Effects of differing radiography certification requirements on income and certification status of dental assistants

by

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Abstract

In recent decades, occupational licensing and certification has become a prevalent part of the U.S. economy and amongst the labor force. The dental assistant industry is a prime example of this labor theme as many are required to possess radiography certification to perform their most prominent task. Using data from the American Community Survey, the Current Populations Survey, and the Dental Assistant National Board, I modeled out the effects of differing certification regimes and the effects on income and certification status of dental assistants. Also, I use a state-level index that acts as a marker of the Scope-of-Practice dental assistants are permitted to accomplish in the workplace. States that do not impose a radiography certificate requirement sees certified dental assistants' incomes rise by 9.5%. This contrasts with states that impose some certification requirement which see a null effect on certified dental assistant income relative to those not certified. Also, those without a high school diploma benefit the most of any education group from the certification as their incomes rise by 40.5%. Finally, through the state-level variable *Prohibition Ratio*, I found states expanding the SOP of dental assistants while keeping the number of prohibited tasks the same, will raise the incomes of dental assistants

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I would like to thank my parents and the rest of my family for investing all their time, money, love and energy to keeping me going, cause without them, none of this would have been possible. I achieved the highest level of education in our family because of you all, this will be the greatest investments our family has ever made… so far.

Chapter 1 - Introduction

Occupational licensing has grown in prominence since the beginning of the modern era with nearly 1 in 4 workers requiring some form of licensing to work (Kleiner & Kruger, 2010; Kleiner & Kruger, 2013). The principal argument for occupational licensing has been that it acts as a signal of the quality of work a potential laborer is willing and able to do. As in every market, labor markets exhibit information asymmetries between buyers and sellers that could use some form of third-party apparatus to mitigate these asymmetries (Akerlof; 1970). Occupational licensing can be used to alleviate these costs from the asymmetry in a variety of different industries (Leland, 1979; Skarbek, 2008, Xia, 2021). This side shows a positive correlation between licensing and income as the alleviation of asymmetric information reduces employer's hiring costs.

The principal argument against occupational licensing sees it as a barrier to entry in the marketplace with some economists referring to it as a retrogression akin to medieval guilds and the Indian caste system where a select "few individuals are going to decide whether other individuals may pursue an occupation" (Friedman, 1962). Occupational licensing would constrict the freedom of laborers to choose what job they want to do by making illegal the unlicensed sale of these services and benefitting those already in the profession, leading to licensed individuals being advantaged over those on the outside of the profession who want to enter the labor market. This would have a direct decrease in the labor supply of that occupation, thereby increasing the incomes of those licensed workers still in the labor force (Stigler, 1971). Since there is an obvious monetary gain to those within the occupation, and since the group of people that fill out the regulatory boards are those that can become the direct benefactors of the regulations, occupational licensing has been seen as being abused by some industries and disrupts the market

within those industries (Friedman, 1962; Gellhorn, 1976; Timmons et al. 2018). Both positive and contra-viewpoints see the main effect of occupational licensing as positive to income and negative to employment.

All 50 states plus D.C. determine the requirements for dental assistants to practice radiography, giving rise to varying certification regimes. Some states, like Kansas, do not require you to hold a radiography certificate to perform radiography, while other states, like Colorado, require a dental assistant to hold a radiography certificate before entering the labor market. There are further variations on the amount of time and effort required to obtain the certification as well, like Nebraska which requires a simple passing of the certification course and subsequent holding of the certificate, compared to more stringent states like Oregon that requires completion of certification course, plus the passing of another separate exam, then filing with the state's dental board a signed form from a licensed dentist or dental hygienist in order to receive certification status. This thesis will examine these state-level variations' effects on the certification status and incomes of dental assistants.

The wider dental industry has been studied using the occupational licensing theme as dentists and dental hygienists are highly certified occupations (Kleiner et al., 2016; Adams, 2004). A study focused directly on dental assistant industry, using similar datasets, found that states imposing a certification saw the minority wage gap decrease (Xia, 2021). This thesis will attempt to set itself apart from these studies and to add to the base occupational licensing literature by providing a differing methodology including differing radiography certification regimes as well as a marker for the dental assistant's scope of practice (SOP). The SOP involves what the dental assistant is allowed to do and what is prohibited. To index the SOP, I have divided the total number of prohibited tasks by the total number of allowed tasks by state. This

index is known as the prohibition ratio and will be used to help determine any effects on certification status and income of dental assistants.

Chapter 2 - Contextual Background

2.1. The History of Dental Assistants in the US.

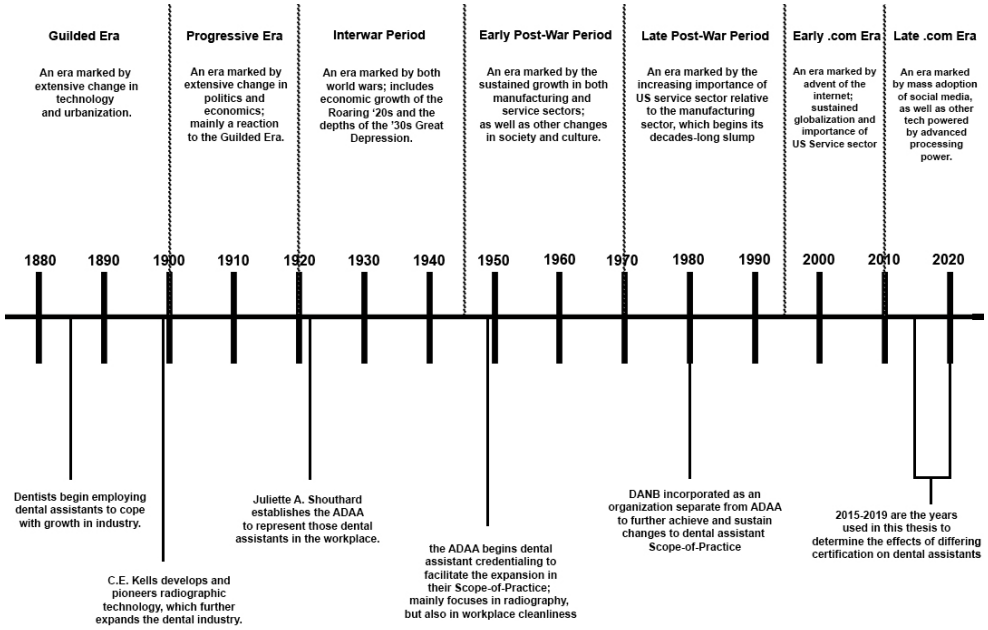
Technological advancements and changes in urbanization during the Guilded Era lead to calls for regulation in the workplace during the Progressive Era and Pre-World War II period. After World War II, service sector jobs saw sustained growth in employment and importance to the U.S. economy compared to goods-producing jobs. This change in the labor force coincides with a change in composition of workers that are either unionized or have some form of occupational licensing (Kleiner & Krueger, 2010). Occupational licensing has become one of the most prominent features of our labor market that even occupations commonly referred to as "low-income" have been legislated to require licensing, such as those working in cosmetology and athletic training (Gellhorn, 1976; Timmons et al., 2018)

The effects of occupational licensing have been well documented. When you restrict the labor supply to those who have a license, then this will decrease the supply and raise the wages of those licensed (Friedman, 1962; Stigler 1971). For example, Timmons and Mills (2018) find in the US optician industry that licensed opticians earned .3-.5% higher incomes for each year the licensing statute was in effect. The example was also extended for licensing intensity and showed that tougher licensing provisions increased their earnings by 2-3% (Timmons and Mills, 2018).

