DOES REGULATION AFFECT ECONOMIC OUTCOMES? THE CASE OF DENTISTRY*

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Abstract

This study examines the role of variations in occupational licensing policies in improving the quality of services provided to consumers and the effect of restrictive regulations on the prices of certain services and on the earnings of practitioners. Theory suggests that more restrictive licensing may raise prices and at the same time raise demand by reducing uncertainty about the quality of the services. This article uses unique data on the dental health of incoming Air Force personnel to analyze empirically the effects of varying licensing stringency among the states. It finds that tougher licensing does not improve outcomes, but it does raise prices for consumers and the earnings of practitioners. These results cast doubt on the principal public interest argument in favor of more stringent state licensing practices.

I. Introduction

Do more restrictive occupational licensing statutes and administrative procedures enhance the quality of services received by consumers? Do more restrictive occupational licensing policies reduce the growth of practitioner supply? Do tougher occupational licensing provisions increase the prices of the services provided and raise the earnings of practitioners?

There are two major views on these questions. One perspective sees more restrictive licensing as an unnecessary barrier to occupational entry that mainly serves the interests of practitioners with little or no benefit to the

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public.[1] The main effects are assumed to be higher prices and, potentially, a negative effect on the quality of services received by consumers.[2] Another perspective focuses on the role that occupational licensing plays in reducing uncertainty in the minds of consumers about the quality of the product.[3] In this view, licensing is also seen as a way of encouraging the formation of human capital, the primary means to enhance the quality of services provided by the regulated practitioner.[4] Further, information asymmetry between sellers and consumers makes licensing a way of improving service quality. Additionally, according to this view, licensing improves outcomes by truncating the bottom of the quality distribution. Unfortunately, no rigorous empirical analysis has been able to address these competing effects for a major occupation in the United States. In this study we examine the effect of relatively more restrictive licensing statutes and administrative practices on the outcome of services rendered, the prices of those services, and the earnings of practitioners.

Occupational licensure has grown dramatically: in 1950 there were approximately 70 licensed occupations, but by the late 1970s there were over 500 covering about 18 percent of the U.S. workforce.[5] With the shift to a more service-oriented economy, the licensed sector is expected to grow more rapidly than the rest of the labor market.

Studies have compared the economic costs of state-by-state licensing to a system of nationwide endorsement, whereby practitioners licensed in one state are admitted to practice in all other states without additional restrictions.[6] A policy of nationwide endorsement represents a potential policy reform, since the proposal is often supported by a majority of the members of a profession relative to deregulation and could be adopted by national professional associations that would lobby regulatory boards.[7] Before such policies are recommended, however, the balance of economic costs and

[1] Lawrence Shephard, Licensing Restrictions and the Cost of Dental Care, 4 J. Law & Econ. 185 (1978).

[2] Milton Friedman & S. Kuznets, Income from Independent Professional Practice (1945).

[3] Kenneth J. Arrow, Essays in the Theory of Risk-Bearing (1971).

[4] Carl Shapiro, Investment, Moral Hazard and Occupational Licensing, 53 Rev. Econ. Stud. 843 (1986).

[5] Morris M. Kleiner, Are There Economic Rents for More Restrictive Occupational Licensing Practices? in Proceedings of Industrial Relations Research Association 177 (1990).

[6] B. Peter Pashigian, Has Occupational Licensing Reduced Geographical Mobility and Raised Earnings, in Occupational Licensure and Regulations 299 (S. Rottenberg ed. 1980); and Morris M. Kleiner, R. Gay, & K. Greene, Barriers to Labor Migration: The Case of Occupational Licensing, 21 Indus. Rel. 383 (1982).

[7] Charles J. Wheelan, Politics or Public Interest? An Empirical Examination of Occupational Licensure (unpublished manuscript, Univ. Chicago, May 1999).

benefits of the current system of occupational licensure needs to be examined more thoroughly.

Our analysis of occupational regulation employs a new data set developed for this study that merges individual health and socioeconomic characteristics of Air Force recruits. We find little support for the position that tougher state regulations for dentists are associated with improved quality of outcomes. Further, more general state-level estimates show that tougher regulations do not appear to influence either complaints to dental licensing boards or malpractice premiums, but they are associated with slower growth in the number of dentists in the state, higher prices for the services examined, and higher hourly earnings for dentists. These estimates are consistent with theoretical models of occupational regulation that imply higher costs to consumers with few benefits.

In this study, we analyze the effect of tougher occupational licensing standards on measured dental outcomes and on the prices of services. Initially, we review the empirical literature on occupational licensing, which mainly focuses on the costs to consumers resulting from restrictions to entry and to interstate mobility. Next, we present a model linking regulation to the flow of new dentists as well as to quality and prices. In the section that follows, we develop the concepts and the unique data on Air Force recruit dental exams and socioeconomic characteristics used to estimate that model. We then specify alternative multivariate statistical models of the effect of more restrictive licensing provisions: first, on the quality of dental outputs, and then on the prices of certain dental services as well as earnings. The conclusions summarize our key results and present tentative policy implications.

A. Previous Empirical Results

It has been suggested that too much research effort has been directed at the effects of barriers to entry into licensed occupations and too little on issues such as demand and the potential output effects.[8] Unfortunately, studies examining the potential benefits have been hampered by the difficulty of obtaining covariates or by other data limitations. Therefore, very few have investigated the benefits that different forms of licensing may have on the quality of services.

Table 1 shows that, until Arlene Holen's work in 1978, major economic studies of the regulation of dentistry ignored quality issues.[9] Previous stud-

[8] Lee Benham, The Demand for Occupational Licensure, in Rottenberg ed., *supra* note 6, at 13.

[9] Arlene Holen, The Economics of Dental Licensing (final report submitted to the U.S. Department of Health and Human Services 1978).

TABLE 1

SUMMARY REVIEW OF STUDIES ON THE ECONOMIC COSTS AND BENEFITS OF STATE OCCUPATIONAL REGULATION IN DENTISTRY

Study	Data and Technique	Measures of Costs and Benefits	Conclusions
Alex Maurizi, Occupational Licensing and the Public Interest, 82 J. Pol. Econ. 399 (1974)	Two pooled state cross sections (1940, 1950) of pass rates were regressed on estimates of excess demand and practitioner income	Decreased pass rates in response to excess demand are assumed to be against the public interest	Pass rate for dentists is found to correlate negatively and significantly with excess demand, but practitioner income is more significantly positive in the first year than negatively significant in the later year
Lawrence Shepard, Licensing Restrictions and the Cost of Dental Care, 4 J. Law & Econ. 185 (1978)	Five-equation model estimated with two-stage least squares employs state-level data for 1970 relating the price of dental services to reciprocity	Price increases resulting from lack of reciprocity measure cost	Lack of reciprocity raises average service prices by $1.87, resulting in a national cost estimated at $700 million in the mid-1970s
Arlene Holen, The Economics of Dental Licensing (1978)	Several measures of dental health, including the examination records of 477 naval recruits from 41 states in 1969, are explored with a series of OLS models employing the state dental exam fail rate as a measure of restrictiveness	Variation in decayed teeth as a fraction of the sum of the decayed, missing, and filled teeth measures quality benefits	A weakly significant negative coefficient on the pass rate suggests that more stringent dental licensing is associated with less dental neglect

Sidney L. Carroll & R. J. Gaston, Occupational Restrictions and the Quality of Service Received, 47 S. Econ. J. 959 (1981)	Several proxies for dental quality including self-described practice busyness and waiting times as well as the some of the same dental health data used by the Holen study, *supra*, are used in equations that first relate practitioner density to restrictiveness measured by a citizenship requirement or reciprocity and then density to the quality measure, employing state-level cross-section data. The less direct quality measures look at all 50 states for 1970; the dental health measure uses 29 states with 1969 data	Short waiting periods and a better oral hygiene index would indicate a possibly positive impact of restrictiveness	The length of work week and delays in seeing patients are positively and significantly related to practitoner density, which in turn is negatively related to restrictiveness as measured by citizenship; oral hygiene is negatively related to density, which, in turn, is negatively related to reciprocity
Brian Boulier, An Empirical Examination of Licensure and Licensure Reform on the Geographic Distribution of Dentists, in Occupational Licensure and Regulations (S. Rottenberg ed. 1980)	Two-stage least-squares estimates of constant elasticity supply and demand functions for dental services are developed using 1967 state-level data	Net benefit measured by changes in consumer surplus and producer welfare resulting from the interstate reallocation of (a fixed total supply of) dentists is estimated to be necessary to equalize service prices among states	Reciprocity, which is assumed necessary and sufficient to establish uniform prices among states, would create an increase in consumer surplus of $52 million in 1978 dollars and would increase producer welfare as well

ies implicitly held quality constant while concentrating attention on estimates of excessive prices or incomes resulting from greater restriction. In part of her work, Holen employed 1968 data on the dental condition of 477 naval recruits,[10] and, on the basis of one measure of quality (employing the number of decayed, missing, and filled teeth) and the use of the state's licensing pass rate to measure restrictiveness, she finds a positive effect of restrictiveness on quality.

