NBER WORKING PAPER SERIES

DOES REGULATION IMPROVE OUTPUTS AND INCREASE PRICES?: THE CASE OF DENTISTRY

Morris M. Kleiner
Robert T. Kudrle

Working Paper 5869

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
January 1997

The authors would like especially to thank Linda Colbeth, Dr. Judith Levin Marshall, In-Gang Na, Lekha Subaiya, and Donghoon Yang for their assistance with this paper. We thank John Budd, Richard Butler, Richard B. Freeman, Jonathan Gruber, and Brian McCall as well as participants at seminars at the London School of Economics and the University of Minnesota for helpful comments. This paper is part of NBER's research program in Labor Studies. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

Does Regulation Improve Outputs and
Increase Prices?: The Case of Dentistry
Morris M. Kleiner and Robert T. Kudrle
NBER Working Paper No. 5869
January 1997
JEL No. J51
Labor Studies

ABSTRACT

This study examines the role of variations in occupational licensing policies and practices in improving the outputs of services provided to consumers, and the effect of restrictive regulations on the prices of certain services. Theory suggests that more restrictive licensing may raise prices, but that it may also raise demand by reducing uncertainty about the competency of the services. This paper uses unique data on the dental health of incoming Air Force personnel to empirically analyze the effects of varying licensing stringency among the states. We find that tougher licensing does not lead to improved outputs, but does raise prices. Our results cast doubt on the principal public interest argument in favor of the impact of more strenuous licensing practices of the more restrictive states.

Morris M. Kleiner
Hubert H. Humphrey Institute of Public
Affairs and Industrial Relations Center
260 Humphrey Center
University of Minnesota
301 19th Avenue, South
Minneapolis, MN 55455-0411
and NBER
MKLEINER@HHH.UMN.EDU

Robert T. Kudrle
Hubert H. Humphrey Institute of Public
Affairs
163 Humphrey Center
University of Minnesota
301 19th Avenue, South
Minneapolis, MN 55455-0411

I. Introduction

Do more restrictive occupational licensing statutes and administrative procedures affect the quality of services received by consumers? Are the quality effects of restrictive occupational licensing provisions similar across income groups? Do tougher occupational licensing provisions increase the prices of the services provided?

There are two major views on restrictive licensing statutes. One view is that more restrictive licensing is an unnecessary barrier on the entry of individuals to occupations that serves mainly the interests of practitioners, with little or no benefit to the public [Shepard, 1978]. The main effects are assumed to drive up prices with potentially a negative impact on the quality of services received by consumers [Friedman and Kuznets, 1945]. The other perspective is that occupational licensing is necessary to reduce uncertainty in the minds of consumer as to the quality of the product [Arrow, 1971]. In this view, licensing also is seen as a way of further enhancing the formation of human capital which is perceived as being the primary method to enhance the quality of services provided [Shapiro, 1986]. Information asymmetry between sellers and consumers makes licensing a way of improving service quality. It also improves service by truncating the bottom of the quality distribution. Unfortunately, no rigorous empirical analysis has been able to answer these questions 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 quality of services rendered and on the prices of those services.

The general policy impact of occupational licensure has grown dramatically: from approximately 70 occupations in 1950 to over 500 in the late 1970s covering about 18 percent of

the U.S. work force [Kleiner, 1990]. With the shift to a more service-oriented economy, this licensed sector is expected to grow more rapidly than the rest of the economy. One argument holds that more rigorous regulatory devices have been used by these occupations to capture economic rents. Moreover, for low-income individuals in the United States, the issue of access to quality services in the regulated sector of the labor market, and the net impacts of highly restrictive licensing practices, have long been subjects of controversy [Rottenberg, 1980].

There are also international policy ramifications of state-by-state licensing in the United States For example, the licensing of occupations has been cited as a significant issue in recent trade/tariff negotiations between the United States and its major trading partners. The European Union has asserted that U.S. state-by-state licensing is an unnecessary impediment to the free movement of workers, while United States negotiators have argued that these restrictions maintain an adequate quality of services for Americans [Wall Street Journal, 1990].

Studies have compared the economic costs of state-by-state licensing relative to a system of nationwide endorsement where practitioners who are licensed in one state are admitted to practice in all other states without additional restrictions [Pashigian, 1980; Kleiner, Gay, and Greene, 1982]. 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 as a labor market policy. Before these types of policies are recommended, however, the balance of economic costs and benefits of the current system of occupational licensure needs to be examined.

Our analysis of occupational regulation finds that tougher state regulations for dentists are not associated with any improved quality of outputs for either new Air Force recruits or the

general population. Further, our state level estimates show that tougher regulations are associated with higher prices for certain services, and somewhat higher salaries. 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 impact 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 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 data used to estimate that model. We then specify alternative multivariate statistical models of the impact of more restrictive licensing provisions; first, on the quality of dental outputs, and then the prices of certain dental services. Our conclusions summarize our key results and present tentative policy implications.

A. Previous Results

Although many theoretical and empirical studies have examined the impact of occupational licensing on costs, relatively few studies have investigated the benefits that different forms of licensing may have by promoting higher quality services. This section will briefly review some of the major studies that have estimated the costs of licensing. We consider both theory and empirical evidence of the effects of licensing provisions on costs to the consumer. We will then review studies examining theoretical and empirical work on occupational licensure's potential benefits to consumers.

Several cost-focused studies have analyzed how occupational licensing affects the public interest [Maurizi, 1974]. Using data from the 1940s and 1950s, Maurizi regressed examination pass rates on a measure of excess demand for entry into a number of professions, among them dentistry. The evidence from pooled regressions supports the premise that licensing boards' power was used to maximize gains from excess demand for dental services.

A study specifically focused on dentistry estimated the costs of licensing on consumer surplus [Boulier, 1980]. The results from the model estimated both price and quantity equations using cross-sectional data of dental services in the 1960s as well as economic welfare gains. His main results indicate that removing licensing constraints on the mobility of dentists would raise the average price of dental services and reduce aggregate quantity of services produced nation-wide, but the reallocation of dentists would yield an increase in consumers' surplus and in the mean net incomes of dentists.

Shepard [1978] showed that the most restrictive state practices have caused the cost of dental care to increase significantly relative to less regulated states. Specifically, the study concludes that where regulatory authorities have constructed barriers to entry, dentists systematically raise fees. Overall, the annual national costs to consumers of dental services of this form of professional control was estimated at $700 million in the mid-seventies.

In spite of the apparent costs, the practice of licensure by state governments continues to grow, and policy makers seem to think that these practices have beneficial effects for their constituents. Proponents of stricter licensing standards, who often include the members of the licensed occupations, suggest that the quality of service offered is enhanced by making standards tougher.