Figure 1 shows a timeline of the U.S. from 1880 through 2020. Above the timeline is the division of U.S. eras and some short descriptions describing the economic changes occurring during the eras. Below the timeline are major events that occurred in the dental assistant industry that are relevant to this project in providing context for understanding the variations this thesis is studying. The most important takeaway from this timeline is that the dental assistant profession

fits nicely into this labor market paradigm of service sector occupational licensing and looking into the history can show why.

Figure 2.1. Timeline of U.S. dental assistant industry



The late 19th century saw dentist and dental-tools inventor, Charles E. Kells, develop and pioneer the radiograph for use in his dental practice. The success and growth of his practice led Dr. Kells to hire his wife and another woman as the first dental assistants in the country (Kracher, 2000). These "Ladies in Waiting" would mostly help mix materials and clean up examination room. The addition of women to the dental workplace also increased the demand for dental work for the women in society "without needing an escort" (Neal, 2021)

The growth of the dental assistant profession was consistent and, in the early 1920s, the American Dental Assistants Association (ADAA) was established to represent dental assistants in the workplace (ADAA, 2022). The initial leader of the association, Juliette A Southard, clarified that the principal market catalysts for the association were "Because in the evolution of progress of the dental profession, the demand has been created for better service in the dental

office; Because organized effort is the road to achievement and success, and the dental office, like other business, should be governed by efficiency." (Southard, 1922). The dental assistant industry is a microcosm of the development in service-producing sector in that the late 1800s and early 1900s lead to professional growth to the point of becoming important enough to have distinct and variable regulations legislated by all states and the federal district.

Starting in the late 1940s, the Scope-of-Practice (SOP) for dental assistants began to be expanded to include the complete exposure and initial interpretation of dental radiographs as well as other intermediate-to-advanced leveled tasks. This would go on to mark a sharp increase in prevalence and importance of dental assistants in the industry, since dental assistants were previously limited to entry-level procedures. The beginning of the 1980s saw the Dental Assisting National Board (DANB) incorporated to facilitate the expansion of the dental assistant industry across the U.S. (Covington, 1948; DANB 2018). By the end of the 20th century, the taking of radiographs had become the primary task of dental assistants.

Despite its large importance and it almost being synonymous with dental assistants, radiography is not the only task performed by dental assistants. Through the efforts of the multiple agencies and the federalist nature of the US, many states expanded the list of relatively high-skilled tasks that dental assistants can do by earning a licenses/certificates specialized to preform said task. While not allowed by all states, coronal polishing, which uses a dental handpiece with rotation speeds up to 300,000 rpm, and sealing pits & fissures, which uses syringes and special sealant material, are two tasks that have become relatively prevalent for dental assistants since the 1980s (Morrison & US Navy, 1990; Xia, 2021).

2.2. Workplace Structure in Dental Industry.

The standard US dentistry is comprised of 4 main positions that work to offer dental services. Table 1 shows these positions in terms of their occupation title, as well as a description of their occupation, income measured from the American Community Survey (ACS) data, occupation number(s) used in the ACS data, as well as the current employment level from the BLS. The ACS will be further justified as one of the principal datasets in section 3.1. Starting at the bottom of the table, in terms of demand for human capital and of income levels, are receptionists/clerks. Their job is typically comprised of the lowest-skilled tasks including calendaring, record filing, and customer service. Following them are dental assistants whose list of task has been expanded on, as previously mentioned, to include tasks such as radiography, coronal polishing, and fissure/pit sealants.

Dental hygienists tasks range from developing x-rays and apply applying sealings to assessing presence of oral diseases and providing preventative care. Typically, dental hygienists go through more extensive training and do dental tasks requiring higher levels of human capital than dental assistants. This concentration of tasks requiring higher levels of human capital rewards dental hygienists with total personal incomes nearly double that of dental assistants at $49,400.

The last occupation is dentists, who have to go through the most extensive training and education to do the most human-capital intensive tasks in a typical dentistry. Dentists also play a special role as being the principal supervisor for the other three positions as many dentists are also owners of the dentistry. This double qualitative factor of having the most skill intensive tasks and of being the business owners gives the typical dentist total personal incomes 5 times larger than dental assistants at $191,800.

Table 2.1. Principal occupations in U.S. dentistry

Occupation[3,5]	Occupation Description[2, 4]	Total Personal Income[3, 6]	Occupation Number[3]	Employment Level (2020)[2]
Dentists	Diagnose and treat dental problems. Supervise other positions in the dental office. occasionally owner of practice.	$191,800	3010	139,200 workers
Dental Hygienists	Examine and provide care for oral diseases and oral hygiene. Take X-rays, apply sealants, and perform other preventative care tasks.	$49,400	3310	206,100 workers
Dental Assistants	High-skilled tasks such as taking X-rays, applying sealants and oral cleansing. Low-skilled tasks can include cleaning dental tools, keeping records, calendaring, giving customer support, and billing	$28,000	3640	330,200 workers
Receptionists, Front-Desk Workers, and other Clerks[1]	Calendaring, record keeping, and giving customer support.	$29,900	5000 through 5999	186,200 workers[7]

Notes: Multiple job titles are used in this manner, while serving the same job function, many of these job titles can be the principal function and is thus what is written down by the surveyed support staff. The category "Office and Administrative Support Occupations" is the general category that lists all occupations coded between 5000 and 5999. Only 12 of the 39 sub-occupations had over 1% of the sample choosing that sub-occupation.

[2]Source comes from BLS except where noted.

[3] Source comes from ACS.

[4] Not directly quoted, rather, personally written summary.

[5] Industry code is equal to 7980 in the ACS data

[6] Variable summarized is ***inctot*,** rounded to the nearest $100

[7] As the ACS is a sample and the BLS does not have the entire occupation for just dental offices only, A google search yielded the statistic from the website: https://www.zippia.com/dental-receptionist-jobs/demographics/

Chapter 3 - Information on Datasets

3.1. The Current Populations Survey and American Community Survey

The Current Populations Survey (CPS) is a nationwide survey that collects and produces data on social, economic, housing, and other demographic characteristics of the US population. In 2015, the CPS began asking questions on certification status obligated by the participant's state or job (Census Bureau, 2019), which is especially relevant for this thesis and will provide the primary role in determining the effects of differing certification regimes. I will supplement the CPS with the American Community Survey (ACS), which is another nationwide survey conducted by the census bureau.