A comparison of Holen's work with part of the analysis of dentistry presented by Sidney Carroll and R. J. Gaston[11] illustrates the difficulty of developing an adequate model of the costs and benefits of restrictiveness. Employing other data from the same clinical study that Holen used, Carroll and Gaston use an oral hygiene index (relating to the soft tissue surrounding the teeth rather than a measure of the condition of the teeth) as the dependent variable and the presence or absence of licensing reciprocity between states as the measure of restrictiveness. They find a result essentially the opposite of Holen's: no increase in the quality of outcomes.

While both the Holen and the Carroll and Gaston studies are creative and valuable, neither directly measures either dental health or restrictiveness satisfactorily. Holen indexes dental health by using a variant of a conventional but approximate measure of the condition of the teeth, while Carroll and Gaston's oral hygiene index is much less appropriate as an outcome measure because it estimates a condition that correlates very imperfectly with overall dental health.

Although some measure of a state's pass rate might arguably be superior to the reciprocity measure used by Carroll and Gaston as a single index of restrictiveness, Holen employs only the raw contemporary pass rate of the recruit's state of residence, which, among other problems, implicitly assumes that the same percentage pass rate implies the same absolute level of competence across states. Neither study acknowledges the complexity of modeling restrictiveness. For example, even if state restrictiveness at a given time could be appropriately measured, there could be a serious mismatch between contemporary state restrictiveness and the restrictiveness applying to various cohorts of dentists practicing in that state. Moreover, neither study acknowledges that, given the propensity for geographic mobility in the United States, a substantial amount of the recruits' dental care may have been received far from the place listed as home.

In addition to important limitations in measuring dental health and re-

[10] R. J. Stepnick, H. J. Keene, & R. Bognore, Dental Caries, Periodontal Disease, and Oral Hygiene Interrelationships in Naval Recruits (Naval Dental Res. Inst. 1975).

[11] Sidney Carroll & R. J. Gaston, Occupational Restrictions and the Quality of Service Received: Some Evidence, 47 S. Econ. J. 959 (1981).

strictiveness, neither study allows for many other key variables and the relationships that could be conditioning the interaction among them. Among other problems, these studies do not consider gender, race, socioeconomic status, or insurance coverage.

Our investigation aims to advance the analysis on all three fronts. We employ a more comprehensive measure of dental health. We develop alternative measures of restrictiveness, including both a ''quality-adjusted'' pass rate and statutory factors, and we attempt to specify our relationships by employing as many plausible controls for economic and demographic factors as possible. This is accomplished using data especially gathered for these purposes.

B. Analyzing Licensure Effects on Demand on Outputs

The theoretical effect of entry reduction on the price of services is well developed; the linkage between quality and demand is also important but receives much less attention in the literature.[12] Current theory and evidence provide inconclusive results about the effects of occupational licensing on the improvement of service sector outputs. To arrive at conclusions concerning overall economic welfare, one must understand the manner in which the institutional imposition of licensure affects supply and demand in specific markets. This analysis aims at discovering the channels through which individuals' dental outcomes are affected by licensing restrictions on the occupation providing the service inputs. We can then develop a measurable model to estimate whether benefits or losses accrue to the consumer from licensing statutes and administrative procedures. Figure 1 shows the expected process of the effect of occupational regulation on dental health status. Along its upper branch, the figure shows how dental regulation operates through state-level pass rates, more restrictive licensing statutes, and reciprocity agreements with other states to restrict the licensing of new dentists. The empirical results for this relationship show that licensing boards increase or reduce new dentists in response to current changes in the market, operating much like a traditional ''cobweb'' cycle.[13] The consequence of restricting entry in any period is to reduce supply and increase the prices of dental services.

The same regulatory factors noted above are shown to influence the quality of dental care. Assuming that lower quality dentists are removed as en-

[12] Dennis W. Carlton & Jeffrey M. Perloff, Modern Industrial Organization (2d ed. 1994).

[13] Alex Maurizi, Occupational Licensing and the Public Interest, 82 J. Pol. Interest 399 (1974); Kleiner, *supra* note 5; and Morris M. Kleiner and Robert T. Kudrle, Do Tougher Licensing Provisions Limit Occupational Entry: The Case of Dentistry (Working Paper No. 3984, Nat'l Bureau Econ. Res. 1992).

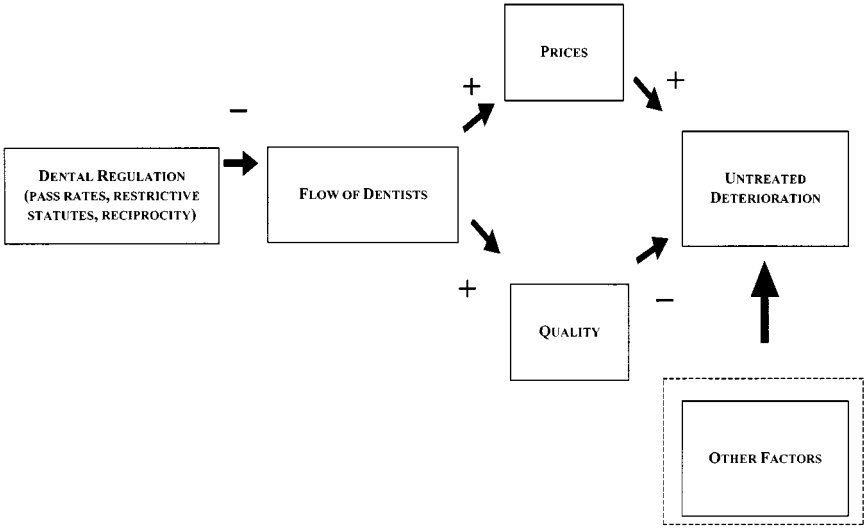

FIGURE 1.—Regulation's impact on untreated dental deterioration

try restrictions are increased, as shown on the bottom portion of Figure 1, the mean quality of a dental visit (which we define as a representative set of services) is increased since the remaining dentists entering the occupation are of higher quality.[14] With this presumed enhancement in quality, the use of services would increase as perceived quality grew.[15] In the absence of any theory or evidence to the contrary, we assumed that the stringency of professionally administered quality controls such as licensure is the best proxy for quality as recognized by the consumer. This factor alone would directly reduce untreated deterioration as shown in Figure 1. However, higher dental prices alone would increase the overall extent of dental deterioration. The net effect of regulation on dental deterioration is therefore theoretically unclear. The overall effect of greater regulation on the quality of services delivered and on dental health needs to be decided with data and analysis.

The basic relationships derived from Figure 1 would suggest that the quality of a dental visit would be negatively related to the pass rate, PR, in a state, assuming time and effort spent with each patient remain the same.

[14] Unfortunately, the quality of a dental visit is an unobservable in our data set with the standard assumptions about the error term of this factor. We assume that the quality of the visit increases with the quality of the practitioner.

[15] Hayne E. Leland, Minimum Quality Standards in Markets with Asymmetric Information, in Rottenberg ed., *supra* note 6, at 265.

Either lower quality candidates would be rejected by a state or those individuals would incur additional occupation-specific training in order to pass the exam. This relationship is presented in equation (1):

$$\mathrm{VQ} = f(\mathrm{PR}, X_1), \tag{1}$$

where visit quality (VQ) is negatively related to the pass rate for dentists and X_1 is a set of other covariates.

In contrast, an increase in the pass rate would enhance the access to dental services. This would provide greater access as more dentists are available in the state, which would reduce the money price of a visit and the office waiting time to see a dentist as well as travel time. This would be included in the implicit or full price for a dental visit. This relationship is shown in equation (2):

$$\mathrm{FP} = f(\mathrm{PR}, X_2), \tag{2}$$

where FP is the full price, which includes time costs; FP is influenced negatively by the pass rate,[16] and X_2 is a set of control variables.

Overall dental outputs would be a function of the quality of a dental visit—which is an unobservable in our model—and the access to dental care. Although others within a dental establishment can provide dental services, all services are under the control, monitoring, and direction of a dentist. For example, in all states dental hygienists must work, by statute, with the guidance of a dentist. Even though we examine only the regulatory requirements for becoming a dentist, we note that restrictiveness measures for dentists and hygienists are highly correlated across states. The Council of State Governments measures of these legal and administrative requirements show a simple correlation of about .90. Therefore, in equation (3) overall dental health is a function of both the full price and dental care quality:

$$\mathrm{DH} = f(\mathrm{FP}, \mathrm{VQ}, X_3), \tag{3}$$

where DH is the dental health of a person in a certain jurisdiction and X_3 is a vector of other covariates. In sum, dental demand depends on three factors: perceived quality, money price, and time price of representative services and other covariates.