It has been suggested that too much research effort has been directed at the effects of barriers to entry and too little on issues such as demand and the potential output effects [Benham, 1980]. Unfortunately, studies examining the potential benefits of occupational licensing have been hampered either by the difficulty of obtaining covariates or other data limitations. Often, the quality of licensing is measured by inputs rather than outputs [Carroll and Gaston, 1981]. For example, quality proxies in dentistry typically measure professionals' measures of their own busyness, rather than direct measures of dental health.

Arlene Holen attempted to measure the direct impact of more stringent licensing requirements on the quality of dental care by using data gathered from individual dental records [Holen, 1978]. Her results suggest that the benefits of licensing include: reduced probability of adverse outcomes, reduced variability in service quality, and greater consumer satisfaction. Holen's most persuasive measure of dental service quality was the amount of untreated or currently existing dental disease in U.S. Navy personnel. Unfortunately, there was no attempt to incorporate the impact of treatment price variation on this measure, although the theoretical literature suggests that price is critical in testing this relationship. Furthermore, many controls were either infeasible or otherwise not included in the Holen study. No control variables were included for whether this was their first encounter in the Navy dental system, socioeconomic status, geographic mobility, gender, race, previous places of residence, or dental insurance coverage.

In fact, a substantial part of their dental service may have been received in parts of the country far removed from their place of enlistment into the Navy. The assumption implicit in the empirical work was that all of the individual's dental care was received in the state in which he

lived prior to enlisting in the Navy. However, given the mobility of most Americans, this is an assumption that may limit the implications of the results toward states with nearby naval stations. Finally, the analysis does not include controls for the quality of the incoming pool of dentists into dental school and subsequent licensing. Clearly, the major gap in our knowledge of occupational regulation is in the effects of the alleged benefits of these policies and practices.

B. Analyzing Licensure Effects on Demand

Since the theory of entry reduction of the price of services is well developed, we will focus this section on the development of models that examine the quality and quantity of output [Scherer and Ross, 1990]. Current theory and evidence provide results that are inconclusive about the effects of occupational licensing upon 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 primarily at discovering the extent to which individuals' dental outcomes are affected by licensing restrictions on the occupation providing the service inputs. From this information we can develop a model to explore whether direct benefits or losses accrue to the consumer from licensing statutes.

Although this study focuses primarily on demand side effects, we do control for dental service prices in our model. Our estimates provide information on the extent of the fulfilment of the stated intention of pro-regulatory policy. If stricter occupational licensure does provide the consumer with information about higher minimum quality in the service markets, observable demand shifts should result from increasing the restrictiveness of licensure.

C. Output Measures and Consumer Welfare

To test whether a consumer has directly benefitted from more or less occupational licensure depends upon the model capturing the major characteristics of the services. These are the flows of services consumed -- often consumed for many years after the initial investment occurred. Thus, our demand model requires measures of multiple attributes of service outputs consumed. While such gauges might be termed quality measures, we will devise composite measures of dental health for the empirical model that are subject to continuous measurement.

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 guarantee that the services actually received by consumers are positively correlated with these proxy measures of input productivity, and the distinction between the number of inputs employed and the quality of output received are quite important. A dental example can establish the distinction between input and the final product. An inferior dentist may require multiple attempts to fill a tooth while another dentist requires only one [Oi, 1973]. Thus, if we define output in terms of frequency of visits or amount of material used in performing the repair, there is apparently a greater demand for the inferior service. This apparent paradox is resolved by recognizing that the consumption of many health services (outputs) continues far beyond service delivery. Instead of measuring the number of separate visits or fillings inserted, 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.[1]

More appropriate research measures of quality can be developed by considering the stock of dental health status HS. Let the depreciation rate of that stock per period as DR. DR lies between zero and one. Then, assuming a constant depreciation rate:

(1) $HS_t = (1 - DR)^t HS_o$

The depreciation rate, DR, is inversely related to the extent of personal and professional preventative investment made by the individual over t periods. We assume that a significant component of preventative care is service performed by professional agents. Another component is clearly related to the consumer's own service provision.

Cumulative depreciation can be written as

$$TD_t = \sum_{i=0}^{t} DR_i$$

where TD is total depreciation and DR is depreciation per period.

Second, a generalized construct of cumulative investment in corrective services can be specified as follows:

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, per period. Then:

$$HS_t = (1 - DR_t + CR_t)HS_{t-1}$$

Assuming a constant rate of net corrective intervention as well as deterioration[2]:

(2) $HS_t = (1 - DR + CR)^t HS_o$ thus we can define untreated deterioration as

$UD_t = HS_0 - HS_t$ [3]

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 (i.e., diet, general health status) [Kudrle and Meskin, 1983].

Let all other things be held constant, the rate (1-DR) will be a strictly increasing function of the quality and quality of prevention:

$$(1\text{-}DR) = f(P_1,P_2,P_3)$$

where P_1 = an index of personal preventive intervention

P_2 = an index of public prevention, fluoridation of public water supplies

P_3 = an index of professional intervention, 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 that are known to contribute to personal preventive behavior and a proclivity to use preventive services. We assume that the "tastes" for these services are normally distributed across individuals controlling for various other attributes. The dental care literature suggests that both unobserved prevention investments are positively correlated with family income and the household head's education level [Kudrle and Meskin, 1983].

The role of licensing is assumed to have its greatest impact on P_3 in above equation 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 drives consumer behavior. Moreover, in all states dentists direct, examine, and otherwise monitor all preventative and corrective care.

Licensing restrictiveness has two major effects on practitioners. First, individuals considering entering an occupation in a state may decide not to pursue that option if the pass rate is low. Statutory provisions such as a waiting period, or a retaking of a state portion of a licensing exam if an individual has qualified in another state may further reduce new entrants. Such procedures may increase the average quality of the instate dentists. Second, for most dentists choosing a state in which to locate, the lower pass rate means that they would stay in the state and study to retake exam, thus presumably enhancing their relevant 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.

D. Analyzing the Impact of Regulation on Outputs

Figure one shows the expected process of how occupational regulation impacts 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 flow of new dentists [Kleiner and Kudrle, 1992]. Over time this could negatively affect the dentist to population ratio in a state. The consequence of restricting entry is to reduce supply and increase the prices of dental services. The same regulatory factors are shown to influence the quality of dental care. Assuming that lower quality dentists are removed as entry restrictions are increased, the mean quality of a dental visit is increased, since the remaining dentists are of higher quality.[4] With this presumed enhancement in quality, the use of their services would increase as perceived quality grew [Leland, 1980]. This factor alone would

directly reduce untreated deterioration as shown in Figure one. However, higher dental prices alone would increase the overall extent of dental deterioration. On balance, the net impact of regulation on dental deterioration is theoretically unclear. The overall impacts on improved outputs of greater regulation needs to be decided with data and analysis.