Table 3.1. Summary statistics for dental assistant from ACS & CPS

Data Source	ACS		CPS	
Variable	Mean	(Std. Dev.)	Mean	(Std. Dev.)
n	18,792		2,186	
Total Income	$28,062.35	($31,707.02)	~~~	
Hourly Wage	~~~		$574.53	($272.40)
Age (years)	39.38	(13.99)	36.59	(12.62)
Hours per Week	30.27	(13.91)	35.36	(8.33)
Female	94.56%	(0.22)	96.90%	(0.17)
White, Non-Hispanic	65.88%	(0.47)	63.31%	(0.47)
Black, Non-Hispanic	4.51%	(0.21)	6.72%	(0.21)
Asian, Non-Hispanic	5.97%	(0.24)	5.08%	(0.21)
Other Race, Non-Hispanic	2.91%	(0.17)	3.71%	(0.18)
Hispanic, All Races	20.73%	(0.41)	21.18%	(0.40)
Married	57.64%	(0.49)	51.28%	(0.50)
Divorced, Widowed, or Separated	14.17%	(0.35)	14.32%	(0.35)
Number of Children in Household 18 years or Younger	.88	(1.09)	.90	(1.12)
Less than a High School Diploma	3.08%	(0.17)	2.74%	(0.45)
High School Diploma or Equivalent	25.93%	(0.44)	29.55%	(0.45)
Some College Credit, but no Degree	41.16%	(0.49)	28.41%	(0.36)
Associates Degree	18.80%	(0.39)	27.36%	(0.36)
Bachelor's degree or higher	11.04%	(0.31)	11.94%	(0.29)
Certified	~~~		42.14%	(0.49)

Notes: Divorced, Widowed, or Separated were put into one variable entitled *Married_No_More.* A Tilda (~) is placed in the cell that does not have a value from that database, so, ACS does not have certified or weekly earnings, but CPS does, while ACS provides total income and CPS does not total weekly earnings include only those who report a weekly/hourly income in the CPS-ORG

Table 3.1 shows the summary statistics from both surveys and the 3rd row contains the sample size for both samples; the ACS sample has about 18,800 dental assistant observations compared to the CPS sample of 2,200 dental assistant observations. The years that this sample ranges from 2015-2019. The only ages to show up are above 16 years old and below 95 years old. The only dental assistants are included as well as the industry code that translates into the survey participant working in a dental office.

The demographics of dental assistants show that dental assistants are primarily female, with 95% of those surveyed being women. Due to the large participation of women in the industry, I have added variables concerning domestic life including marital status and number of children currently living in the household. The demographics of age and race show no major variation from the U.S. as well as those relationship characteristics including number of children and marriage status.

Education is important to this thesis as certification status can be used in place of the benefit received from higher education. Nearly all dental assistants have a high school diploma, but less than 40% of dental assistants have an associate degree or higher. The pro-side of the occupational licensing debate holds that certification status acts as a substitute for university degrees, as both can be interpreted as being two sides of the same coin. If this is true, then states that have differing certification regimes would have differing educational premiums on the incomes received by dental assistants.

There are benefits and costs to using both datasets. A benefit of the ACS, for example, is that it offers a larger sample size than the CPS (Census Bureau, 2017). The primary cost of using

the ACS compared to the CPS is the lack of a certification status question on the ACS. In place of using the same model from the CPS, I will modify the model with binary variables of the differing regimes that vary by state. I justify the use of this model with the ACS as the differing regimes affecting the most central task of dental assistants could lead to changes in income for the group.

3.2. The Dental Assistant National Board

As mentioned in section 2.1, the dental assistant profession followed many other service-sector professions and established a labor association to facilitate and protect their practice. By 1980, the ADAA had established their official certification board as a separate incorporated organization to continue this facilitation with the Dental Assistant National Board (DANB). This section examines the variables that the DANB provides this thesis.

Table 3.2. Radiography certification regimes in the U.S.

Radiography Regime Type	Level of Protectionism	Description	States
Type 1	Lowest	Certificate not required to perform radiography.	Alabama, Alaska, Hawaii, Idaho, Illinois, Kansas, Missouri, Nevada, New York, West Virginia, & Wisconsin
Type 2	Lower	Certificate required to perform, but employment not restricted. Must simply hold a certificate.	Arizona, Georgia, Kentucky, Louisiana, Mississippi, Nebraska, Pennsylvania, Rhode Island, South Carolina, Virginia, & Wyoming
Type 3:	Higher	Certificate required to perform, but employment not restricted. Must hold certificate, register with state dental board, and/or pass other non-radiography exam(s).	Arkansas, Florida, Iowa, Maryland, Minnesota, New Hampshire, New Jersey, New Mexico, North Dakota, Ohio, Oklahoma, Oregon, South Dakota, Tennessee, Texas, Vermont, & Washington
Type 4	Highest	Certificate required to perform. Employment will be terminated unless certificate is carried by practicing dental assistant	California, Colorado, Connecticut, Delaware, D.C., Indiana, Maine, Massachusetts, Michigan, Montana, North Carolina, & Utah

Notes: Each type is derived from radiography requirements described by the DANB. The protectionism level is personally done and correlates in sync with the type number, i.e. the higher the type the larger the protectionism level.

Since the dental assistant industry is legislated at the state level, DANB offers state-by-state information guides to help dental assistants navigate the federalist regulatory set-up. These information guides include important and up-to-date information on radiography requirements, education and exam requirements, delegable functions and supervision levels, as well as the functions prohibited.

Appendix A contains figure 6.1 which shows the map of the U.S. color-coded by state for each type of radiography certification regime. I was able to categorize the industry into 4 principal regimes that proceed in terms of the requirements needed to meet in order to perform radiography in the state. Table 3.2 contains the 4 types of regimes, a brief description of those regimes, and the list of states that follow this regime type.

The table starts with Type 1, which is the least restrictive regime, that does not have any requirements on performing radiography. Dental assistants in Type 1 states are not prohibited in any manner and would be considered the least restrictive. Type 2 is the first regime to require a radiography certificate to perform radiography and logically succeeds Type 1 in magnitude of restriction faced by dental assistants.

Type 2 states do not require anything more than the simple possession of the certificate, which contrasts with Type 3 states that require a certificate but require dental assistants to go through further testing or registration in order to be allowed to perform radiography. This additional barrier gives a further restrictive quality for Type 3 in comparison to Type 2. Finally, Type 4 is the most restrictive regime in the U.S. as dental assistants in those states are barred from employment unless they have a radiography certificate.