Many studies of service demand have attempted to overcome the problem of variability in service output by making quality adjustments based on characteristics of inputs. However, there is no assurance that the services actually received by consumers are positively correlated with these proxy

[16] Further, more dentists might be more effective lobbying for dental coverage in medical health plans in both the public and private sectors, thus reducing point-of-service money prices.

measures of input productivity, and the distinction between the number of inputs employed and the quality of output received are quite important. An inferior dentist may require multiple attempts to fill a tooth to the same standard of quality that another dentist can accomplish at once.[17] Instead of measuring the number of separate visits or fillings, suppose we examine the dental condition a number of years after the intervention. From this perspective, an individual treated by the inferior dentist and one by the more skilled dentist may be observed to have one filled tooth. Therefore, we can infer that the output of services made possible by the original investments has been identical, regardless of input activities.[18]

Appropriate research measures of quality can be developed by considering the stock of dental health status, HS. The depreciation rate, DR, which lies between zero and one, is inversely related to the extent of personal and professional preventive investment made by the individual over t periods, as well as the stock of untreated previous deterioration. We assume that a significant component of preventive care is service performed by professional agents. Another component is clearly related to the consumer's personal dental care.

As dental health status depreciates, corrections can be performed to repair damage. Thus, the stock can be, in a sense, replaced at some rate, CR. Then in equation (4),

$$\mathrm{HS}_t = (1 - \mathrm{DR}_t + \mathrm{CR}_t)\mathrm{HS}_{t-1}. \tag{4}$$

At a given time a person's dental health can be represented by equation (5):

$$\mathrm{TD}_t = \sum_{i=0}^{t} (1 - \mathrm{DR}_t + \mathrm{CR}_t)\mathrm{HS}_0. \tag{5}$$

Thus we can define untreated deterioration[19] as[20]

$$\mathrm{UD}_t = \mathrm{HS}_0 - \mathrm{HS}_t. \tag{6}$$

[17] W. Oi, The Economics of Public Safety, 4 Bell J. Econ. 3 (1973).

[18] To have comparable service flows or rates, the individuals must be the same age and otherwise similar or adjustment for such differences must be made.

[19] The term CR is net intervention, and, because corrective interventions often need replacement or repair, the ratio of gross to net corrective intervention will typically grow over time.

[20] This formulation does not embrace some orthodontic and other procedures other than repair that might in rare cases make possible an improvement in the initial functioning dental condition after a complete set of permanent teeth have developed. By focusing on dental health, we also ignore issues of cosmetic dentistry.

The deterioration of dental health status will vary considerably across individuals because of genetic factors that we cannot control for, as well as for some uncontrolled environmental reasons (that is, diet or general health status).[21]

Let all else be held constant, and $(1 - \mathrm{DR}_t)$ will be a strictly increasing function of the quality and quantity of prevention in equation (7):

$$(1 - \mathrm{DR}_t) = f(P_{1t}, P_{2t}, P_{3t}), \tag{7}$$

where P_1 = an index of personal preventive intervention; P_2 = an index of public prevention, the fluoridation of public water supplies; and P_3 = an index of professional intervention, mainly cleaning and sealants.

In developing an empirical construct, a measure of only one aspect of the three relevant variables, the fluoridation of the water supply in the areas where an individual has lived, is available to us. The other two variables are unobservables in our model that we attempt to capture through the employment of proxies known to contribute to personal preventive behavior and a proclivity to use preventive services. The dental care literature suggests that both unobserved prevention investments are positively correlated with family income and the household head's education level.[22] Overall, we assume that controlling for various attributes satisfies the usual assumptions about the error term.

Licensing restrictiveness has two major effects on practitioners. First, individuals considering entering an occupation in a state may decide not to when the pass rate is low.[23] Statutory provisions, such as a waiting period or a requirement to retake of a state portion of a licensing exam if an individual has qualified in another state, may further reduce new entrants. Such restrictions may increase the average quality of the in-state dentists. Second, for most dentists choosing a state in which to locate, initial failure would result in more study and retaking the exam, thus presumably enhancing occupation-specific human capital. In both of these cases the average quality of dentists in the state would rise, but prices may also rise because the supply of dentists and access to dental services would be reduced.

[21] Robert T. Kudrle & Lawrence Meskin, Introduction to Reducing the Cost of Dental Care (R. T. Kudrle & L. Meskin eds. 1983).

[22] *Id.*

[23] We estimated that the present-value cost to dentists who fail the exam was approximately $54,000 in 1997 dollars. This estimate was derived by initially assuming that the individual becomes a licensed practitioner by passing the exam the next time it is given, which is every 6–12 months, and the individual is employed as a dental assistant in the interim. Following Solomon W. Polachek, Occupational Self-Selection: A Human Capital Approach to Sex Differences in Occupational Structure, 63 Rev. Econ. & Stat. 60 (1981), the estimate assumes the average lag and includes lost earnings growth of 1 percent for the next 5 years due to lost experience and nominal earnings growth differences.

In addition to its obvious significance for CR in equations (4) and (5) licensing is assumed to have a major effect on P_3 in equation (7) because preventive services must be delivered under a dentist's supervision in all states, and we assume that views about the quality of dentistry rather than those that might be formed about ancillary services drive consumer behavior.

C. Concepts and Data

Two major difficulties have plagued attempts to model consumer benefits in previous studies of occupational regulation. First, researchers lacked data detailing statutes and pass rates as measures of state restrictiveness. Second, they lacked comparative data on the results of services provided. Our data sets focus on both of these issues as well as on essential controls, acknowledged by previous researchers.

We collected detailed dental legal information from each state's statutes for the period from 1960 to 1994, updating it with similar data gathered by the Council of State Governments.[24] We also obtained pass rate data from the American Dental Association; prior research has shown that the pass rate is the key measure of restrictiveness.[25]

Previous studies have employed pass rates with incomplete attention to the possible variation in their meaning across states. For example, a high pass rate in California could be controlling dental practice at a higher level of quality than a low pass rate in North Dakota if the average quality of the applicant is sufficiently higher in California. We have attempted to deal with this problem by including a common quality factor in our estimating equations. All incoming dental students have taken national entrance examinations, and we include the mean incoming score on that examination for the most appropriate dental school for each state. In general, one dental school dominates the production of dentists for a given state.[26] This variable is used to control for the premarket educational abilities of the stock of dentists.[27]

Developing the most appropriate new measures of the dependent and

[24] Council of State Governments, Occupational Licensing (1987, 1994). This source also cataloged new information on the licensure of dental hygienists and dental assistants.

[25] Maurizi, *supra* note 13; M. Getz, J. Siegfried, & Terry Calvani, Competition at the Bar: The Correlation between the Bar Examination Pass Rate and Profitability of Practice, 67 Va. L. Rev. 863 (1981); Kleiner, Gay, & Greene, *supra* note 6; Kleiner & Kudrle, *supra* note 13.

[26] For those states that have more than one dental school, the scores were weighted by the relative size of the cohorts.

[27] Derrick Neal & W. R. Johnson, The Role of Pre-market Factors in Black-White Wage Differences, 104 J. Pol. Econ. 869 (1996).

some independent variables involved several steps. As stated, we assembled measures for each significant dimension of restrictiveness. Time-series data are important for many measures because the stock of practitioners at any time is composed of a large number of separate ''vintages'' with varying qualifications. For the period that most of our sample was growing up, however, from the beginning of 1960 to the end of the period in 1987, there was a rank-order correlation of .60 for the states maintaining their either high or low level of restrictiveness as measured by pass rates and statutory measures through a summated rating scale.[28]

We were unable to find any agency in the United States that routinely collects data on varying dental conditions along with appropriate controls. Therefore, we employed a unique source of medical and demographic information from a sample of new enlistees into the U.S. Air Force. We gained the cooperation of the commander of Lowry Air Force Base near Denver, Colorado, historically a major base for new recruits. We designed and provided a questionnaire that Air Force personnel administered as part of the initial dental examination required of everyone. Although persons were not obliged to cooperate, no one declined to fill out the questionnaire. Some forms were not fully completed, but only about 5 percent of them were unusable for that reason. Some self-reporting errors arise because of the retrospective nature of the questions, but the recruits were told that the results were to be used anonymously. We were able to obtain access for only a limited period in early 1992 because the base was closing.