The basic relationships derived from this analysis would suggest that the quality of a dental visit would be negatively related to the pass rate, PR, (or positively to the stringency of other regulation) in a state. 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 3:

(3) $VQ = f(PR, X_1)$

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

In contrast, an increase in the pass rate would enhance the access to dental services. This would occur as more dentists are available in the state, which would reduce the office waiting time for a visit and the time it takes to travel in order to see a dentist. This would be included in the implicit or full price for a dental visit, which we will call access. This relationship is shown in equation 4.

(4) $FP = f(PR, X_2)$

where FP is the price which includes waiting time, which is influenced negatively by the pass rate,[5] and X_2 is a set of other 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 with the guidance of a dentist by statute. Therefore, in equation 5 overall dental condition is a function of access and dental care quality.

(5) $QO = f(FP,VQ,X_3)$

where QO is the dental condition of a person in a certain jurisdiction and X_3 is a vector of other variables. In sum, dental demand depends on: (1) perceived quality, (2) money price, and (3) time price.

E. Concepts and Data

Two major difficulties have plagued previous studies of occupational regulatory effects relating to the modeling of the level of consumer benefits. First, they lacked data detailing statutes and pass rates as measures of restrictiveness for states. Second, they lacked comparative data on the results of services provided. Our data sets focus on both of these issues as well as problems that other researchers have stated should be dealt with in estimating the potential output benefits of occupational licensing.

Initially, we collected detailed statutory information from 1960 to 1987 for dentists, which we obtained from each state's statute codes, and then linked this to similar data gathered by the Council of State Governments [1987].[6] We obtained pass rate data from the American Dental Association. Prior research has shown that the pass rate is the key measure of restrictiveness when other state controls are accounted for [Maurizi, 1974; Getz, Siegfried, and Calvani, 1981; Kleiner, Gay, and Greene, 1982; and Kleiner and Kudrle, 1992].

Previous studies have employed pass rates with incomplete attention to the possible variation in their meaning across states. For example, a low pass rate in California could be controlling dental practice at a higher level of quality than a high pass rate in North Dakota if the average quality of the applicant is higher in California. We have attempted to deal with this problem by including a common quality factor in our estimating equation. 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.[7] In general, one dental school dominates the production of dentists for a given state. While somewhat approximate, this variable is used to control for the premarket education abilities of the stock of dentists [Neal and Johnson, 1996].

Developing the most appropriate new measures of the dependent and some independent variables used in this analysis involves several steps. First, as stated above we assembled measures for each significant dimension of restrictiveness allegedly contributing to quality enhancement. 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" that are subject to varying qualifications, although for the period that most of our sample was growing up there was a correlation of .60 for the states maintaining their either high or low level of restrictiveness from the beginning 1960, to the end of period which was 1987.[8] Second, indices were developed that allowed for the assessment of previous and current dental deterioration (TD), the amount of correction (TC) and the amount of correction needed to bring the individual to a disease-free state (TU). A smaller amount of untreated disease implies a higher dental health status.

A licensed dentist worked with us to develop the coding and examined the dental forms for each of the individuals who were examined by Air Force dentists who agreed to be in our sample, ensured that licensing standards and health outcome measures were appropriately specified. Even though we examine the regulatory requirements for becoming a dentist, we note that restrictiveness measures for dentists and hygienists are highly correlated across states using the Council of State Governments measures of these requirements at around a simple correlation of .90.

Because there are likely to be concerns regarding the reliability and validity of various elements of the restrictiveness index, alternative formulations were devised. The indices were devised with the object of maximizing the probable quality of a typical set of services to an individual twenty-one years of age. 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. We used this measure both independently and as the basis of an overall measure of licensing restrictiveness.

In order to obtain variables for individuals in the specified model we employed a unique source of medical and demographic data from the personnel records of the United States Air Force. In our investigation, we were unable to find any agency in the United States that routinely collects data that can properly control for environmental and demographic factors contributing to varying dental conditions. We collected data on a wide range of demographic and economic variables through a questionnaire administered by Air Force dental personnel to entering recruits. Other analysis has found that the socioeconomic backgrounds of military recruits, including Air Force recruits, very closely match the background of average Americans

[Boesel, 1989]. Data were gathered on the age, gender, race, and household income. The education of the head of the household and household income (corrected by number of members) were especially important because they were known from previous research to affect the demand for dental services [Kudrle, 1980; Kudrle and Meskin, 1983]. Fluoridation affects the incidence of cavities, the single most important dental 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. 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 last two years. Place of residence was also used to identify the restrictiveness of dental regulation at the state level.[9]

Table 1 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 matches the country as a whole (12.6 years and $29,458). Our sample contains over 23 percent of nonwhite Americans, but only 17 percent of the individuals in our data set are women.

Further, 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 impact of varying licensing procedures on the quality of services received for individuals who may be most adversely impacted by tougher regulation. Consequently, using the Air Force Base sample should enhance the generalizability of our results to other similar cohorts. The exact information obtained from the examinations and coding rules involved a recording of

dental corrections (CR) and any form of current tooth-related deterioration (DR). Periodontal information is not used in the study.[10]

Dental public health specialists have well-developed views about the constituents of health and to some extent their relative importance. In addition to formulation of CR and DR, which dental professionals would regard as appropriate measures of dental outcomes, we also will use a measure of the dollar value of the deviation from a disease-free dental condition [Christen, Park, Groves, Young, and Rahe, 1979]. We use the national average fees for general practitioners obtained from the 1992 survey from Dental Economics as the prices to bring each person in our sample up to the optimal level of dental care. This survey provides state-by-state averages for most major dental procedures for only the 1990s. We will use both the dollar value index and a more conventional index of dental condition developed by dental researchers to examine the robustness of our dual measures. In addition, ratios are developed of untreated dental problems to total dental depreciation and the dollar value of untreated to total depreciation. The means of these values as well as those for most of the other variables are also presented in Table 1.[11]

Since we asked each of the persons in our sample all the places they lived, we are able to create a data set of 464 observations, where each individual observation contains information on household variables and state characteristics weighted by time the person spent in the state. Since there is no clear consensus from the dental establishment regarding which stage of individual development or age has the greatest effect on dental outcomes, our analysis assigns equal weight to each age period.[12] Therefore, for each state observation we give proportional weights to each state characteristic based on how long the individual spent in that state.[13] Measures of heavy,

medium and light regulatory licensing statutes and entrance exams were developed by noting that the average pass rate for the United States was 85 percent. Levels below 80 percent with either no reciprocity or no endorsement provision for out-of-state dentists were termed as being heavily regulated. Medium regulations were those states with pass rates between 80 and 90% and a provision for reciprocity or endorsement. Light regulation included those states with pass rates above 90% and either a provision for reciprocity or endorsement.