To help distinguish this thesis from those that also delve into the dental assistant industry, I will use a ratio composed of the number of tasks mentioned by these state-by-state information

guides. To compose this ratio, I will take the number of tasks prohibited by each state divided by the total number of tasks mentioned. Both the numerator and denominator are tallied by counting the number from each information guide for every state.

Appendix A contains figure 3 which show a U.S. map and the variations in number of tasks prohibited at each state. Figure 4 shows a U.S. map and the variation in total number of tasks allowed. Finally, figure 5 shows a U.S. map and the variation from the prohibition ratio. This map is effectively a combination of the two preceding figures. Appendix B contains table 4 which shows the exact count for every state the number of tasks allowed and prohibited, as well as the computed prohibition ratio that I will use to determine the effects of limiting the SOP of dental assistants in the workplace.

Chapter 4 - Methodology

4.1. Certification Status Model

The first model will test the effect of differing certification policies on the percentage of dental assistants certified. It is logical that changing the cost in terms of time and effort would influence the amount of people certified. Figure 2 shows the model that this thesis uses to determine the effect of certification. I omit Type 1 as that will be our modular starting point, since they do not require any radiography certification, so, the three remaining types will contain binary values indicating the effect of each type on the percentage certified.

Equation 4.1. Certification status by regime type using the CPS dataset

$$\text{Certified} = \beta_0 + (\text{Type 2})*\beta_1 + (\text{Type 3})*\beta_2 + (\text{Type 4})*\beta_3$$

This model will be run separately for individual characteristics and for education levels, the former to make the model more robust and the later to examine any influence education has on certification status, as they can be considered as substitutes. If they are substitutes, then the lower the education level a dental assistant has, the more likely they would be willing to get certified.

Part of the argument for earning a certificate is that it helps expand the SOP of the certificate holder. To help distinguish this thesis from others that also investigated the dental assistant industry, I have added the prohibition ratio of each state as an indicator of the limitations placed on dental assistants in each state. The reason for the ratio and not the direct number of tasks prohibited is that there is a large amount of variation in the number of tasks as well as the human capital required to complete those tasks.

4.2. Income Models

The second model will test the effects of the differing certification regimes on the income of dental assistants. These regimes represent varying levels of protectionism in the dental assistant industry. Protectionism effectively raises the cost of those non-certified, so, the increasing level of protection would increase the cost of not being certified. This increasing cost would incentivize dental assistants to earn a certificate.

Figure 3 shows the model used to determine the effects on income by the certification status of the dental assistant and the prohibition ratio faced at the state-level. Like the previous model, I will first run the model as is and then add independent variables to better justify any results from the prior. Unlike the previous model, I will run the model by the regime type that each state represents to show how the different regimes effect the wage-premium received by dental assistants.

Equation 4.2. . Income model using the CPS dataset

$$\text{Log (Hourly Wage)} = \beta_0 + (\text{Certified})*\beta_1 + (\text{Prohibition Ratio})*\beta_2$$

The anti-certification side argues that those with certification benefit more from harsher requirements than those without certification status. To test this argument out, I will run the regression on income by the regime type imposed. Conversely, a pro-certification argument says that those dental assistants with lower education levels will see a higher premium from certification status rather than those with higher education levels as those with lower education are either benefiting more from the signaling or human capital effects that certification offers. To test this argument out, I will also run this income model by those who do not hold a high school diploma, those that do hold a high school diploma, and those that hold at least an associate degree or higher.

When the model is adjusted for the ACS database, which does not include certification status, then I can still utilize it to find out any effects on income. Figure 4 shows the modified model that I will use for the ACS database, the major difference is that I will use the differing regimes types to determine the changes in income. The prohibition ratio is still in the model as it was integral for mapping out the SOP of dental assistants in the U.S.

Equation 4.3. Modified income model using the ACS dataset

$$\text{Log (Total Personal Income)} = \beta_0 + (\text{Type 2})*\beta_1 + (\text{Type 3})*\beta_2 + (\text{Type 4})*\beta_3 + (\text{Prohibition Ratio})*\beta_4$$

Since the ACS is an annual survey and the CPS is a monthly survey, the dependent income variables are different and reflect the timeframe surveyed. The annual ACS contains data on the total personal income earned from all jobs over the previous 12-month period, which is different from the weekly earnings variable that the monthly CPS offers. The biggest problem from the total personal income variable is that it includes all income earned from multiple sources, which means that the effects of differing types could turn out either null or nothing of true inferential importance for this thesis to proceed with.

Chapter 5 - Results

5.1. Certification Status Model

The results for the certification status model can be found in table 4. First, I run the regression as the model by itself, then I add individual controls, finally I add the controls based on the year surveyed. The final 3 columns of the table show the regression run by 3 educational attainment levels: those with less than a HS diploma, those with a HS diploma, and finally those with an associate degree or higher.

Table 5.1. Results of certification status model using the CPS

Sample Division	Total sample		Less than HS Diploma	Has HS diploma	Has an associate degree or higher
	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Percentage Certified				
Sample Years	2015-2019				
Type 2	0.0554** (0.0276)	0.0552* (0.0293)	0.3216* (0.1692)	0.0055 (0.0478)	0.1058*** (0.0380)
Type 3	0.2244*** (0.0323)	0.2126*** (0.0333)	0.0956 (0.0657)	0.1815*** (0.0412)	0.2483*** (0.0378)
Type 4	0.1210*** (0.0254)	0.1198*** (0.0273)	0.2250*** (0.0753)	0.0757* (0.0412)	0.1741*** (0.0327)
Individual controls	No	Yes	Yes	Yes	Yes
Number of observations	2,186		60	1,266	859

Notes: Each column is a separate regression run on the certification model. All regressions have year-fixed effects. Each type is a binary variable, i.e. for type 1 states each value is inputted as a zero (0). Column 1 runs the certification model without individual control then the rest of the table has individual controls. Binary variables were added for each year of the sample. For columns 3-5, the regression was run by those without a HS diploma, those with a HS diploma which includes people with some college credit but no degree, and those with an associate degree or higher. Including the prohibition ratio, a variable seen in the other models, came out as statistically insignificant. All errors are clustered at the state level and shown in parenthesis below each point-estimate. Significance levels *** p<0.01; ** p<0.05; * p<0.1.

The base model shows positive relationships between increased protectionism and percentage of dental assistants certified for each type of regime. This continues for the two succeeding regressions accounting for individual controls and year-fixed controls. Although Type 2 does not come out as statistically significant it remains with a positive coefficient for

each regression. The only other variable to come out statistically insignificant was the effects of prohibition ratios on certification status.

When I divide the sample into educational attainment, I begin to see more promising results that relate to central question. Those without a HS diploma have the largest increases in certification status, as they are the ones who are most likely to benefit from earning a certificate that acts as a substitute for educational attainment. Each regime increased their certification status by 32.2% for Type 2, by 9.6% for Type 3 and by 22.5% for Type 4.