Data were gathered on the age, gender, and race of the recruit, on the education of the head of the household, and the total income of the household in which the recruit grew up. Parents' education and income (corrected by number of members) were especially important because they were known from previous research to affect the demand for dental services.[29] Fluoride reduces the incidence of cavities, the single most important dental

[28] Both David Bartholomew, The Statistical Approach to Social Measurement (1996), and Andrew Wang, Economic Reform and State Enterprise Productivity in China: An Application of Robust Estimation and Latent Variable Measurement Methods (Ph.D. dissertation, Harvard Univ., Dept. Econ. 1997), use summated rating scales based on unweighted values aggregated to form a single variable. After 1987 dental board scores were reported by region rather than state. Regional results checked with a shift-share allocation did not reveal a qualitative change in the pass rates to 1991. More recently, as reported in Lawrence Meskin, Time for a Dental Board Checkup, 125 J. Am. Dental Assoc. 1418 (1994), the American Association of Dental Schools adopted as a goal the elimination of all state and regional licensing examinations and their replacement with examinations in dental school or a national examination.

[29] Given the average age of 21, the head of household was self-reported for each enlistee to be his father, mother, or legal guardian. Also see Robert T. Kudrle, Dental Care, in National Health Insurance: Conflicting Goals and Policy Choices (J. Feder, J. Holohan, & T. R. Marmor eds. 1980); Kudrle & Meskin, *supra* note 21.

disease in young people. Because the public water supply can be a major source of fluoride, we obtained residence location and duration from birth until entry into the Air Force from all persons in the sample. Place of residence was also used to identify the restrictiveness of dental regulation at the state level.[30] Further, we asked new Air Force recruits if their family was covered by dental insurance and how many times they went to the dentist in the previous 2 years.

Indices of dental outcomes were developed that allowed for the assessment of previous and current dental deterioration (TD), the amount of repair already performed on an individual (TC), and the amount of repair needed to bring the individual to complete correction (UD). A smaller amount of untreated disease implies a higher dental health status. A licensed research dentist worked with us to develop the coding and examined the dental forms for each of the individuals. These persons had been examined by Air Force dentists who ensured that dental health status was appropriately specified. The information obtained from the dental examinations resulted in the coding of dental corrections (CR) and any form of untreated tooth-related deterioration (UD). Periodontal information is not explicitly used in the study.[31]

Table 2 presents the means and standard deviations for the individuals in our sample for licensing and state characteristics. Geographic spread is diverse, and the education (12.7 years) and family income ($27,621) of recruits closely matched the country as a whole (12.6 years and $29,458) for the early 1990s from Current Population Survey estimates. Our sample contains over 23 percent of nonwhite Americans, but only 17 percent of the individuals in our data set are women.

Other analysis has found that the socioeconomic backgrounds of military recruits, including Air Force recruits, closely match the background of average Americans.[32] In particular, this sample contains a sufficiently large sample of individuals from low-income households (approximately 22 percent below the U.S. designated poverty level) to allow us to examine the effect

[30] Since the children of military personnel enlist to greater degree than the general population, we checked this issue in our sample. We found that only 27 individuals may have spent all or part of their childhood in military households and therefore would have received care isolated from local dental markets.

[31] Many of the examinations lacked this information, and there is a paucity of precision in this measure due to the absence of periodontal probing or the use of any of the standard periodontal indices by the Air Force on routine dental examinations. Periodontal condition plays an important part in the dental health status of the general population, but it is less useful in a sample of very young adults since periodontal disease is not a major problem in this age group.

[32] David Boesel, The DOD Survey of Recruit Socioeconomic Backgrounds (U.S. Def. Manpower Data Center 1989).

TABLE 2

MEANS AND STANDARD DEVIATIONS

Variable	Mean	SD
Quality measures ($N = 464$):		
Total dental depreciation ($)	669	768
Dollar value of untreated correction ($)	227	328
Dollar value of previous treatment ($)	442	668
Price of filling ($)	44.84	7.17
Price of cleaning ($)	76.52	15.98
Individual characteristics ($N = 464$):		
% male	82.7	. . .
% nonwhite	24.8	. . .
Years of education	12.7	1.99
Age	21.60	2.46
Household age	2.62	1.78
Family income ($)	27,842	19,398
% with dental insurance coverage	57.9	49.5
Average dental visits (last 2 years)	2.63	2.55
State characteristics ($N = 50$):		
Fluoridation rate (%)	53.25	41.21
Average malpractice insurance fees ($)[a]	1,912	761
Average quality score of dentists in state dental school	4.68	.39
Weighted pass rate	85.8	6.98
Endorsement statute (%)[b]	58	. . .
Citizenship requirement (%)[c]	22	. . .
Public use sample data (1990 census; $N = 3,361$ dentists)		
Hourly income ($)	41.02	43.02
Annual income ($)	81,948	58,470
% married	83	. . .
% U.S. citizens	92	. . .
% nonminority	91	. . .
% female	13	. . .
Age	43	10
Hours worked weekly	41	10

[a] Fees are shown for a dentist with 10 years of experience.
[b] Applicants receive a license if they meet entry requirements in force at the time of initial licensure.
[c] The individual must be a citizen in order to be licensed in the state.

of varying licensing procedures on the quality of services received for individuals who may be most adversely affected by tougher regulation. Consequently, using the Air Force base sample should enhance the generalizability of our results to other similar cohorts.

We converted the UD value of untreated deterioration into a monetary measure as a method of evaluating the cost of bringing an individual to an optimal dental condition.[33] We used the national average fees for corrective

[33] A. G. Christen *et al.*, United States Air Force Survey of Dental Needs, 98 J. Am. Dental Assoc. 726 (1979).

treatment by general practitioners obtained from the 1992 survey from *Dental Economics* as the prices to bring each person in our sample up to the best possible level.[34] This survey also provides state-by-state average prices for most major dental procedures that we use for our state-level analysis.[35] The means of these values as well as those for most of the other variables are also presented in Table 2.

Each of our 464 individual observations contains information on household variables and state characteristics weighted by the time the person spent in each of the 50 states. Since there is no clear consensus from the dental establishment regarding which stage of dental development has the greatest effect on dental outcomes, our analysis assigns equal weight to each age period.[36] By comparison, this sample is similar in size to the 477 observations of naval enlistees from 41 states used by Holen and by Carroll and Gaston.[37]

We asked all enlistees where and how long they lived at each location, giving state characteristics proportional weights corresponding to the time spent in that state.[38] Measures of heavy, medium, and light regulatory licensing statutes and qualifying exams were developed by noting that the average pass rate for the United States was approximately 85 percent. Levels below 80 percent with either no reciprocity or no endorsement provision for out-of-state dentists were designated to be heavily regulated. Medium

[34] Dental Economics (unpublished manuscript, tables on prices of dental procedures by state 1993).

[35] We also estimated the more conventional summated rating scale of dental condition developed by dental researchers to examine the robustness of our results. As explained in H. Klein *et al.*, Studies on Dental Caries: Dental Status and Dental Needs of Elementary School Children, 53 Pub. Health Reporter 751 (1938), and J. W. Knutson *et al.*, Dental Needs of Grade-School Children in Hagerstown, Maryland, 27 J. Am. Dental Assoc. 579 (1940), the most widely used measure of overall dental health is the DMF (that is, the value of decayed, missing, and filled teeth). The DMF is considered to have a range of 0–128 and is a summated rating scale for our purposes. The mean DMF for our sample was 13.5, with a range of 0–35. While the mean corresponds to a rather low overall number of cavities, the range suggests a varied experience. The mean dollar amount of total previous correction is $442 (SD = 668), while the average dollar amount to bring individuals to a disease-free state is $227 (SD = 328). All 50 states were represented in this analysis. Our results were similar using both physical and value metrics.

[36] According to the Bureau of the Census Vital Health Statistics of the United States, Dental Statistics 10 (1988), only one-third of persons under age 4 use dental services. We, therefore, estimated our model assuming no dental care for persons of this age. Additional analysis showed that this assumption had no qualitative effect on our basic results.

[37] Holen, *supra* note 9; Carroll & Gaston, *supra* note 11.

[38] In order to estimate models that are consistent with those presented in the analysis in Holen, *supra* note 9, we also estimate the models allocating each individual to a state, based on the last state the person lived in prior to enlistment in the Air Force. The results are consistent with the ones shown in Table 4.

regulations were those states with pass rates between 80 percent and 90 percent and a provision for reciprocity or endorsement. Light regulation included those states with pass rates above 90 percent and either a provision for reciprocity or endorsement.[39]

One of the major advantages of having a data set like the one we have gathered is the ability to reduce unobserved heterogeneity. Since the group that formed the basis of our measures of dental care quality has similar ages and interests, and somewhat similar abilities, the unobservable variation relative to a randomly selected grouping of ages, interests, and abilities should be greatly reduced. An analysis of the general population would likely suffer from a wider variation in such characteristics, as well as including persons with failing general health, which would be more difficult to control for using standard statistical approaches. Without such heterogeneity our analysis of differences in untreated dental outcomes should more likely be explained by economic, environmental, and policy variables about which we have data rather than large differences in attributes that we cannot measure or observe. Of course, the use of such a select group for our analysis reduces our ability to generalize to the U.S. population. To partially correct for this potential shortcoming and to compare with the results from our selected sample, we use other state and national data to examine quality and price effects of varying restrictiveness.