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 have similar ages, interests, and career aspirations, this should reduce the unobservable variation relative to a randomly selected grouping of ages, interests, and aptitudes. An analysis of the general population would likely suffer from a wider variation in characteristics, including failing general health, that would be more difficult to control for using standard statistical approaches. Therefore, differences in untreated dental outcomes in our analysis would more likely be explained by economic, environmental, and policy variables about which we have data 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 monitor the results from our selected sample, we use other national data sets to examine quality and price effects. This also serves as additional sensitivity analysis of our Air Force data set.

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

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

(6) $TD_i = X_{i1}\beta + R_i\delta + \epsilon_i$

(7) $TC_i = X_{i2}\gamma + R_i\eta + \epsilon_i$

First, in equation 6, TD_i is the cumulative depreciation of the individual's dental condition drawn from clinical examination of Air Force recruits and aggregated by the amount of past and present expenditure estimated to bring the teeth for each individual to maximally repaired condition, or alternatively by a count of the number of treated and untreated diseased surfaces and missing teeth. X_{ij} is a vector of personal attributes of the Air Force recruits that include economic and demographic characteristics of the person as well as dental service price. R_i are the measures of state regulation including licensing provisions and county fluoridation measures of each recruit weighted by the length of time the person was in the state or area. β, δ, γ, and η are unknown parameter vectors and ϵ is an i.i.d. error term. Equations (6) and (7) are generated by individual demand for preventive and corrective care, respectively.

The independent variables in equation (6) includes ones that we posit determine personal, public health, and professional contributions to prevention. It should be stressed that the restrictiveness variable in this equation is for dentists only, as is the case in equation (7).

Second, TC in equation (7) is an index of corrective services. The independent variables in equation (7) include all of the variables found in equation (6) except the prevention price variable, which is captured indirectly by the inclusion of the (instrumented) accumulated

depreciation in the equation. In addition, a corrective price variable is employed.[14] An estimate of (6) using a Tobit specification to account for individuals who had no dental problems shows, not surprisingly, that unobservable personal and genetic characteristics dominate overall dental care; the equation is not significant. Unfortunately, the difficulty of explaining total deterioration implies an unsatisfactory instrumental variable which performs poorly in the second stage of an attempt to estimate total correction. An OLS estimate of (7), however, yields coefficient estimates quite consistent with the reduced form estimations to which we now turn.

In its reduced-form equation from equations (6) and (7) we can estimate UD/TD (untreated dental depreciation divided by total depreciation) as follows:[15]

(8) $UD_i / TD_i = X_{i3} \lambda + R_i \pi + \epsilon_i$.

where we have the reduced-form impact multiplier coefficients derived from (6) and (7). In this case the X_i is 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 π are unknown parameter vectors and ϵ_i is the error term.[16]

In large part the variable that is of most interest is the impact of the licensing variables on the amount of untreated dental outcomes at the time the individual entered the Air Force. 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 Table 2 we present estimates of the impact of licensing pass rates and statutes on the untreated dental outcomes and their marginal effects using a Tobit specification. 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 which took the value 1 when the mean was put in and 0 otherwise [Little and Rubin, 1987].[17] In our sample 68% had some uncorrected dental deterioration and 90% had some measurable deterioration during their lifetime. Given the number of zero observations in our data set, the Tobit specification corresponds to the appropriate functional form.[18]

The estimates presented for the independent variables in Table 2 are presented in the column along with additional controls for gender, race, and age.[19] Our estimates show that in columns 1 and 3 that the pass rate is not statistically significant. In columns 2 and 4 we show the impact of the categorical variables of high and medium restrictiveness relative to a regime of less tough regulation. All of the specifications consistently show that licensing had no impact on untreated dental deterioration. The only consistently significant variables in our models were health insurance and the education level of the sampled individual.

To test for model robustness, we employed several additional specifications. In one specification we included the dentists to population ratio along with the pass rate and found no significant changes in the results. We then 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 the table show that these variables are also not significant with low chi-squared scores.

We also examined the impact of the dentist to population ratio on untreated deterioration. In this case, we estimated the specified equation on only individuals who had some untreated dental deterioration. This sample included 318 individuals. Using the same model as the one in

Table 2, we found that the relative number of dentists was statistically significant at the .01 level in reducing untreated deterioration with a marginal effect of .08. These estimates suggest that stricter regulation is associated with fewer qualified dentists which, in turn, is related to greater untreated dental deterioration.

Sensitivity tests included a subsample of those persons who did not move and therefore had no change in their regulatory regime. This included 363 individuals in our sample. The estimates again showed no statistically significant impact of any licensing variables, but the effects of dental insurance again were robust. 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 our specifications.

Next, in order to attempt to further reduce the potential unobserved heterogeneity we grouped all those individuals who had incomes in the upper one-third of our income and education distribution, and had dental insurance and then created pairs of observations [Freeman and Kleiner, 1990]. These individuals may be assumed to have common socioeconomic characteristics. We then divided them into groups 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.[20] However, for individuals who were in the lowest income groups the mean values of untreated deterioration was 2 percent lower among those persons exposed to more regulation. The differences were not large by any standard measure.

One argument against tougher licensing standards is that individuals with lower incomes are more likely to be served by lower quality practitioners, and are the group most likely to see

their preferred service quality diminished. In Table 3 we test for this hypothesis by dividing our individual data set into three groups by income strata, and estimate Tobit equations. The last two columns include individuals with the lowest incomes in our data set, and licensing pass rates or statutes are not statistically significant. The variable that again was significant was the presence of insurance coverage. The signs are consistent with the theoretical model. These results do not show that stricter occupational licensing practices and policies has any beneficial impact for any of the income groups in our sample. Furthermore, the maximum likelihood test for the joint significance of the licensing provisions are not different from zero.[21]

As additional checks, we use two other measures of dental service quality in Table 4. In the first data set, 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 ten years experience as a dependent variable. Independent variables include state economic and demographic variables, 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 4, consistent with our earlier findings that regulation did not improve dental outcomes.

Overall, our results show that licensing does not improve dental health outputs as measured by our sample of dental recruits. Moreover, while Figure 1 suggests that stricter licensing could increase quality, outputs do not appear to be improved based on the failure of malpractice insurance rates or complaints against dentists to be lower where regulation is more stringent.

