing restrictions are taken into account. We provide basic tabulations from the data in Table 1. In Table 2 estimates showing the results of a national cobweb model that uses time series estimates of licensing pass rates as a variable are provided. Table 3 presents estimates of state level cobweb models in order to test for the robustness of the results at the subnational level. In Table 4 results are shown for a state-level cobweb model that accounts for alternative types of state licensing provisions and pass rates.

Table 1 presents the means and standard deviations for the labor market and licensing variables we use to estimate the national and state cobweb models. These data show considerable variation in the various labor market variables. There is, for example, over a $9,156 standard deviation in constant dollar dental incomes, and also a $1,908 standard deviation in earnings of new college graduates over the time period 1960 to 1984. Additionally, the three major occupational licensing variables: pass rates, citizenship, and years since the statute was changed, show considerable variation over time and across states. There is also considerable change in the number of dental enrollees and graduates during the different time periods we analyzed. Since we were able to obtain licensing information and complete labor market data for only the 30 most populous states, our analysis is somewhat limited. These states, however, account for over 90 percent of all dentists in the U.S. with no a priori reason to suggest different

labor market responses for the remaining dentists. An examination of data from these states suggest that there is variation in regulatory restrictiveness and that these variables have the potential to influence the labor market responses of individuals choosing where to practice.

In Table 2 we report a national cobweb model of the labor market for dentists, similar to ones estimated by Freeman for lawyers (Freeman, 1975). The results shown for both enrollees and new dentists imply that the basic cobweb model is reasonably robust in explaining variations in new enrollees and in new dentists even when varying specifications of lagged values are used.[5] In columns five and six we replicate Freeman's lagged adjustment model for dentists shown in our equation (2), which include average salaries for the total period of professional education (Freeman, 1975). In columns four and five we anticipate the model used for data availability reasons in the state-level results that follow. Instead of lagged enrollments, as an explanatory variable we employ lagged new dentists.

Columns two, four and six show the estimates of the model when occupational licensing provisions are taken into account. We use the yearly national pass rate as our measure of licensing over time since we can directly estimate the potential costs to individuals who fail the state level exam.[6] Our results show that occupational licensing

[5] The choice of appropriate lags vary since some dental school requirements vary from three to four years. Therefore, we used both three and four year lags in our estimation procedure for national and state estimates to test for sensitivity and found consistent results. Models with three-year lags are shown; estimates with four year lags are available from the authors.

[6] The estimated cost to individuals who fail the exam was approximately $35,000 in 1984. This estimate was derived by assuming that the individual becomes a licensed dentist by passing the exam the next time it is given, which is about every six to twelve months, and the individual works as a dental assistant during the intervening period. The estimate includes lost earnings growth of about one percent for the next five years due to lost experience and normal earnings growth (Polachek, 1981).

as proxied by pass rates are always positive and usually significant in influencing new enrollees and the number of dental graduates at the national level. However, since dental licensing is a state-by-state-process, it may be difficult to fully capture the differences in "national" dental licensing statutes and administrative procedures.[7]

National estimates of the impact of licensing pass rates provide evidence of the impact of regulation on occupational choice, but they fail to capture licensing as a state by state process. The decision to enter an occupation within a particular jurisdiction is influenced by state economic conditions as well as the licensing practices that exist in that state. Therefore, to model the potential impact of state policies on occupational choice and entry more accurately we estimated occupational choice and entry cobweb models at the state level.

The results of the partial adjustment model are shown in Table 3 for both dental enrollees and new dentists. The model's specification is consistent with the basic cobweb model, but we expanded it to allow pooling of time-series and cross-section data as well as having the national dental and state labor market variables as controls.[8] More specifically, we control for the year, state-specific fixed effects and endogenous variables that are part of the basic model. We also estimate the model with a Newey and West covariance matrix which corrects for autocorrelation and heteroskedasticity in pooled

[7] We also estimate all our results as a quadratic function with pass rates and pass rates squared and find little change in our basic results. However, the use of the quadratic formula produces a significant coefficient value of .56 for dentists, while the values for enrollees are not statistically significant.