Dental assistants with an associate degree or higher have higher coefficients for each regime type than those dental assistants with only a HS diploma. Comparing the entirety of columns 6 and 7 in table 4 shows exactly this phenomenon. What could explain this? it could be that those with HS diplomas and those with an associate degree and higher are considered apart of two separate educational classes that require two separate levels of discipline to achieve, i.e., college is more difficult than high school but those with a college education are more prepared to take on other educational processes, like those described in the different radiography regimes.

Recall that dental assistants in Type 4 states are not allowed to enter the job market as dental assistants without a radiography certificate, so, theoretically they would have the largest effects on certification status. This is only true for dental assistants without a HS diploma, they have a statistically significant increase of 32.2% in the certification status. This contrasts with those that have a HS diploma or above (majority of the sample) where they have lower certification status than those dental assistants in Type 3. The CPS is a survey that asks respondents to self-report their occupations, so, it is possible that the sample is experiencing some form of occupation inflation.

Fisher and Houseworth (2013) find evidence that individuals can inflate their occupational importance and self-report an occupation which pays higher but requires higher skills. Taking this into account, I could infer that there are receptionists or other front desk workers that self-report as dental assistants, thus giving a lower percentage of certified dental assistants in states that make employment conditional on radiography certification (Type 4) than those states that do not impose employment restrictions (Type 3). Also, it could be possible that if the process is more difficult in protectionist states, then dental assistants in protectionist states will choose to become dental hygienist. The reasoning behind this is that if it is costlier to become a dental assistant, relative to a dental hygienist, then dental assistants will become dental assistants

To see if there is any effect between protectionism and shifts in labor from dental assistant to dental hygienists, I tested out the difference in the number of dental assistants as a ratio to the number of dental hygienists. Appendix B has Table 6.2 which shows the number of dental assistants, number of hygienists, and the ratio between these two numbers. These are sourced from the ACS dataset that I utilize in this thesis, mainly for the size of its dataset compared to the CPS dataset. Table 6.3 show the ratios by regime type and those regimes with the highest levels of protection (Type 3 & Type 4) also have the highest ratio of dental assistants to dental hygienists. This signifies that protectionism of dental assistants draws workers into being a dental assistants relative to dental hygienists

5.2. Income Model

The results for this section can be found in table 5 and table 6. Table 5 shows the initial income model mentioned in section 4.2 ran with and without individual characteristics, then run for the 3 education classes from table 4. Table 6 shows the same income model but ran

separately by the 4 radiography regimes to determine any potential differences in the wage premium received from certification.

The results from table 5 of the initial regression shows results in line with the literature. I see that certified dental assistants have 8.1% higher wages than non-certified dental assistants, this decreases to 5.6% when introducing individual characteristics to the model. Those without a HS diploma saw incomes rise the most with 40.5% compared to 3.5% for those with a HS diploma. This implies that a radiography certificate is substitutable with a HS diploma as those without one have 6 times the rate of a wage premium from certification. This implication would fit appropriately with the pro-certification argument, as these certificates are either building up the human capital or signaling to the employer the work they can do.

Conversely, if I were to compare the differences between those dental assistants with a HS diploma and those with an associate degree or higher. Those with a HS diploma receive a 3.5% wage premium while those with an associate degree receive a 5.2% wage premium. This difference suggests that there is a slight complementary effect with certification and education levels as those with the higher levels of education benefit more relative to those with a lower education level.

Table 5.2. Results from initial income model using the CPS

Sample Division	Total sample		Less than HS Diploma	Has HS diploma	Has an associate degree or higher
	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Log (Hourly Wage)				
Sample Years	2015-2019				
Certified	0.0812*** (0.0269)	0.0564** (0.0233)	0.4053*** (0.1219)	0.0350 (0.0238)	0.0515 (0.0390)
Prohibition ratio	-0.0265*** (0.0098)	-0.0224*** (0.0072)	-0.0586 (0.0430)	-0.0249*** (0.0083)	-0.0233* (0.0138)
Individual controls	No	Yes	Yes	Yes	Yes

Number of observations	1,772	35	989	748

Notes: each column is for a separate regression using the initial income model for the CPS database All regressions have year-fixed effects. All errors are clustered at the state level and shown in parenthesis below each point-estimate. Binary variables were added for each year of the sample. Certified is a binary variable and the prohibition ratio is a state-level variable. Column 1 shows the initial results for the income model, then following in column 2 is the same regression including individual characteristics. Columns 3-5 include the results of the income model run by education type. Significance levels *** p<0.01; ** p<0.05; * p<0.1.

In the main regression involving the complete sample, the prohibition ratio consistently comes out around -2.7% and -2.2% with and without both individual characteristics and year fixed controls. The prohibition ratio does have those with increasing education levels see their wages drop more than those with lower education levels. Those with an associate degree see a relationship of -2.3% while those with only a HS diploma see -2.5% and then even further for those without a HS diploma at -5.9% This falls in line with SOP literature that barring people from certain tasks or jobs would decrease their income.

When I regress the income model by each certificate regime (Table 6), I still see that certification status retains its positive correlation with income across all 4 types of regimes, though not statistically significant for Type 3 states that have extensive certification requirements but no restrictive employment measures. Type 4 states, while being statistically significant, do not allow us to infer anything important about certification status, as the wage premium received from certification is probably a reflection of the difference in wages between dental assistants and receptionists, not certified and non-certified dental assistants.

Table 5.3. Results from initial income model using the CPS, regressed by regime type

Sample Division	Type 1 (1)	Type 2 (2)	Type 3 (3)	Type 4 (4)
Dependent Variable	Log (Hourly Wage)			
Sample Years	2015-2019			
Certified	0.0951* (0.0510)	0.0443 (0.0255)	0.0032 (0.0359)	0.0097 (0.0629)
Prohibition ratio	-0.0252** (0.0079)	-0.0015 (0.0155)	-0.0213 (0.0149)	-0.0531** (0.0202)

Individual Controls	Yes	Yes	Yes	Yes
Number of observations	375	348	594	455

Notes: each column is for a separate regression using the initial income model for the CPS database All regressions have year-fixed effects. All errors are clustered at the state level and shown in parenthesis below each point-estimate. Certified is a binary variable and the prohibition ratio is a state-level variable.

If I compare the differences in wage premiums received by certified compared to non-certified dental assistants in Type 1 and Type 2 states, then I see the effects of implementing regulations that require certification. In Type 1 states, where certification is not required, those dental assistants certified see incomes rise by 9.5%, which is over double the rate of the wage premium of 4.4% that Type 2 dental assistants receive. When looking at the differences between Type 1 and Type 3 states I see an even greater difference since Type 3 dental assistants see a .3% statistically insignificant wage premium from certification. If I recall to table 4 in section 5.1, then I can see Type 3 dental assistants have higher certification rates, but lower (or even null) wage premiums. This phenomenon might be an example of decreasing returns from increasing the relative supply of certified dental assistants over non-certified dental assistants.