D. Estimating a Model of Dental Health Based on Individual Demand

In order to begin an evaluation of states in term of costs and benefits, we first rated each state using the average value of our index of dental health for the sample of Air Force recruits for that state. The highest and lowest five states in each category are presented in Table 3, and the dental restrictiveness index of the state was rated high, medium, or low. In panel A we rank the states with the best average dental condition. The states with a middle category of tough licensing, like Wisconsin and Rhode Island, have the highest quality rankings using this scale. In panel B we rank the five states that have the worst dental condition. We find that Idaho and Alaska have the highest value of untreated deterioration. Hawaii is among the more restrictive states, yet has high levels of deterioration. This ordering does not show a clear relationship of regulation to dental outcomes. These results, of course, do not take into account other covariates that may influence un-

[39] Those states that had lower pass rates but had reciprocity or endorsement were moved to the medium level of restrictiveness. Five states changed restrictiveness categories using this convention.

TABLE 3

FIVE HIGHEST AND LOWEST RANKED STATES USING THE DENTAL QUALITY INDEX AND INFORMATION FROM AIR FORCE ENLISTEES

A. STATES WITH HIGHEST DENTAL QUALITY

Lowest Weighted Total Deterioration			Lowest Weighted Untreated Deterioration		
Rank	State	State Restrictiveness Index	Rank	State	State Restrictiveness Index
1	Rhode Island	Medium	1	Rhode Island	Medium
2	Wisconsin	Medium	1	Wisconsin	Medium
3	Utah	Medium	1	Vermont	Medium
4	Iowa	Medium	1	Nebraska	Medium
5	Missouri	Medium	5	Utah	Medium

B. STATES WITH LOWEST DENTAL QUALITY

Highest Weighted Total Deterioration			Highest Weighted Untreated Deterioration		
Rank	State	State Restrictiveness Index	Rank	State	State Restrictiveness Index
1	Hawaii	High	1	Idaho	Medium
2	Connecticut	Medium	1	Alaska	Low
3	Alaska	Low	1	Minnesota	Medium
4	Idaho	Medium	1	Kentucky	Low
5	Arizona	Medium	5	Wyoming	Medium

treated dental deterioration. We now turn to multivariate analysis that controls for these factors.

We specify the model below to be consistent with our demand model and with Figure 1, which outlines regulation's effect on consumer welfare. We specify the following model of individual dental health based on the demand for dental services:

$$\mathrm{TD}_i = X_{t1}\beta + R_i\delta + \varepsilon_i; \tag{8}$$

$$\mathrm{TC}_i = X_{t2}\gamma + R_i\eta + \varepsilon_i. \tag{9}$$

In equation (8), TD_i is the cumulative depreciation of the individual's dental condition drawn from clinical examination of Air Force recruits and aggregated by the estimated amount of past expenditure as well as the estimated expenditure needed to bring the teeth of each individual to fully repaired condition. In equation (9), TC is the total estimated value of corrective services actually obtained by individual *I*. The term X_{ij} is a vector of personal attributes of the Air Force recruits that include economic and demographic characteristics of the person. The terms R_i are the measures

of state regulation including licensing provisions as well as a control for the presence of flouridated public water supply in the area of residence weighted by the length of time the person was in the area.[40] The term R_i includes the prices of representative preventive and restorative procedures. The terms β, δ, γ, and η are unknown parameter vectors, and ε is an independently and identically distributed (i.i.d.) error term.

The independent variables in equation (8) include ones that we posit determine personal, public health, and professional contributions to prevention.[41] It should be stressed that the restrictiveness variable in this equation is for dentists only, as is the case in equation (9).

An estimate of (8) using a Tobit specification to account for individuals who had no dental problems, about 10 percent of our sample, shows, not surprisingly, that unobservable personal and genetic characteristics dominate overall dental disease. Our estimation of equation (9) finds total deterioration to be a significant determinant of total correction.[42] This equation suffers from simultaneity bias because of the inclusion of total deterioration. Since we were unable to develop a suitable instrument for total depreciation, we report OLS estimates in Appendix Table A1, and turn to reduced-form estimates.

Our study concerns the effect of varying regulation on dental health through both prices and services rendered; attention should therefore focus on reduced-form estimates. In addition, the OLS estimates are quite consistent with the reduced-form results.

Because there is likely to be a substitution between preventive and corrective care, the estimates of untreated deterioration divided by total deterioration in reduced form should provide additional insights into the relationship between more restrictive licensing practices and the measures of enhanced dental outcomes. In a reduced-form equation based on equations

[40] Fluoridation policies are frequently determined by substate jurisdictions. Since we had information on the city or county and duration of stay for all of the recruits, we constructed an index for each person in the sample. In other aggregate estimates where we needed state fluoridation averages, we constructed another index weighted by the share of a state's population exposed to public fluoridation.

[41] Only professional preventive services have money price as a (nontrivial) component. The principal public health measure, fluoridation, is a local public good, while flossing and brushing overwhelming involve a time price. All of the evidence suggest that, despite the higher shadow price of personal prevention for persons with higher incomes, preventive behavior increases with income. This result conforms with the hypothesis in Victor R. Fuchs, Time Preference and Health: An Exploratory Study in Economic Aspects of Health 93 (Victor R. Fuchs ed. 1982), that the rate of time preference is a powerful determinant of health-enhancing behavior.

[42] In addition, our estimation of equation (9) finds education and insurance coverage to be significant determinants of total correction. These results are shown in Appendix Table A1.

(8) and (9) we can estimate UD/TD (untreated dental depreciation divided by total depreciation) as follows:[43]

$$\mathrm{UD}_i/\mathrm{TD}_i = X_{t3}\lambda + R_i\eta + \varepsilon_i, \tag{10}$$

where we have the reduced-form impact multiplier coefficients. In this case the X_i is again a vector of characteristics of the Air Force recruits, R_i is the weighted state- and area-specific characteristics of the licensing variables, λ and η are unknown parameter vectors, and ε_i is the error term.[44]

In our sample 68 percent had some uncorrected dental deterioration and 90 percent had some measurable deterioration during their lifetime. Given the number of zero observations in our data set resulting from either zero deterioration or as a consequence of complete correction, the Tobit specification is an appropriate functional form.[45] In Table 4 we present Tobit estimates of the effect of licensing pass rates and statutes on the dollar value of untreated dental disease, and their marginal effects.[46] To maintain as large a sample as possible, when our questionnaire lacked information on a covariate, we substituted the means for missing values and added a dummy variable that took the value one when the mean was employed and zero otherwise.[47]

Columns 1–4 of Table 4 show results of estimates that include only measures of restrictiveness as well as household and individual demographic characteristics as determinants of untreated deterioration. In columns 5–8 we include a number of additional controls. Coefficient estimates and mar-

[43] In order to check for functional form of our specifications, we also estimated total untreated dental depreciation with total depreciation as an independent variable along with X_{ij} R_{ij} measures and found no qualitative changes in our basic results.

[44] We do not include the number of visits to the dentist during the last 2 years since it would be potentially endogenous with untreated dental outcomes. We also used the number of dental visits as an instrument and found no statistical effect. However, we did estimate the model with this variable to control for access to dental services and to be consistent with other specifications, such as those developed by Holen, *supra* note 9, in her initial examination of this issue, and found no qualitative differences from those presented in our Table 4.

[45] We also estimated the equations presented in Table 4 with 308 observations corresponding to all persons with nonzero correction and found results consistent with the estimates presented. In addition, we estimated our reduced-form Tobit with 416 observations corresponding to all persons who had nonzero deterioration during their lifetime and found no qualitative differences relative to those shown in Table 4.

[46] As Helena Chmura Kraemer & Sue Thiemann, How Many Subjects? Statistical Power Analysis (1987), demonstrates, given the sample size of 464, the power of the test for our model implies a 70 percent chance of detecting a significant result at a .05 confidence level if the real effect size is .1.

[47] Estimates using only those observations for which we had complete data on the covariates produced no qualitative differences in the results. These estimates are available from the authors; see Roderick Little & D. Rubin, Statistical Analysis with Missing Data (1987).