G. Impact of Tougher Regulations on the Prices of Dental Care

One of the key issues in occupational licensing has been the role of tougher regulations on dental service prices. We estimate price equations 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 this case, regulation can increase prices by either enhanced demand through better visits, or restricting the supply of dentists through the control of new entrants or migrants. In either case, prices are assumed to increase. The basic model is specified as follows:

$$(9) \qquad P_j = X_j\omega + R_j\mu + \epsilon_i$$

where P is the logarithm of the price for dental services faced in state $_j$, X_j is a vector of state supply and demand characteristics that influence the price of dental services in state $_j$ that include income in the state, education of the population, the quality of dentists, and the average age of persons in the state, R_j are measures of state licensing impact measured as licensing requirements and as an overall assignment of heavy, medium, and light levels of regulation, ω and μ are unknown parameter vectors and ϵ_i is an i.i.d. error term.

The ordinary least squares regression estimates of the impact of supply and demand factors as well as licensing regulations on the prices of the most commonly used corrective procedure and for a "market basket" of dental services are presented. The estimates shown in the first two columns of Table 5 relate the impact of licensing variables, measured both as pass rates and statutory provisions, on the state prices of a standard dental filling. This is the most common form of corrective dental procedure in the United States In columns 3 and 4 estimates are presented of the forms of dental correction found in our sample of Air Force recruits. Each

corrective procedure was weighted by its use in the Air Force sample, and priced by state to form the basis of state estimates of the weighted average cost of those procedures in each state. This then forms the basis of the dependent variable for the estimates shown in the Table.

The log of dental price regressions in Table 5 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. For example, a ten percent increase in the state pass rate would be associated with a similar reduction in the prices of these measures of dental services. Further, a state that changed from a low level of restrictiveness to one that was in the most restrictive grouping could expect to see an increase in the price of dental services of 14 to 16 percent. This result is in the high range of estimates found by Shepard in the 1970s of the impact of more restrictive dental licensing on prices of between 8.5 and 18 percent [Shepard, 1978], and is consistent with the statistical results of other analysts we cited in the literature review. We also simulated the impact of a person in Kentucky, a low regulation state, with one standard deviation above average dental care using the Air Force recruits' data, and assumed that he had his dental work performed in California -- a state with tough licensing laws and procedures. The impact would be to increase the overall costs by $1630 for the types of dental procedures this person needed, after controlling for income per capita differences in the two states.

We also estimated an equation of the impact of regulation on the logarithm of average dental salaries by state for the period 1978 through 1987. In the final column of Table 5, the estimate of a simple wage model of the impact of licensing on state level dental incomes is presented. We found that moving from a low to a high regulation state was associated with a moderately significant 10 percent income increase using the same controls as those listed in

Table 5 for the price equations. Given the lack of individual level controls and somewhat imprecise estimates these results should be viewed as merely suggestive of the impact of state dental regulation on dental salaries.

II. Conclusions

We have analyzed the impact of stricter occupational licensing requirements on the quality of outcomes and dental prices using actual dental records of consumers. 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. We modeled a demand based approach to the relationship of prevention and correction of dental deterioration. We developed a construct that helped examine the importance of personal, public, and professional intervention. This extension of current theory provided the basis for gathering the kind of data we needed to examine the relationship of licensing to consumer welfare. Next, we showed how regulation influences both the number of dentists, and the quality of a dental visit. Prices can then affect net deterioration.

Our data gathering focused on getting information that both measured the stringency of occupational licensing and outputs of dental services, and prices. Initally, we gathered data from the published pass rates obtained from the American Dental Association and from statutes governing dental licensing. We also gathered a unique data set of survey and administrative records from new recruits into the U.S. Air Force and measured outcomes in terms of the dollar value of untreated dental disease, as well as other data reflecting the national population.

Our multivariate estimates showed that increased licensing restrictiveness did not improve dental health, but did raise the prices of basic dental services. Further, using pairing techniques for tougher versus less rigorous states in terms of their licensing standards, we found that the states with the more restrictive standards provided no significantly greater benefits in terms of lower cost of untreated dental disease. Our estimates on the price equations are consistent in showing that more regulated states have higher dental prices. Consequently, overly restrictive policies that limit customer access could reduce the welfare of consumers. These results are consistent with the view that tougher licensing standards imposed by the most rigid state statutes and administrative procedures may be an unnecessary restriction on the entry of individuals with little to no benefit to the public.

These results do not provide evidence to support or refute the overall role of occupational licensing as an institution relative to a regime of, for example, certification which does not restrict occupational entry by statute. Rather our analysis is only focused on 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 developing more difficult standards regarding reducing the pass rate on dental exams or making it more difficult for out of state practitioners to enter, then our analysis suggests that there would be no gains to consumers in terms of better dental care. Further, our analysis applies mainly to dental care of young adult patients, although we also provide some evidence for more general quality outcomes. We therefore 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 these practices.

TABLE I
Means and Standard Deviations of Measures of Dental Quality, Individual, and State Characteristics
1992

Variable	Mean	Standard Deviation
Quality Measures (N=464)		
Total Dental Depreciation	$658	760
Dollar value of untreated correction	$223	327
Dollar value of previous treatment	$435	657
Indexed untreated correction	3.4	4.1
Indexed total correction	9.37	12.06
Price of filling	$44.84	7.17
Price of Cleaning	$76.52	15.98
Individual Characteristics (N=464)		
Percent male	82.7	37.8
Percent nonwhite	24.8	43.2
Years of education	12.7	1.99
Age	21.60	2.46
Household size	2.62	1.78
Family income	$27,842	19,398
Percent dental insurance coverage	57.9	49.5
Average dental visits (last two years)	2.63	2.55
State characteristics (N=50)		
Fluoridation rate	53.25	41.21
Average malpractice Fees (for dentist with 10 years experience)	$1,912	761
Average quality of dentists in state dental school	4.68	.39
Weighted pass rate	85.8	6.98
Endorsement statute (percent)	50.4	50
Citizenship requirement (percent)	8.18	28

TABLE II

Reduced-Form Tobit Estimates and Their Marginal Effects of the Impact of State Licensing Regulations on Untreated Dental Deterioration[1] (N=464)[2]