The prohibition ratio retains its negative relationship for every single regime type. Type 1, Type 3, and Type 4 all are statistically significant above the 90% confidence interval. Type 3 dental assistants correlate with -3.5% for the prohibition ratio and -3.0% for Type 4 dental assistants.

5.3. Modified Income Model

Table 5.4 shows the results from the modified income model discussed at the end of section 4.2. As always, I begin the regression with the base model, then with individual characteristics and then again with year-fixed effects for robustness. Like the certification status model, Type 2, Type 3, and Type 4 are all binary variables and the prohibition ratio still represents the state-level variations in prohibiting tasks/total allowed tasks.

After accounting for both year-fixed controls and individual controls, I begin to see how regulating the most prominent dental assistant task effects the incomes of dental assistants overall. Type 2 sees a coefficient of -2.3% against total personal income of dental assistants, this would imply putting a small barrier hampers the dental assistant's income. Type 3, however, shows the reverse with an increase in personal income of 3.4%, this would signify that going through a more extensive certification process rewards Type 3 dental assistants as opposed to Type 2 dental assistants who are restricted by the state through the certification process, thus forgoing the ability to do radiography (recall table 4). Type 2 and Type 3 were not above the 90% confidence interval however, so, it is possible that they are not different from type 1 in terms of incomes.

Table 5.4. Results from modified income model using the ACS

Sample Division	Total sample	
	(1)	(2)
Dependent Variable	Log (Total Personal Income)	
Sample Years	2015-2019	
Type 2	0.0107 (0.0351)	-0.0235 (0.0255)
Type 3	0.0878*** (0.0270)	0.0341 (0.0290)
Type 4	0.0351 (0.0367)	0.0457* (0.0251)
Prohibition ratio	-0.0422** (0.0186)	-0.0308*** (0.0082)
Individual controls	No	Yes
Number of observations	16,282	

Notes: Column 1 represents the results from the modified income model that uses the ACS without individual characteristics, then column 2 is run with individual characteristics. Binary variables are included for the year for year-fixed controls as well. All errors are clustered at the state level and shown in parenthesis below each point-estimate. Significance levels *** p<0.01; ** p<0.05; * p<0.1.

The logic continues for Type 4 dental assistants as well, especially as they were the only type with total personal incomes significantly different from Type 1 dental assistants. Type 4 dental assistants earn 4.6% higher incomes than Type 1 dental assistants. If I assume there are

slightly higher levels of occupation inflation in Type 4 states than in Type 1 states, then this could imply that barring employment until the dental assistant has a certificate will reward them somewhat like the certification wage premiums seen in table 5, as those premiums were around 5-7%.

The prohibition ratio shows a negative coefficient for each regression of the model that was run. -4.2% without individual characteristics and 3.1% with individual characteristics. Both of these add more weight to the pro-expansion SOP argument either that limiting the SOP reduces the productive capacity of workers or that expanding the SOP increases the productive capacity of workers.

Chapter 6 - Conclusion

This thesis set out to test how the variations that exist in certification requirements on radiography affect a dental assistant's certification status and income. When I begin with certification status alone, Type 3 and Type 4, the most protectionist regimes, having statically significant increase in the certification rate, compared to Type 2 which, while being only slightly more protectionist than Type 1, had a statistically insignificant increase in certification status from Type 1. This suggests that increasing the costs of not having a certification on dental assistants will incentivize them to increase their certification status.

When I look at the way certification status affects income, I universally see positive correlations in income. The wage premium that was received was highest for those without a HS diploma, but relatively similar for those with a HS diploma or associate degree and higher. This large difference could be a sign that a radiography certificate is a substitute for HS diploma for those without a HS diploma, but only acts as a small signal of the human capital or discipline required to do high-skilled tasks for those with a HS diploma or above.

Also, I see that the stricter the restrictions that regime imposes, the lower their wage premium from certification will be. Type 1 has the largest wage premium but also has the lowest certification status, compared to Type 3 which has the lowest (even null) wage premium but a significantly higher certification status. Another example is the difference between Type 2 and Type 3, which the former has higher wage premium and smaller certified dental assistant population and the latter has the lowest wage premium but the highest rate of certified dental assistants. This leads us to conclude that certification is especially effective for those dental assistants who work in states populated by non-certified dental assistants. A significant takeaway from this thesis is that regimes that impose the least protectionist certification measures will see

the largest benefits from the certification. Those benefits obviously can come in the form of human capital or signaling, but that is topic for another research paper at a different time.

For almost the entirety of the thesis, prohibition ratio was found to be negative with income, the only regime with a positive correlation was Type 2. When looking at the certification status, I see that it is consistently negative and statistically insignificant. While this was one of the main features to try and distinguish this thesis from others, it is still beneficial to know what effects wages and certification status for future research.

I conclude that radiography certification is beneficial for those that need it to substitute with a HS diploma, or for those that need it to complement it with their HS diploma or associate degree. This beneficial quality is diminished or nullified when states begin to implement protectionist measures, greatly incentivizing dental assistants to go through the extensive processes to be apart of the protected class. This implies that states should allow those dental assistants who want to take the initiative to either improve themselves or signal their quality of work over others. Conversely, they should not impose tough restrictions on dental assistants or their ability to do the work.

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Appendix A - U.S. Maps of Regulatory Variables