TABLE 4

REDUCED-FORM TOBIT ESTIMATES AND THEIR MARGINAL EFFECTS OF THE IMPACT OF STATE LICENSING REGULATIONS ON UNTREATED DENTAL DETERIORATION ($N = 464$)

	DEPENDENT VARIABLE: DOLLAR VALUE OF UNTREATED DETERIORATION/TOTAL DEPRECIATION							
INDEPENDENT VARIABLE	(1)	Marginal Effects (2)	(3)	Marginal Effects (4)	(5)	Marginal Effects (6)	(7)	Marginal Effects (8)
High regulation	...	...	−.065	−.045	...	...	−.023	−.016
			(.073)				(.086)	
Medium regulation	...	...	−.116*	−.081	...	...	−.081	−.057
			(.056)				(.067)	
Restrictiveness of statute	.008	.006	...	...	.010*	.007	...	...
	(.005)				(.005)			
Pass rate	.004	.003	...	...	.002	.001	...	...
	(.003)				(.005)			
Income per family member	−.003	−.002	−.003	−.002	.001	.001	.001	.001
	(.002)		(.002)		(.002)		(.002)	
Education	−.023*	−.016	−.023*	−.016	−.028*	−.01	−.027*	−.019
	(.012)		(.012)		(.012)		(.011)	
Insurance coverage	...	...	...	...	−.259*	−.183	−.261*	−.184
					(.055)		(.056)	
Academic ability of dentists in the state	...	...	...	...	.016	.011	.004	.003
					(.056)		(.053)	
Fluoridation	...	...	...	...	.0003	.0002	.0003	.0002
					(.001)		(.001)	
Constant	.232		.673*		.856		1.04*	
	(.353)		(.163)		(.739)		(.417)	
Log likelihood	−348.58		−347.51		−327.19		−326.99	
Likelihood ratio test for joint significance of restrictiveness variables	1.82		3.96		1.59		1.99	
Mean and standard deviation of the dependent variable	.35							
	(.36)							

NOTE.—Estimated with controls for gender, race, age, childhood in military, and missing values. Standard errors in parentheses and include corrections for group biases.

* Significant at the .05 level.

ginal effects include standard errors corrected for grouped data.[48] Pass rates in all specifications are found to be statistically insignificant. We also show the effect of the categorical variables of high and medium restrictiveness relative to a regime of less tough regulation. These specifications find that only medium regulation is significant and negative on untreated deterioration in column 3 but is not significant in column 7 when additional variables are added that control for demand-side factors. We also used a maximum-likelihood test for the joint significance of all the licensing-related variables that include the pass rate and the statutory variables. The results presented at the bottom of Table 4 show that these variables together are also not significant.[49] The only consistently significant variables in our models were dental health insurance and the education level of the head of the household. The insurance results are consistent with outcomes from health insurance experiments.[50]

As an additional sensitivity test, we dropped the top 5 percent of the individuals with highest untreated deterioration from our sample. Appendix Table A3 presents these estimates, and they show no substantive change in the basic result. An additional test divided the data into three categories by income of the head of the household; it showed no effect of regulation on dental outcomes. There were no greater effects of regulation for higher or lower income groups, suggesting that regulation does not serve to provide greater service quality for low-income groups.[51]

Sensitivity tests also included a subsample of those persons who did not move and therefore had no change in their regulatory regime; this included 363 individuals. The estimates again showed no statistically significant effect of any licensing variables, but the effects of dental insurance again were statistically significant. We also interacted the pass rate with the mean entrance exam scores for the state dental schools, and this variable was not significant in any of the specifications presented in Table 4. Additional tests of the robustness of the estimates controlling for unobserved heterogeneity

[48] Additional specifications that included controls for the interaction of the licensing variables and income showed no substantial changes in the results. We also used just the summated rating scale without dollar value for the procedure and found no effects of the licensing variables. See also Brent R. Moulton, Random Group Effects and the Precision of Regression Estimates, 32 J. Econometrics 385 (1986).

[49] These estimates used national prices construct the dependent variables. In Appendix Table A2 we use state-by-state prices to construct the same variables. The results are similar to those in Table 4. Adding price as an independent variable showed no major changes for our measures of regulation.

[50] Joseph P. Newhouse, Free for All? Lessons from the RAND Health Insurance Experiment (1993).

[51] These estimates are available from the authors.

by economic status showed no large or significant effects of occupational licensure on untreated deterioration.[52]

As additional checks, we use two other more aggregate measures of dental service quality in Table 5. First, we use the ratio of the complaints filed against dentists at each of the state licensing boards to the number of dentists in the state as the dependent variable. Second, we use the average malpractice insurance rates in a state for a dentist with 10 years experience as a dependent variable. Independent variables include state economic and demographic variables such as average education in the state, percent minority, age and age^2, per capita income, fluoridation, and the test scores for new dental students in the state, as well as measures for the levels of restrictiveness of state licensing. The coefficients for none of the licensing variables are statistically significant in Table 5.

In Table 6 we address the issue raised in the theoretical model in Figure 1 regarding the role of regulation on the supply of dentists. In this specification the dependent variable is the log change in the number of dentists per capita from 1980 to 1990, the principal period for the analysis of the sample of Air Force recruits. Consistent with stock-adjustment or cobweb models of the labor market,[53] the independent variables are the logarithm of per capita income in the state, the logarithm of the dentists per capita in 1980, and measures of regulation that include the state pass rate for dentists and indices of the relative levels of overall dental regulation. These estimates are consistent in showing that higher levels of regulation are associated with smaller changes in dentists per capita. The levels of regulation variables, consistent with Figure 1, show that greater regulation is associated with fewer dentists. The pass rate variable in column 1 is statistically significant and positive, suggesting that higher pass rates are associated with greater changes in dentists per capita in the state. Using the estimates of the long-run effect multiplier from the model, the estimated effect of a

[52] In a manner similar to Richard B. Freeman & Morris M. Kleiner, The Impact of New Unionization on Wages and Working Conditions, 8 J. Labor Econ. S8 (1990), we grouped all those individuals from families who had (*a*) incomes in the upper one-third of our income and education distribution and (*b*) dental insurance, and then created pairs of observations. These individuals are assumed to have common socioeconomic characteristics. We then divided individuals within these categories into groups from states that had the most and least rigorous licensing standards, creating a set of paired observations by individuals who were the most similar based on their incomes. We then examined their untreated deterioration values. Again, we could find no statistically significant differences in untreated deterioration between those groups in high- and low-regulated states. However, for individuals who were in the lowest income groups the mean value of untreated deterioration was 2 percent lower relative to those persons who had lived in states with more regulation. This result was not statistically significant using a difference-in-means test.

[53] Richard B. Freeman, Legal Cobwebs: The Changing Market for Lawyers, 57 Rev. Econ. & Stat. 171 (1975).

TABLE 5

ORDINARY LEAST SQUARES ESTIMATES OF THE IMPACT OF STATE LICENSING REGULATIONS ON STATE COMPLAINT RATES AND MALPRACTICE INSURANCE PREMIUMS ($N = 50$)

	DEPENDENT VARIABLE			
	Complaints/Dentists		Log Insurance Premiums	
INDEPENDENT VARIABLE	(1)	(2)	(3)	(4)
Restriction index of statute	.02	...	.0004	...
	(.009)		(.025)	
Pass rate	.002	...	−.007	...
	(.004)		(.010)	
High regulation	...	−.04	...	.07
		(.08)		(.21)
Medium regulation	...	−.11	...	−.11
		(.06)		(.16)
State per capita income	−.017	−.0007	.13*	.14*
	(.014)	(.014)	(.04)	(.04)
Academic ability	.02	.018	−.10	−.04
	(.05)	(.046)	(.14)	(.13)
Fluoridation	.0004	.0001	−.003	−.004
	(.0008)	(.0008)	(.002)	(.002)
Constant	7.64	11.55	10.74	18.65
	(13.64)	(13.32)	(38.03)	(36.81)
R^2	.13	.13	.28	.30
F-test for joint significance of the restrictiveness variables	2.07	2.22	.26	.77
Mean and standard deviation of the dependent variable	.29		$1,912	
	(.13)		(769)	

NOTE.—Estimated with controls for state-level measures of education, percent minority, average age of residence in the state, and age^2. Standard errors are in parentheses.

* Significant at the .05 level.

10 percent increase in the pass rate is to increase dentists per capita by 2 percent.

Overall, our results show that licensing does not improve dental health outcomes as measured by our sample of dental recruits. Moreover, treatment quality does not appear to improve significantly on the basis of the reduced cost of malpractice insurance or a lower complaint rate against dentists, where regulation is more stringent. Finally, stricter regulations are associated with reduced dentists per capita in a state.

E. Effect of Tougher Regulations on the Prices of Dental Care and Earnings of Practitioners

One of the key issues in occupational licensing has been the role of tougher regulations on dental service prices. We estimate price equations

TABLE 6

IMPACT OF OCCUPATIONAL REGULATION ON THE CHANGE IN THE NUMBER OF DENTISTS PER CAPITA BY STATE, 1980–90 ($N = 50$)

	DEPENDENT VARIABLE: LOG CHANGE IN DENTISTS PER CAPITA	
INDEPENDENT VARIABLE	(1)	(2)
Pass rate	.003*	
	(.001)	
High regulation		−.04
		(.04)
Medium regulation		−.04
		(.03)
Log of state in income per capita in 1990	.16	.11
	(.10)	(.10)
Log of dentists per capita in 1980	−.17*	−.16*
	(.07)	(.08)
Constant	−1.09	−.38
	(.90)	(.85)
R^2	.23	.17

NOTE.—Estimated using data from the 1980 and 1990 U.S. Statistical Abstracts. Standard errors are in parentheses.