	DEPENDENT VARIABLE							
	Untreated Deterioration/Total Depreciation				Dollar Value of Untreated Deterioration/Total Depreciation			
INDEPENDENT VARIABLES[3]		Marginal Effects		Marginal Effects		Marginal Effects		Marginal Effects
High restrictive	---		-.03 (.08)	-.03	---	---	.02 (.08)	.01
Medium restrictive	---		-.08 (.07)	-.06	---	---	-.02 (.06)	-.01
Lesser restrictiveness of statute	-.02 (.029)	-.02	---	---	-.031 (.029)	---	---	--
Pass rate	.005 (.005)	.004	---	---	.004 (.005)	.004	---	---
Price of prevention	.0007 (.0020)	.001	.000 (.002)	.00	.000 (.001)	.00	-.002 (.005)	-.00
Price of correction	.006 (.004)	.001	.002 (.005)	.00	.005 (.004)	.004	.002 (.005)	.00
Income per family member	.002 (.002)	.000	.002 (.002)	.00	.002 (.002)	.001	.002 (.002)	.00
Education	-.032* (.012)	.001	-.03* (.01)	-.02	-.029* (.012)	-.02	-.028* (.01)	-.02
Insurance coverage	-.28* (.05)	-.16	-.27* (.05)	-.19	-.26* (.05)	-.18	-.26* (.05)	-.18
Academic ability of dentists in the state	-.034 (.072)	-.019	-.04 (.07)	-.02	.04 (.07)	.03	.02 (.07)	.02
Fluoridation	.0005 (.0005)	-.01	.0004 (.0006)	.00	.0002 (.0006)	.00	.0003 (.0005)	.00
Constant	.712 (.868)	---	1.34 (.46)	---	.35 (.87)	---	.87 (.47)	---
Log likelihood	-329.90	---	-329.85	---	-330.09	---	-330.85	---
Maximum likelihood test for joint significance of restrictiveness variables	1.54	---	1.64	---	1.72		.20	

[1]With controls for gender, race, age, childhood in military, and missing values.

[2]Standard errors are in parenthesis.

[3]Asterisk indicates significance at the .05 level.

TABLE III

Reduced-Form Estimates by Income of the Impact of State Licensing Regulations on the Dollar Value of Untreated Dental Deterioration[1]

Dependent Variables	**Dollar Value of Untreated Deterioration[2]/Total Depreciation**					
Independent Variables[3]	**High Income N=153**		**Middle Income N=158**		**Low Income N=153**	
Pass rate	.003	---	.007	---	---	.009
	(.010)		(.008)			(.009)
Lesser restrictiveness of statute	-.037	---	-.019	---	---	-.01
	(.054)		(.048)			(.04)
High restrictiveness	---	.06	---	-.05	.03	---
		(.16)		(.15)	(.14)	
Medium restrictiveness	---	.03	---	-.06	.02	---
		(.13)		(.11)	(.11)	
Price of prevention	.003	-.001	-.004	-.003	.002	.002
	(.003)	(.010)	(.003)	(.003)	(.003)	(.003)
Price of correction	-.001	.002	.007	.005	.001	.007
	(.008)	(.003)	(.007)	(.007)	(.001)	(.007)
Education	-.03	-.03	-.013	-.009	-.04	-.04*
	(.02)	(.02)	(.020)	(.023)	(.02)	(.017)
Insurance coverage	-.15	-.14	-.35*	-.29*	-.27*	-.22*
	(.12)	(.12)	(.086)	(.086)	(.08)	(.06)
Academic ability of dentists in the state	.14	.12	.029	.02	-.08	-.04
	(.14)	(.13)	(.12)	(.12)	(.11)	(.09)
Income	.004	.004	.02	.02	.02	.01
	(.003)	(.004)	(.019)	(.019)	(.02)	(.02)
Constant	-.50	-.87	-.29	.83	1.87*	2.00
	(1.58)	(.92)	(1.49)	(.79)	(.83)	(1.57)
Log-likelihood	-110.17	-108.38	-103.56	-103.83	-103.27	-102.92
Maximum likelihood test for joint significance of restrictiveness	.78	.09	.63	.21	.56	.21

[1]With controls for gender, race, age, childhood in military, fluoridation, and missing values.
[2]Standard errors are in parenthesis.
[3]Asterisk indicates significance at the .05 level.

TABLE IV

Ordinary Least Squares Estimates of the Impact of State Licensing Regulations on State Complaint Rates and Malpractice Insurance Premiums[1] (N=50)[2]

	DEPENDENT VARIABLES			
INDEPENDENT VARIABLES[3]	Complaint Rates		Log Insurance Premiums	
Restriction index of statute	.03 (.02)	---	.04 (.06)	---
Pass rate	.002 (.004)	---	-.008 (.010)	---
High regulation	---	-.02 (.07)	---	.13 (.20)
Medium regulation	---	-.06 (.06)	---	-.03 (.15)
State per capita income	-.01 (.01)	-.008 (.014)	.13* (.04)	.14* (.04)
Academic ability	.04 (.05)	.03 (.001)	-.13 (.13)	-.10 (.13)
Fluoridation	-.0002 (.0008)	-.0001 (.0008)	-.003 (.002)	-.002 (.008)
Constant	12.98 (14.13)	10.65 (14.08)	9.78 (36.98)	14.00 (36.55)
R^2	.10	.08	.30	.29
F-test for joint significance of the restrictiveness variables	1.05	.62	.64	.57

[1]Estimated with controls for state level measures of education, percent minority, average age of residence in the state, and age-squared.

[2]Standard errors are in parenthesis.

[3]Asterisk indicates significance at the .05 level.

TABLE V

Ordinary Least-Squares Estimates of the Impact of State Licensing Regulations on the Logarithm of Prices of Dental Services and Salaries[1] (N=50)[2]

	DEPENDENT VARIABLES				
INDEPENDENT VARIABLES[3]	Log Price of Filling a Cavity		Log of Weighted Price of the Most Common Procedures in the Air Force Sample		Log of Dental Salaries 1978-87
Restriction index of statute	-.008 (.020)	---	.003 (.018)	---	---
Pass rate	-.01* (.003)	---	-.01* (.002)	---	---
High regulation	---	.16* (.06)	---	.14* (.06)	.10* (.06)
Medium regulation	---	-.06 (.05)	---	-.06 (.04)	.05 (.04)
State per capita income	.04* (.01)	.05* (.01)	.05* (.01)	.05* (.01)	.02* (.01)
Academic ability	.03 (.04)	-.24 (.60)	---	.01 (.04)	.02 (.04)
Fluoridation	-.001 (.001)	-.03 (.005)	---	-.0007 (.0006)	.0005 (.0006)
Constant	-2.44 (12.05)	3.10 (11.23)	3.22 (.29)	3.00 (10.45)	47.55 (21.23)
R^2	.60	.56	.64	.68	.60
F-test for joint significance of restrictiveness variables	7.01*	11.24*	7.15*	10.47*	1.53