[8] We also estimate the model employing deviations from national trends. Estimates using a deviation from the national average approach produced the same qualitative results as in Tables 3 and 4.

time-series analysis (Newey and West, 1987).[9] These sensitivity tests show that our results are robust across data sets and econometric specifications.

The estimates at the state level are generally as robust as the national estimates. For example, salary estimates for dentists are significant and positive for enrollees. Further, measures of opportunity costs or earnings of individuals in the state are significant and negative as hypothesized. Collinearity between state and national dental incomes and estimated opportunity costs quite understandably render the discovery of state specific effects more problematic. Table 3 reports results with the national variables both omitted and included. For new dentists, the national labor market variables seem to dominate the state level ones in choosing the occupation. Overall these results strongly corroborate the general appropriateness of the cobweb approach while confirming the importance of state level variables including licensing restrictiveness.

The results of a similar model expanded to include measures of occupational licensing statutes and pass rates along with a selectivity adjustment variable are presented in Table 4. First, the coefficients for dental salaries in the state remain as hypothesized and are generally significant. Second, the most important licensing variable is the pass rate. The coefficients for citizenship and the time since the statute was changed, in columns three and six, are not different from zero and are consistent with prior studies.[10] Further, the introduction of a selectivity adjustment for the number of persons taking the exam in the state does not change the basic finding of the impact of

[9] Estimates without Newey-West corrections show no qualitative changes in our results.

[10] This result is consistent with other empirical studies of the impact of licensing statutes on economic variables (Pashigian 1980; Kleiner, Gay and Greene 1982; and Kleiner 1990).

licensing pass rates.[11] We also checked for selectivity at time of enrollment by estimating the relationship between the number of applicants to dental school per enrollee lagged by three years, on the state pass rate. We found no significant results, (i.e., results had t-ratios of 1.00 or lower when the estimates are controlled by year).

The coefficient estimates for the pass rates in Table 4 show a positive and generally significant impact. In all our specifications for data gathered on enrollees or new dentists, the pass rate is positively associated with larger numbers of potential or new dentists in the state. For example, a one percent increase in the pass rate is associated with an increase in the number of new dental enrollees that plan to practice in the state using data over the period 1970 to 1984 of between .19 and .32 percent depending on the specification employed.

The results presented in Table 4 suggest that models of entry into state-licensed professions, such as dentistry, suffer from potential omitted variable bias if the role of state occupational regulation is not explicitly considered. Further, our results are robust; they show that pass rates on state administered exams have a significant influence in alternative specifications employing different data sets (i.e., the number of dental school entrants from the state and the number of new dentists to the state). In occupations where the state or its designees have significant control over the content of licensing exams and the scores required to pass them, this factor is an important variable that should be included in estimates of models of occupational choice and entry.

[11] The selectivity adjustment was estimated in a manner consistent with the "s method" developed by Murnane, Olson, and Newstad (1985). The value for the predicted number of individuals taking the exam was added to adjust for potential selectivity bias in the enrollment and new dentist equations.

CONCLUSIONS

This study has examined the impact of the stringency of occupational licensing provisions on the occupational entry of dentists. Developing and testing a cobweb model of occupational entry into dentistry without licensing related variables for occupational entry, we find that the model works reasonably well at both the national and state levels. We then introduce the role of state occupational licensing as a potential omitted variable. In a national time series model we find that licensing as measured by the pass rate is positive and usually statistically significant. Furthermore, at the state level in pooled cross section-time series models, we find that more restrictive licensing of dentists, as measured through the occupational pass rate, is positive and in most cases significant in influencing the number of new entrants and graduates of dental school programs. Our results suggest that economists who examine occupational entry in licensed occupations may have omitted variable bias by failing to include measures of occupational regulation. Further, this study adds to the evidence that state occupational licensing continues to have important labor market consequences for both practitioners and the public.