* Significant at the .05 level.

using both state and our individual-by-state observations. Our reduced-form price equation assumes that prices of the most common dental services in a state are a function of both supply and demand factors in the state. In our model, regulation can increase prices both by enhanced demand through better visits and by supply restriction through the control of new dentists or migrants. In either case, prices are assumed to increase. The basic model is specified as follows:

$$P_j = X_j\omega + R_j\mu + \varepsilon_i, \tag{11}$$

where P is the logarithm of the price for dental services in state j, X_j is a vector of state supply and demand characteristics that influence the price of dental services in state j, including income in the state, the average age and education of the population, percent minority, percentage of state with fluoridation, and the quality of dentists; R_j are measures of state licensing effect measured as licensing requirements and a category of states with especially heavy levels of regulation; ω and μ are unknown parameter vectors; and ε_i is an i.i.d. error term.

The OLS regression estimates of the effect of supply and demand factors as well as licensing regulations on the prices of filling a cavity and provid-

TABLE 7

ORDINARY LEAST SQUARES ESTIMATES OF THE IMPACT OF STATE LICENSING REGULATIONS ON THE LOGARITHM OF PRICES OF DENTAL SERVICES ($N = 50$)

	DEPENDENT VARIABLE: LOG PRICE OF FILLING A CAVITY		DEPENDENT VARIABLE: LOG OF WEIGHTED PRICE OF THE MOST COMMON PROCEDURES IN THE AIR FORCE SAMPLE	
INDEPENDENT VARIABLE	(1)	(2)	(3)	(4)
Restriction index of statute	.01	...	.009	...
	(.008)		(.008)	
Pass rate	−.01*	...	−.01*	...
	(.003)		(.003)	
High regulation	...	.11*	...	.11*
		(.06)		(.06)
State per capita income	.03*	.04*	.04*	.05*
	(.01)	(.01)	(.01)	(.01)
Academic ability	−.04	−.03	−.03	.03
	(.05)	(.04)	(.04)	(.04)
Fluoridation	−.001	−.001	−.001	−.001
	(.0007)	(.0008)	(.0007)	(.001)
Constant	−4.97	8.01	−4.35	7.72
	(12.14)	(13.34)	(11.31)	(12.31)
R^2	.60	.48	.64	.54
F-test for joint significance of the restrictiveness variables	7.99*	...	7.73*	...
Mean and standard deviation of the dependent variable ($)	43.10		47.42	
	(8.04)		(8.67)	

NOTE.—Estimated with controls for state-level measures of education, percent minority, average time of residence in the state, and age^2. Estimates of high regulation relative to medium and low regulation are presented. There are no significant effects of high and medium regulation relative to low. Standard errors are in parentheses.

* Significant at the .05 level.

ing the most needed dental services by the Air Force recruits are presented in Table 7. The estimates shown in the first two columns relate the effect of licensing variables, measured both as pass rates and statutory provisions, on the state prices of a standard dental filling, the most common corrective dental procedure in the United States. In columns 3 and 4, estimates are geared to the dental correction needed in our sample. Each corrective procedure was weighted by its use in the Air Force sample and priced by state to form estimates of the weighted average cost of those procedures in each state, which is the dependent variable.

The log dental price regressions in Table 7 show that tougher licensing, as measured by the pass rate or the overall measure of restrictiveness of the state, is associated with an increase in prices. Using the results from the

table, a state that changed from a low or medium to highest restrictiveness could expect to see an increase in the price of dental services of about 11 percent. This result is in the low range of estimates of between 8.5 and 18 percent found by Shepard in the 1970s for the effect of more restrictive dental licensing on prices[54] and is consistent with the statistical results cited in the literature review. We also simulated the effect of a person in Kentucky, a low-regulation state, with one standard deviation above average dental deterioration using the Air Force recruits' data, and assumed that he had his dental corrections performed in California—a state with tough licensing laws and procedures. The effect would be to increase the overall costs by $1,630 for the types of dental procedures this person needed, after adjusting for general price-level differences in the two states.

Given the increase in prices shown in Table 7, are there similar increases in hourly income or salaries by dental practitioners? In Table 8 we use data from the 1 percent sample from the 1990 Public Use Sample from the census to attempt to answer this question. We obtained the individual files from all persons in the data set who listed themselves as private-practice dentists with their hours worked in dentistry, total earnings from dentistry, and other socioeconomic characteristics. There were 3,361 such dentists in the sample who made over $5,000 from their dental practices and were under 65 years of age, our criteria for inclusion. This is the cohort that was most likely to have treated the persons in the Air Force sample.

In Table 8 we estimate the effect of pass rates and state statutes or, alternatively, the effect of being in a high- or medium-regulation state relative to a low-regulation state on the usual hourly earnings of the Public Use Sample dentists.[55] In columns 1–4, we present the estimated wage equation with controls for standard human capital variables, the mean scores of the entering dentists to the major dental school in the appropriate state, and a dummy variable for whether that state was part of a regional testing program in 1990 (when these programs became widespread). The standard errors are corrected for grouped data.[56] We find in columns 1 and 2 that a 10 percent increase in the pass rate is associated with a significant 6 percent decrease in hourly dental earnings. The results using categorical variables in column 3 show that dentists in the most regulated states earn a statistically significant 12 percent more than practitioners in the least regulated

[54] Shepard, *supra* note 1.

[55] We also estimated the equations with average annual earnings from Steven Ruggles *et al.*, Integrated Public Use Microdata Series (IPUMS), Ver. 2.0 (1997), as the dependent variable and found similar results to those presented in Table 7.

[56] Moulton, *supra* note 48.

TABLE 8

ORDINARY LEAST SQUARES ESTIMATES OF THE IMPACT OF STATE LICENSING REGULATIONS ON HOURLY EARNINGS FROM DENTISTRY (N = 3,361)

	DEPENDENT VARIABLE: LOG OF HOURLY EARNINGS			
INDEPENDENT VARIABLE	(1)	(2)	(3)	(4)
Intercept	−.55	−.75	−1.28*	−1.29*
	(.46)	(.46)	(.37)	(.36)
High regulation	. . .	. . .	.12*	.11*
			(.04)	(.04)
Medium regulation	. . .	. . .	.03	.03
			(.03)	(.04)
Restrictiveness of statute	−.01	−.01	. . .	. . .
	(.01)	(.02)		
Pass rate	−.006*	−.005*	. . .	. . .
	(.002)	(.002)		
Female	−.45*	−.45*	−.45*	−.45*
	(.05)	(.05)	(.05)	(.05)
Nonminority	.20*	.21*	.20*	.21*
	(.06)	(.06)	(.05)	(.06)
Age	.16*	.16*	.16*	.16*
	(.01)	(.01)	(.01)	(.01)
Age^2	−.002*	−.002*	−.002*	−.002*
	(.0001)	(.0001)	(.0001)	(.0001)
Citizen	.14*	.14*	.14*	.14*
	(.06)	(.06)	(.05)	(.06)
Married	.20*	.20*	.20*	.20*
	(.04)	(.04)	(.04)	(.04)
Academic ability	.05	.07	.08	.08
	(.05)	(.05)	(.05)	(.04)
Region	No	Yes	No	Yes
R^2	.20	.20	.20	.20
F-test for joint significance of the restrictiveness variables	4.82*	4.09*	6.21*	5.47*
Mean and standard deviation of the dependent variable	41.02 (43.58)			

NOTE.—Estimates include a dummy for those states that were part of a regional testing service. Standard errors are in parentheses and include corrections for group biases.

* Significant at the .05 level.

states. We add controls for the major census region in which the dentists lives in column 4 of the table to control for regional effects that our other variables may not be capturing. With these additional controls the estimate falls to a still statistically significant 11 percent using the categorical variables for state regulation. Alternative estimates with varying specifications using pooled state time-series data gave similar results.[57] The estimates

[57] We used state-level data from the American Dental Association published in Council on Dental Education, Suppl. 11 to the Annual Report 86/87 1–27 (1987), along with data

from the table show that dentists could increase their wages by practicing in the most restrictive states.

II. Conclusions

We have analyzed the effect of stricter occupational licensing requirements on economic outcomes, dental prices, and earnings using dental records of the consumers of these services. Prior studies failed to examine fully the potential benefits of the licensing process, including the potential increase on both quality and quantity of service sector outputs. Initially, we reviewed the empirical literature on occupational licensing. Next, we sketched a model linking regulation to the flow of new dentists as well as to quality and prices. We then developed necessary data using an especially designed instrument that linked Air Force recruit dental exams with socioeconomic characteristics. Alternative multivariate statistical models were used to test the effect of more restrictive licensing provisions, first on dental outcomes and then on the prices of dental service prices and practitioner earnings.