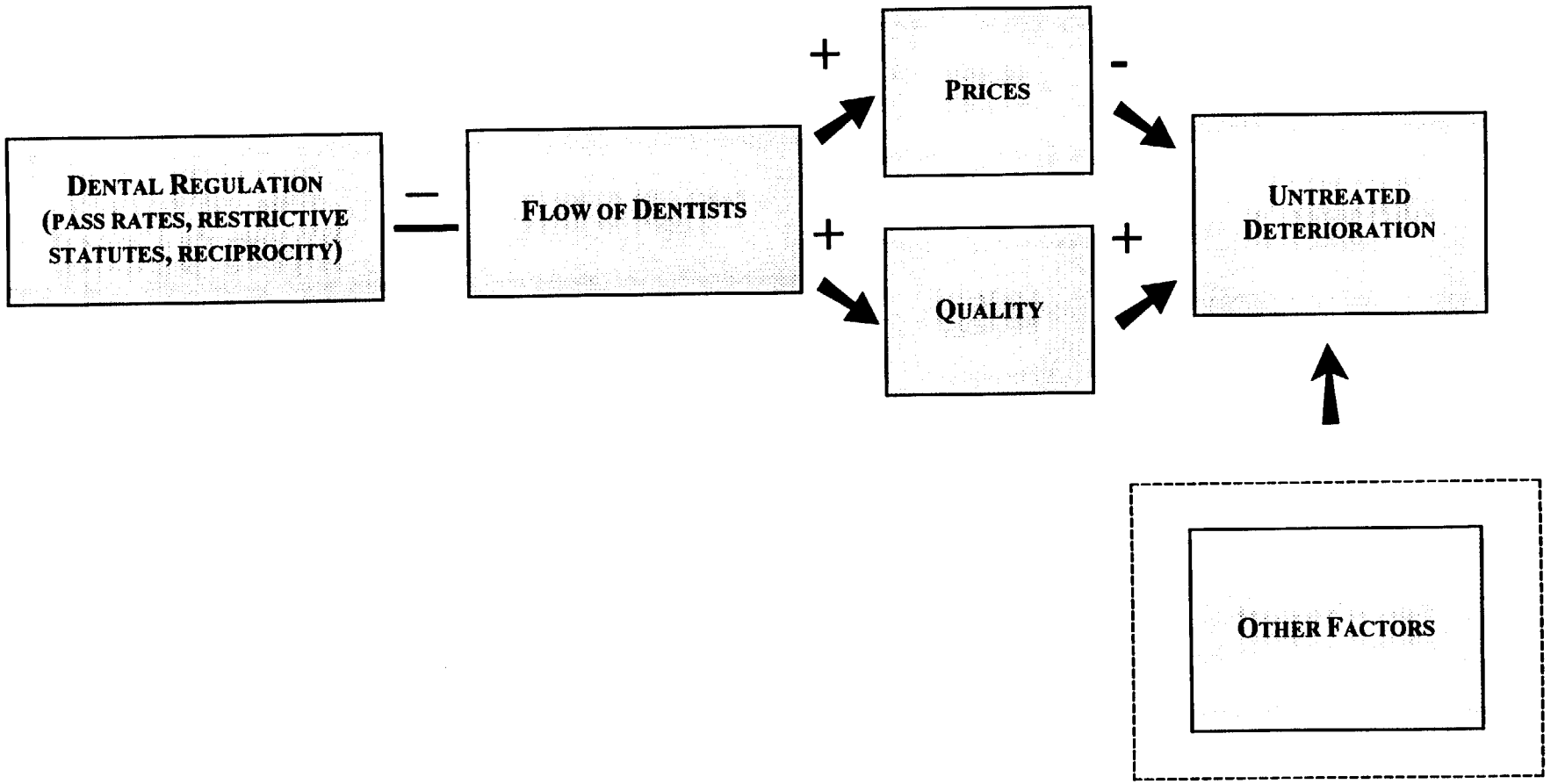
[1]Estimated with controls for state level measures of education, percent minority, average age of residence in the state, and age-squared.

[2]Standard errors are in parenthesis.

[3]Asterisk indicates significance at the .05 level.

FIGURE I

Regulation's Impact on Untreated Dental Deterioration



REFERENCES

Arrow, K. J. Essays in the Theory of Risk-Bearing, Chicago, IL: Markham Publishing Co., 1971.

Benham, L. "The Demand for Occupational Licensure," Occupational Licensure and Regulation, S. Rottenberg, ed. Washington, DC: AEI, 1980, 13-25.

Boesel, David. "The DOD Survey of Recruit Socioeconomic Backgrounds." Washington, DC: U.S. Defense Manpower Data Center, 1989.

Boulier, B. "An Empirical Examination of Licensure and Licensure Reform on the Geographic Distribution of Dentists," Occupational Licensure and Regulation, S. Rottenberg, ed. Washington, DC: AEI, 1980, 73-97.

Carroll, S. L., and R. J. Gaston. Occupational Restrictions and the Quality of Service Received: Some Evidence, Southern Economic Journal, Vol. 47, No. 4, April (1981), 959-976.

Christen, A. G., P. R. Park, R. C. Groves, J. M. Young, and A. J. Rahe. "United States Air Force Survey of Dental Needs, 1977 Methodology and Summary of Findings," Journal of the American Dental Association, Vol. 98, March (1979), 726-730.

Council of State Governments. Occupational Licensing, Lexington, KY: Council of State Governments, 1987.

Freeman, Richard B., and Morris M. Kleiner. "The Impact of New Unionization on Wages and Working Conditions," Journal of Labor Economics, Vol. 8, No. 1 (1990), S8-S25.

Friedman, M., and S. Kuznets. Income from Independent Professional Practice, New York, NY: NBER, 1945.

Getz, M., J. Siegfried, and Terry Calvani. "Competition at the Bar: The Correlation Between the Bar Examination Pass Rate and Profitability of Practice," Virginia Law Review, Vol. 67, No. 5, June (1981), 863-885.

Holen, Arlene. The Economics of Dental Licensing, Final Report submitted to the Department of Health and Human Services, 1978.

Klein, H., C. E. Palmer, and J. W. Knutson, "Studies on Dental Caries: Dental Status and Dental Needs of Elementary School Children," Public Health Reporter, Vol. 53 (1938), 751-765.

Kleiner, Morris M. "Are there Economic Rents for More Restrictive Occupational Licensing Practices?" Proceedings, Industrial Relations Research Association, 1990, 177-185.

Kleiner, Morris M., R. Gay, and K. Greene. "Barriers to Labor Migration: The Case of Occupational Licensing." Industrial Relations, Vol. 21, No. 3 (1982), 383-391.