Table 1
Means and Standard Deviations for State Labor Market and Licensing Variables for Dentists, 1960-84
N = 720 for state and 24 for national results
(1982 dollars)

	Mean	Standard Deviation
Salary of Dentists	$63,015.00	9575.00
Salary of New Dentists	$35,024.00	5043.00
Salary of New College Grads	$20,843.00	1296.00
State Per Capita Income	$9,156.00	1908.00
Licensing Pass Rate - State (Percent)	83.45	7.06
National	87.62	4.84
States Having Citizenship Requirement (Percent) (1960-1978)	50.88	50.04
Number of Years Since The Statute was Amended (1960-1978)	4.80	4.45
Dental Enrollees (1960-1984)	4953.40	448.78
Dental Graduates (1960-1984)	4036.40	956.78
New Dentists (1960-1984)	3410.04	1074.18

Table 2
National Cobweb Estimates for Dental Enrollees (1960-84) and Graduates (1960-84)

	Enrollees (1)	(2)	Graduates (3)	(4)	(5)	(6)
Salary of New Dentists	.12 (.08)	.04 (.07)	.13 (.10)	.11 (.11)	.46 (.09)	.36 (.06)
Salary of New College Grads	-.24 (.19)	.00 (.15)	-.24 (.23)	-.16 (.25)	-.68 (.20)	-.41 (.13)
Pass Rate		.56 (.14)		.21 (.29)		.61 (.17)
Lagged Endogenous Variable	.94 (.04)	1.04 (.04)	.99 (.05)	1.04 (.08)		
Lagged Enrollment					1.11 (.05)	1.22 (.03)
Intercept	1.59 (1.48)	-3.19 (1.65)	1.09 (1.73)	-.76 (3.15)	.89 (1.64)	-4.39 (1.62)
R^2	.96	.98	.96	.96	.98	.98
D.W.	2.78	2.74	2.26	2.56	2.15	2.24

Standard Errors are in parentheses

All variables in logarithmic form

Table 3
State Cobweb Model Estimates for New Dentists (1960-1984) and Enrollee (1970-1984) Rates*

	New Dentists				Enrollees			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
State Salary of Dentists	.29 (.04)	.02 (.04)	.04 (.07)	.09 (.10)	.13 (.07)	.15 (.09)	.11 (.08)	.22 (.12)
Average Earnings in State	-.04 (.04)	-.20 (.06)	-.03 (.04)	.12 (.07)	-.07 (.07)	-.11 (.15)	-.13 (.07)	-.49 (.22)
National Salary of Dentists			.49 (.11)	.40 (.13)			.57 (.30)	-.06 (.20)
National Salary of New College Grads			-.42 (.36)	-.98 (.11)			.17 (.36)	.25 (.35)
Intercept	-3.71 (.51)		-3.08 (2.20)		-.21 (1.08)		-8.68 (4.90)	
Year	X	X	X	X	X	X	X	X
State Fixed Effects		X		X		X		X
Lagged Endogenous Variable	X	X	X	X	X	X	X	X
R^2	.96		.96		.98		.97	

Standard Errors are in parentheses

All variables in logarithmic form

* All estimates use Newey-West corrections for heteroskedasticity and autocorrelation and Hausman tests.

Table 4
State Cobweb Estimates for New Dentists and Enrollee Rates with Varying Licensing Provisions, 1971-1984*

	New Dentists			Enrollees		
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	21.56 (13.98)		25.25 (83.96)	-26.79 (20.47)		113.22 (71.97)
State Salary of Dentists	.14 (.07)	.09 (.09)	.39 (.19)	.13 (.10)	.29 (.15)	.36 (.16)
Average Earnings in State	.05 (.05)	-.15 (.16)	.09 (.12)	.00 (.07)	-.59 (.25)	-.20 (.12)
State Pass Rate	.09 (.06)	.46 (.08)	.46 (.18)	.26 (.10)	.19 (.12)	.32 (.16)
Provision for Citizenship			.003 (.020)			-.02 (.02)
Time Since Statute Was Changed			.01 (.02)			-.002 (.002)
With Controls For:						
Year	X	X	X	X	X	X
State Fixed Effects		X			X	
Selection Adjustment for Number Taking the Exam	X	X	X	X	X	X
Lagged Endogenous Variable	X	X	X	X	X	X
National Salary of Dentists	X	X	X	X	X	X
National Earnings of New College Grads	X	X	X	X	X	X
R^2	.99		.99	.99		.99

Standard Errors are in parentheses. All variables in logarithmic form.

* Estimates for columns (3) and (6) include only 1971-78. All estimates use Newey-West corrections for heteroskedasticity and autocorrelation and Hausman tests.

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