Figure 6.1. U.S. map of radiography certification regime types

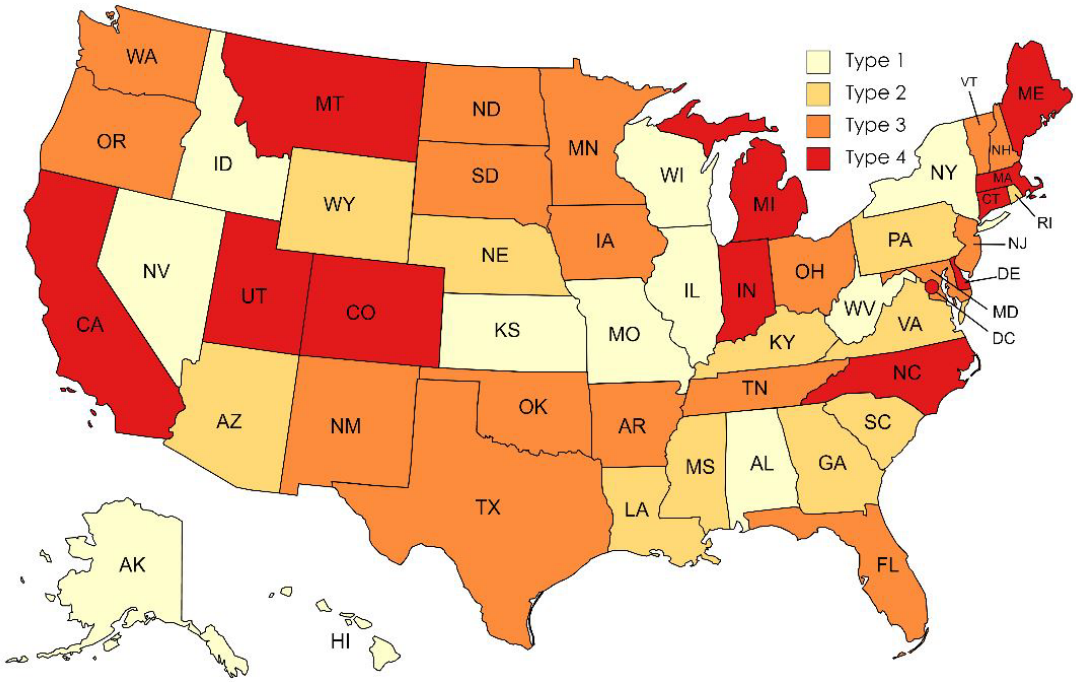


Figure 6.2. U.S. map of prohibited tasks

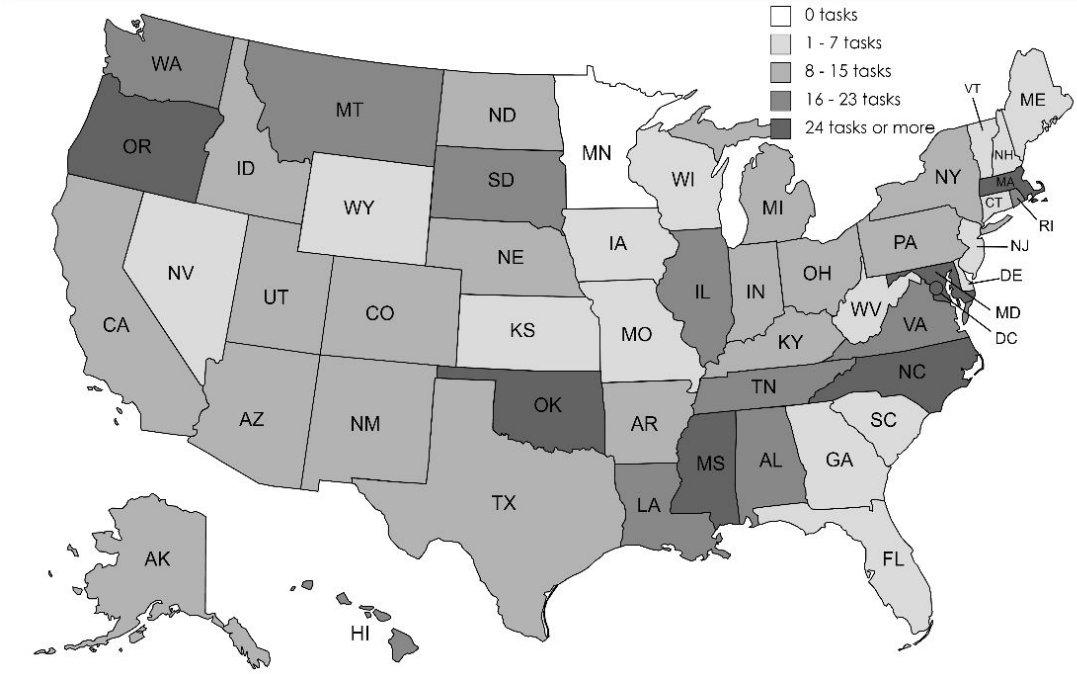


Figure 6.3. U.S. map of allowed tasks

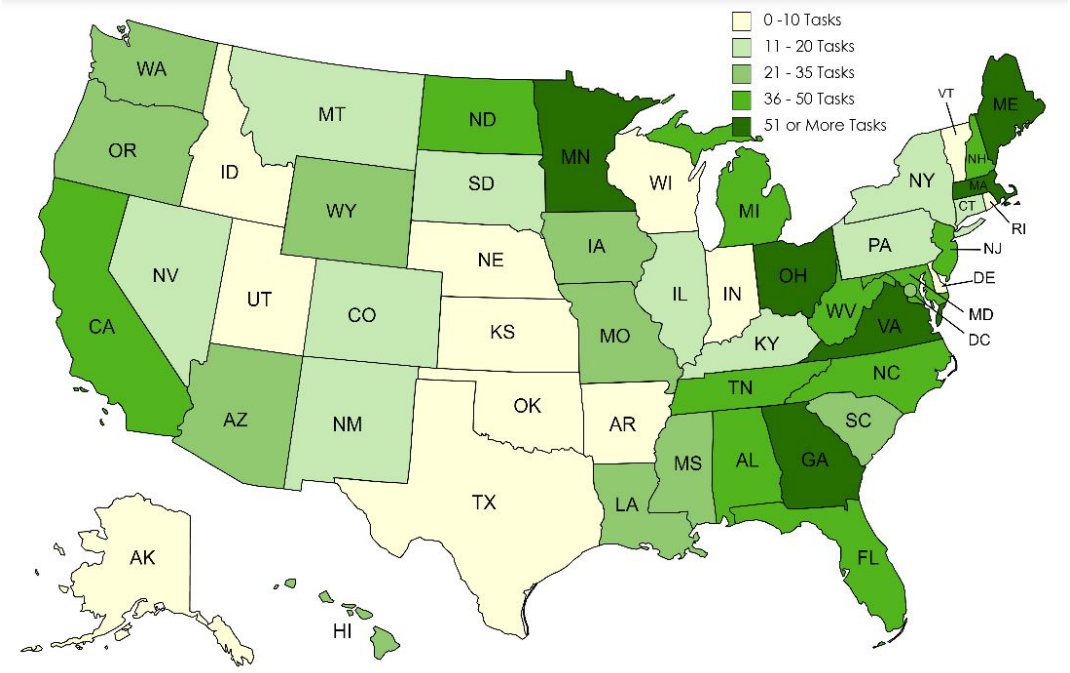
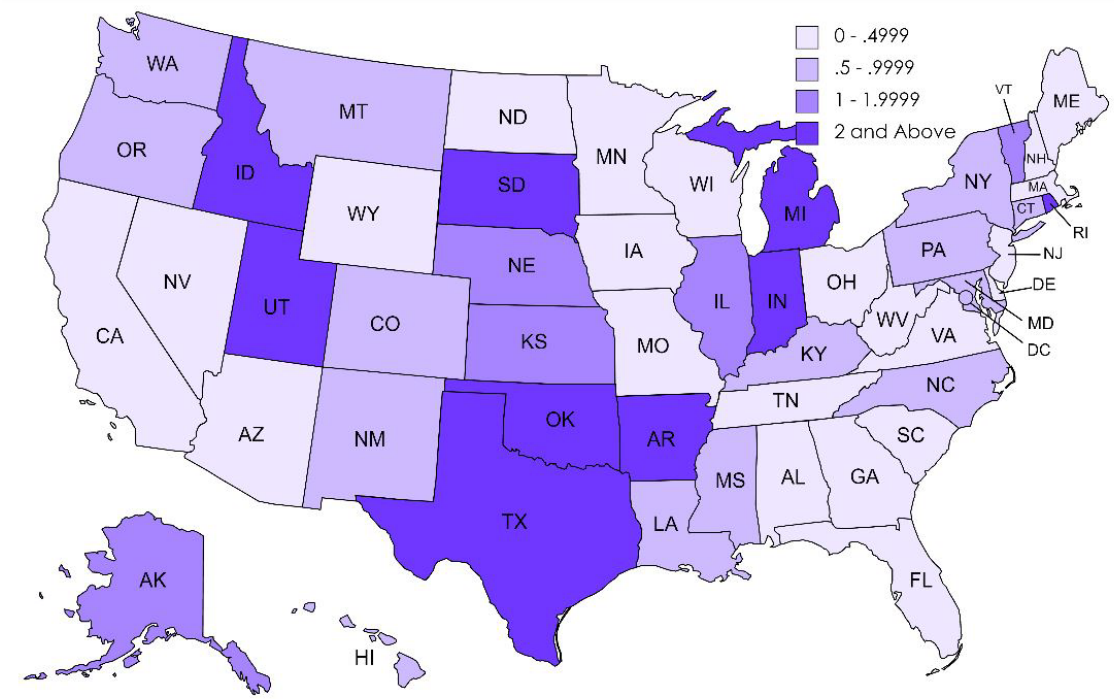