Kleiner, Morris M., and Robert T. Kudrle. "Do Tougher Licensing Provisions Limit Occupational Entry: The Case of Dentistry?" National Bureau of Economic Research, Working Paper 3984, 1992.

Knutson, J. W., H. Klein, and C. E. Palmer. "Dental Needs of Grade-School Children in Hagerstown, Maryland," Journal of the American Dental Association, Vol. 27 (1940), 579-588.

Kudrle, Robert T. "Dental Care, Chapter 12," National Health Insurance: Conflicting Goals and Policy Choices, J. Feder, J. Holahan, and T. R. Marmor, eds. Washington, DC: The Urban Institute, 1980.

Kudrle, Robert T., and L. Meskin. "Introduction," Reducing the Cost of Dental Care, R. T. Kudrle and L. Meskin, eds. Minneapolis, MN: University of Minnesota Press, 1983.

Leland, Hayne E. "Minimum quality Standards In Markets with Assymetric Information," Occupational Licensure and Regulation, S. Rottenberg, ed. Washington, DC: AEI, 1980, 265-284.

Little, Roderick, and D. Rubin. Statistical Analysis with Missing Data, New York, NY: John Wiley and Sons, 1987.

Marcus, M., A. L. Koch, and J. A. Gershen. "An Empirically Derived Measure of Oral Health Status for Adult Populations," Journal of Public Health Dentistry, Vol. 40, No. 4, Fall (1980), 334-345.

Marcus, M., A. L. Koch, and J. A. Gershen. "Construction of a Population Index of Adult Oral Health Status Derived From Dentists' Preferences," Journal of Public Health Dentistry, Vol. 43, No. 4, Fall (1983), 284-294.

Maurizi, A. "Occupational Licensing and the Public Interest," Journal of Political Economy, Vol. 82, March/April (1974), 399-413.

Meskin, L. "Time for A Dental Board Checkup," Journal of the American Dental Association, Vol. 125, November (1994), 1418-1420.

Neal, Derrick, and W. R. Johnson. "The Role of Pre-Market Factors in Black-White Wage Differences," Journal of Political Economy, Vol. 104, October (1996), 869-895.

Oi, W. "The Economics of Public Safety," Bell Journal of Economics, Vol. 4, No. 1, Spring (1973), 3-28.

Pashigian, B. P. "Has Occupational Licensing Reduced Geographical Mobility and Raised Earnings?" Occupational Licensure and Regulation, S. Rottenberg, ed. Washington, DC: AEI, 1980, 299-333.

Rottenberg, S. "Introduction." Occupational Licensure and Regulation, Washington, DC: American Enterprise Institute, 1980, 1-13.

Scherer, F. M., and D. Ross. Industrial Market Structure and Economic Performance, Boston, MA: Houghton Mifflin Company, 1990, 15-56.

Shapiro, C. "Investment, Moral Hazard and Occupational Licensing," Review of Economic Studies, Vol. 53 (1986), 843-862.

Shepard, L. "Licensing Restrictions and the Cost of Dental Care," Journal of Law and Economics, Vol. 4, No. 1, April (1978), 185-201.

Vital Health Statistics. "Dental Statistics," (1988), 10.

Wall Street Journal. August 21, 1990, A-2.

ENDNOTES

1. 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.

2. If the rate of natural deterioration is constant over time and the efficacy of corrective interventions are not infinitely lived (which they typically are not), a constant net CR will mean a rising rate of gross CR because of the growing flow of deteriorating intervention, if one assumes that the correction deteriorates at a constant rate, i.e., where TC is total correction; GR is gross correction per period and r is the rate at which corrective interventions lose effectiveness.

$$TC_t = \sum_{i=0}^{t} GR_i(1-r)^i$$

3. The index of the investment rate in corrective services, CR, is assumed to be less than DR so that one can rule out improvements beyond a condition of "optimality" given the original structure. We assume, in order to avoid problems in these measures, that there are no contributions of purely cosmetic dentistry.

4. Unfortunately, the quality of a dental visit is an unobservable in our data set with the standard assumptions of the error term (μ, σ^2) of this factor.

5. As more dentists are available in a state, prices, including waiting time, would fall. 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.

6. They also cataloged new information on the licensure of dental hygienists and dental assistants.

7. For those states that have more than one dental school, the mean value of the overall scores for new dentists was used.

8. After 1987 dental board scores were reported by region rather than state. By checking regional results and using a shift-share allocation there did not appear to be qualitative change in the pass rates to 1991. More recently, the American Association of Dental Schools have adopted as a goal a policy of eliminating all state and regional licensing exams [Meskin, 1994].

9. Since military personnels' children 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.

10. 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.

11. The most widely used measure of overall dental health is the DMF (i.e., the number of decayed, missing and filled teeth) [Klein, Palmer and Knutson, 1938; Knutson, Klein and Palmer, 1940]. Marcus et al., constructed a more comprehensive index of adult oral health status [Marcus, Koch and Gershen, 1980, 1983]. The present study adopts some of the elements of that index, but it does not utilize the index as it was originally constructed because all of the required data are not available from the Air Force dental examinations. The DMF is considered to have a range of 0 to 128. The mean DMF for the sample was 13.5, with a range of 0 to 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 $435 (s.d. $657), while the average dollar amount to bring individuals to a disease free state is $223 (s.d. $327). All 50 states were represented in this analysis.

12. According to Dental Vital Statistics only one-third of persons under age 4 use dental services. We, therefore, also estimated our model assuming no dental care for persons of this age, and using this assumption had no qualitative impact on our basic results [Vital and Health Statistics, 1988].

13. In order to maintain consistency with Holen's analysis, 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 show no qualitatively different results than the ones shown in Tables 2 through 5.

14. It should be noted that equation (4) cannot be strictly correct. If DR is zero, then CR must be zero as well.

15. We also estimated total untreated dental depreciation with total correction as an independent variable with X_{ij} and π_{ij} and found no qualitative changes in our basic results.

16. In this model we do not include the number of visits to the dentist during the last two years since it would be potentially endogenous with untreated dental outcomes. 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 [1978] in her initial examination of this issue and found no qualitative differences.

17. Estimates using only those observations for which we had complete data on the covariates produced no qualitatitive differences in the results. These estimates are available from the authors.

18. We estimated the equations presented in Table 2 with 316 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 2.

19. Additional specifications that included controls for the interaction of the licensing variables and income showed no substantial changes in the results.

20. These estimates are available from the authors upon request.

21. All of the sensitivity tests of the models estimated in Table 2 were implemented for the equations in Table 3, and the results were consistent with those shown in Table 3.