Given the model in Figure 1, we are able to provide some evidence on how tougher dental regulation reduces the flow of dentists to the states over time. We also show that stricter regulation raises prices but has no effect on untreated deterioration. If our model is correct, this occurs through higher quality dental visits and hence greater demand at any full price, an unobservable in our data. On the other hand, more stringent regulation does not appear to affect some indirect measures of service quality, such as lower malpractice premiums or fewer patient complaints. We leave to future research to show how, or if, this relationship can be empirically verified.

Our multivariate estimates show that increased licensing restrictiveness did not improve dental health, but it did raise the prices of basic dental services. Further, using several tests for the robustness of our estimates, we found that the states with more restrictive standards provided no significantly greater benefits in terms of lower cost of untreated dental disease. Our estimates of the price equations show that more regulated states have somewhat higher dental prices. In addition, more regulated states have dentists with higher hourly earnings. These results are consistent with the view

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from the U.S. Census Bureau, Statistical Abstract of the United States (1988), in a pooled time-series estimate of high and medium versus low levels of regulation from the 38 largest states from 1978 to 1987 (the only years for which we could obtain full data for all of our covariates) on the log of dentists incomes. We found a coefficient value of .10 (SE = .06) with controls for state per capita income, academic ability of dental school entrants, level of fluoridation in the state, education level, percent minority, average age of the residence in the state, and age^2. These results are available from the authors.

that tougher licensing standards imposed by the most rigid state statutes and administrative procedures may be an unnecessary restriction on entry with little to no benefit to the public. Consequently, moving toward more restrictive policies that limit customer access to these services could reduce the welfare of consumers.

These results do not provide evidence to support or reject the overall efficacy of occupational licensing as an institution relative to a regime of, for example, certification that does not restrict occupational entry by statute. Rather, our analysis addresses only the potential costs and benefits to consumers of developing more rigid standards in states that have relatively relaxed ones. To the extent that states are considering a reduction in the pass rate on dental exams or making it more difficult for out-of-state practitioners to enter, our analysis suggests that there would be no gains to consumers in terms of overall dental health. Further, although our analysis applies mainly to dental care of young adult patients, we also provide some evidence for the general population. We encourage more analysis of the type employed in this paper for other highly regulated occupations so that economists, consumers, and policy makers can more accurately assess the potential outcomes of licensing practices.

APPENDIX

TABLE A1

ESTIMATES OF A MODEL OF DENTAL HEALTH BASED ON INDIVIDUAL DEMAND-TOBIT ESTIMATES: TOTAL DENTAL DEPRECIATION ($N = 464$)

	DEPENDENT VARIABLE: LOG DOLLAR VALUE OF TOTAL DEPRECIATION		DEPENDENT VARIABLE: LOG DOLLAR VALUE OF TOTAL INCOME	
INDEPENDENT VARIABLE	(1)	(2)	(3)	(4)
Total depreciation	...	...	.095*	.094*
			(.009)	(.009)
High regulation	...	−.50	...	−.67
		(.51)		(.41)
Medium regulation	...	−.23	...	.039
		(.42)		(.37)
Restrictiveness of statute	−.01	...	−.01	...
	(.031)		(.05)	
Pass rate	−.03	...	.05	...
	(.025)		(.02)	
Price of prevention	−.0009	.002	.002	.007
	(.004)	(.005)	(.005)	(.010)
Price of correction	.019	.011	.005	.002
	(.021)	(.012)	(.03)	(.016)
Income per family member	−.0008	−.001	−.002	−.001
	(.009)	(.009)	(.012)	(.02)
Education	.032	.034	.134*	.14*
	(.055)	(.055)	(.071)	(.07)
Insurance coverage	−.203	−.191	.859*	.869*
	(.222)	(.222)	(.282)	(.282)
Academic ability of dentists in the state	.081	.053	.534	.375
	(.292)	(.267)	(.369)	(.337)
Fluoridation	.003	.003	.005	.005
	(.003)	(.003)	(.003)	(.003)
Constant	.205	2.94	−9.06	−3.48
Log likelihood	−987.45	−987.17	−990.59	−990.04
Likelihood ratio test for joint significance of restrictiveness variables	1.23	1.80	2.49	3.57

NOTE.—Estimated with controls for gender, race, age, childhood in military, and missing values. Standard errors are in parentheses and include corrections for group biases.

* Significant at the .05 level.

TABLE A2

REDUCED-FORM TOBIT ESTIMATES AND THEIR MARGINAL EFFECTS OF THE IMPACT OF STATE LICENSING REGULATIONS ON UNTREATED DENTAL DETERIORATION ($N = 464$): DOLLAR VALUES FROM STATE-LEVEL PRICES

	DEPENDENT VARIABLE: DOLLAR VALUE OF UNTREATED DETERIORATION/TOTAL DEPRECIATION							
INDEPENDENT VARIABLE	(1)	Marginal Effects (2)	(3)	Marginal Effects (4)	(5)	Marginal Effects (6)	(7)	Marginal Effects (8)
High regulation	...	...	−.066	−.046	...	...	−.02	−.02
			(.073)				(.09)	
Medium regulation	...	...	−.118	−.082	...	...	−.08	−.06
			(.056)				(.07)	
Restrictiveness of statute	.008	.006	...	...	.010	.007	...	...
	(.005)				(.005)			
Pass rate	.004	.003	...	...	.002	.001	...	...
	(.003)				(.005)			
Income per family member	−.003	−.002	−.003	−.002	.001	.001	.001	.0001
	(.002)		(.002)		(.002)		(.002)	
Education	−.023*	−.016	−.023*	−.016	−.028*	−.02	−.027*	−.02
	(.012)		(.011)		(.010)		(.01)	
Insurance coverage	...	...	...	...	−.26*	−.18	−.26*	−.18
					(.06)		(.06)	
Academic ability of dentists in the state	...	...	...	...	.02	.01	.004	.003
					(.06)		(.053)	
Fluoridation	...	...	...	...	.0003	.0002	.0002	.0002
					(.001)		(.001)	
Constant	.231		.675		.865		1.041	
	(.345)		(.146)		(.740)		(.42)	
Log likelihood	−348.60		−347.48		−327.18		−326.97	
Likelihood ratio test for joint significance of restrictiveness variables	1.83		4.07		1.60		2.02	

NOTE.—Estimated with controls for gender, race, age, childhood in military, and missing values. Standard errors are in parentheses and include corrections for group biases.

* Significant at the .05 level.

TABLE A3

REDUCED-FORM TOBIT ESTIMATES AND THEIR MARGINAL EFFECTS OF THE IMPACT OF STATE LICENSING REGULATIONS ON UNTREATED DENTAL DETERIORATION (N = 441): DELETING OUTLIERS AT THE TOP 5%

	DEPENDENT VARIABLE: DOLLAR VALUE OF UNTREATED DETERIORATION/TOTAL DEPRECIATION							
INDEPENDENT VARIABLE	(1)	Marginal Effects (2)	(3)	Marginal Effects (4)	(5)	Marginal Effects (6)	(7)	Marginal Effects (8)
High regulation	...	...	−.073	−.049	...	...	−.02	−.01
			(.075)				(.09)	
Medium regulation	...	...	−.101	−.068	...	...	−.07	−.04
			(.055)				(.07)	
Restrictiveness of statute	.009	.006	...	...	.010	.007	...	...
	(.005)				(.005)			
Pass rate	.005	.003	...	...	.003	.002	...	...
	(.003)				(.005)			
Income per family member	−.002	−.002	−.003	−.002	.001	.001	.001	.001
	(.002)		(.002)		(.002)		(.002)	
Education	−.023*	−.016	−.023*	−.016	−.028*	−.02	−.027*	−.02
	(.011)		(.011)		(.010)		(.01)	
Insurance coverage	...	...	...	...	−.24*	−.17	−.25*	−.17
					(.05)		(.01)	
Academic ability of dentists in the state	...	...	...	...	.02	.01	−.002	−.001
					(.06)		(.056)	
Fluoridation	...	...	...	...	.0006	.0004	.0005	.0003
					(.001)		(.001)	
Constant	.086		.625		.569		.933*	
	(.336)		(.141)		(.759)		(.43)	
Log likelihood	−329.67		−329.50		−309.53		−309.88	
Likelihood ratio test for joint significance of restrictiveness variables	2.45		2.81		1.89		1.18	

NOTE.—Estimated with controls for gender, race, age, childhood in military, and missing values. Standard errors are in parentheses and include corrections for group biases.

* Significant at the .05 level.

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