Figure 6.4. U.S. map of prohibition ratio



Appendix B - Tables

Table 6.1. List of allowed and prohibited tasks, with calculated prohibition ratio by state

State	*Personal Tasks*	*Direct Tasks*	*General Tasks*	Total Tasks	Prohibited Tasks	Prohibition Ratio
Alabama	0	38	0	38	17	.4474
Alaska	0	9	0	9	11	1.222
Arizona	0	19	7	26	6	.2308
Arkansas	5	0	0	5	13	2.6
California	0	40	3	43	10	.2326
Colorado	0	14	0	14	12	.8571
Connecticut	0	13	0	13	7	.5384
Delaware	0	10	0	10	4	.4
D.C.	0	33	0	33	32	.9697
Florida	0	45	3	48	6	.125
Georgia	0	51	0	51	3	.0588
Hawaii	0	29	0	29	17	.5862
Idaho	0	2	0	2	14	7
Illinois	0	13	0	13	19	1.4615
Indiana	0	3	0	3	8	2.667
Iowa	1	19	10	30	5	.1667
Kansas	0	5	0	5	5	1
Kentucky	0	12	0	12	8	.6667
Louisiana	0	27	0	27	19	.7073
Maine	0	34	17	51	6	.1176
Maryland	0	32	9	41	36	.8780
Massachusetts	0	41	37	78	27	.3462
Michigan	0	15	27	42	10	.238
Minnesota	5	30	18	53	0	0
Mississippi	0	28	0	28	27	.964
Missouri	0	22	0	22	7	.3182
Montana	0	19	1	20	19	.95
Nebraska	0	8	1	9	10	1.111
Nevada	0	17	0	17	4	.2353
New Hampshire	0	37	8	45	3	.0667
New Jersey	0	46	0	46	4	.0870
New Mexico	0	11	5	16	9	.5625
New York	0	15	0	15	13	.8667
North Carolina	0	42	0	42	41	.9762
North Dakota	0	31	15	46	13	.2826
Ohio	1	51	9	61	13	.2131
Oklahoma	0	5	0	5	29	5.8

State	*Personal Tasks*	*Direct Tasks*	*General Tasks*	Total Tasks	Prohibited Tasks	Prohibition Ratio
Oregon	0	21	5	26	24	.923
Pennsylvania	0	11	0	11	8	.7272
Rhode Island	0	6	0	6	21	3.5
South Carolina	0	22	0	22	5	.2272
South Dakota	0	0	11	11	22	2
Tennessee	0	48	0	48	22	.4583
Texas	0	4	2	6	14	2.333
Utah	0	3	0	3	13	4.333
Vermont	0	4	0	4	6	1.5
Virginia	0	67	0	67	18	.2687
Washington	0	32	5	32	23	.7188
West Virginia	0	36	0	36	3	.0833
Wisconsin	0	0	0	0	3	~~~
Wyoming	0	21	8	29	6	.2069

Table 6.2. Ratio of dental assistants to dental hygienists

State	Number of Dental Assistants	Number of Dental Hygienists	DA to DH ratio
Alabama	201	253	0.794466
Alaska	40	23	1.73913
Arizona	451	244	1.848361
Arkansas	162	110	1.472727
California	2971	1224	2.427288
Colorado	345	287	1.202091
Connecticut	223	166	1.343373
Delaware	43	43	1
D.C.	19	11	1.727273
Florida	1129	736	1.533967
Georgia	504	423	1.191489
Hawaii	110	58	1.896552
Idaho	120	59	2.033898
Illinois	704	493	1.427992
Indiana	351	300	1.17
Iowa	229	121	1.892562
Kansas	145	121	1.198347
Kentucky	253	185	1.367568
Louisiana	267	135	1.977778
Maine	49	52	0.942308
Maryland	335	218	1.536697
Massachusetts	423	345	1.226087
Michigan	657	575	1.142609
Minnesota	362	275	1.316364

State	Number of Dental Assistants	Number of Dental Hygienists	DA to DH ratio
Mississippi	124	104	1.192308
Missouri	333	204	1.632353
Montana	66	32	2.0625
Nebraska	126	77	1.636364
Nevada	191	95	2.010526
New Hampshire	93	96	0.96875
New Jersey	628	354	1.774011
New Mexico	108	61	1.770492
New York	1078	697	1.546628
North Carolina	629	422	1.490521
North Dakota	44	44	1
Ohio	581	501	1.159681
Oklahoma	216	101	2.138614
Oregon	361	234	1.542735
Pennsylvania	661	536	1.233209
Rhode Island	63	50	1.26
South Carolina	300	215	1.395349
South Dakota	40	54	0.740741
Tennessee	345	294	1.173469
Texas	1694	865	1.958382
Utah	303	162	1.87037
Vermont	31	49	0.632653
Virginia	534	321	1.663551
Washington	617	367	1.681199
West Virginia	79	76	1.039474
Wisconsin	424	322	1.31677
Wyoming	39	34	1.147059

Table 6.3. Ratio of dental assistants to dental hygienists

Radiography Regime Type	The # of dental assistants/ The # of dental hygienists
Type 1	1.46
Type 2	1.45
Type 3	1.60
Type 4	1.80

Notes: it is possible that the increasing protectionism level leads to more dental assistants not moving into dental hygienists positions, so, the final results were backward from the initial thoughts.