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Walden University

COLLEGE OF HEALTH SCIENCES

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Mary Hotaling

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
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Walden University
2011

Abstract

Effect of Clinical Laboratory Practitioner Licensing on Wages

by

Mary Hotaling

MS, St. John's University, 1992

BS, New York Institute of Technology, 1988

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Health Services

Walden University

February 2011

Abstract

Professional licensing directly affects about 29% of U.S. workers and is considered a primary means to establish and maintain health care practitioner competence. Clinical laboratory practitioner licensing was largely ignored in the literature with only 2 studies 30 years apart that provided conflicting conclusions regarding wage effects. This research provided the first study of clinical laboratory practitioner licensing effects on wages after controlling for human capital and individual characteristics wage determinants. This nonexperimental correlational study extended the literature on licensing effects on wages, including women's wages and professions not uniformly licensed across 50 states. The theoretical foundation relied on the human capital wage model that wages vary according to human capital investment, namely education and experience. Census 2000 5% Public Use Microdata Sample provided wages and control variable data, including educational attainment, experience, gender, marital status, and children. Using hierarchical regression analysis, this study found clinical laboratory practitioner wages were significantly higher (5.8%) in licensing states compared to nonlicensing states after controlling for these human capital and individual characteristics, R^2_{change} ($p < .001$). Female clinical laboratory practitioners working in licensing states earned significantly higher wages (5.0%) compared to those in nonlicensing states, R^2_{change} ($p < .01$). This study has potential for positive social change in clinical laboratory practitioner licensing policy development, implementation, and analysis by providing urgently needed empirical wage data for legislators to make informed decisions on costs to adopting such legislation.

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Dedication

This study is dedicated to my husband John and fast growing sons Jack and Aidan.

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I would like to acknowledge my committee chair, William Barkley, PhD, who extended his hand and pointed me in the direction of the light, and Ches Jones, my committee member, who has been my faculty mentor since I began the PhD in Health Sciences program. I wish to thank Gary Burkholder, PhD, my University Reviewer for working with me to produce my best possible dissertation.

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Chapter 1: Introduction to the Study

Background

It has been a decade since the reports *To Err Is Human: Building a Safer Health System* (Kohn, Corrigan, & Donaldson, 2000) and *Crossing the Quality Chasm: A New Health System for the 21st Century* (Corrigan, Donaldson, Kohn, Maguire, & Pike, 2001) focused national attention on improving the quality and safety of health care delivery. Yet, although the United States still ranks highest in per capita health care spending in the world, there remains considerable evidence of gaps between recognized standards of care and actual health care practice and delivery . Davis, Schoen, and Stremikis (2010) report that surveys of patients and physicians rank the United States last or next to last among industrialized countries in quality dimensions including: access to health care services, patient safety, coordination of care, efficiency, and equity in health care. To this end, Greiner and Knebel (2003) assert professional licensing is considered an important means of assuring high quality health care practitioners.

Professional Licensing

Professional licensing is a long-standing form of governmental regulation legally limiting the practice of an occupation to those possessing a license and prohibits nonlicensed individuals from providing those services (Young, 1987). Greiner and Knebel (2003) asserted that health care professional licensing is a primary method believed to have the most leverage in establishing both initial competence and maintenance of practitioner competence. Greiner and Knebel also noted that state licensing boards charged with protecting the public set minimum competence standards that are typically established through specific education, experience, licensing examination, moral character assessment, and other requirements.

Professional licensing or its equivalent is certainly not a new labor market phenomenon, even in the 14th century, the medieval guilds of Europe strictly regulated entry into the skilled professions. Occupational regulation through professional licensing began in the United States during Colonial times (Hogan, 1983; Young, 1987). Kleiner and Krueger (2008) observed professional licensing has grown significantly in the United States over the past 50 years; in the 1950s, less than 5% of the workforce was required to hold a license, but by 2006, that number increased to 29%. Equally important, Kleiner and Krueger also commented that, during this same period, unionization steadily declined, presumably as a result of the shift from a manufacturing to a service-based economy.

Professional licensing continues to expand and currently professions including clinical laboratory practitioners (Steward & Schulze, 2005), electroneurodiagnostic technologists (Gaiter, 2008), solar power installers (Parker, Bower, & Weissman, 2002), and tower climbers (Wilcox, 2007) seek state licensing across the United States. Stephenson and Wendt (2009) argued that despite the penetration and expansion of licensing in the labor market, the associated politics and economics received comparatively little academic study or public scrutiny by comparison with other labor market interventions, such as unionization and changes in the minimum wage.

Clinical Laboratory Medicine

Clinical laboratory medicine is an underrecognized but integral component of health care that extends across research, clinical, and public health settings. There are more than 200,000 federally certified laboratories under the Clinical Laboratory Improvement Amendment (CLIA); these laboratories perform approximately 6.8 billion laboratory tests annually with revenues estimated at $52 billion (G-2 Reports, 2007). Overall, it is estimated that laboratory testing has an impact on over 70% of medical decisions across the patient care continuum, from the prevention and diagnosis through the treatment and management of a disease (Forsman, 1996). Despite the medical utility of clinical laboratory testing, the American Clinical Laboratory Association (2004) observed that laboratory services accounted for only 3% of health care spending and 2% of Medicare expenditures.

Whereas licensing for physicians, pharmacists, nurses, and physical therapists is required in every state, the licensing of clinical laboratory practitioners remains contentious. As of February 2011, only 11 states and one territory license laboratory practitioners: California, Florida, Hawaii, Louisiana, Montana, Nevada, New York, North Dakota, Rhode Island, Tennessee, West Virginia, and Puerto Rico (American Society for Clinical Laboratory Science, 2011). State licensing legislative activity has recently surged, with New York adopting clinical laboratory personnel licensing law after several concerted attempts over 30 years (Balachandran, Walker, Taylor, Cheng, & Wheeler, 2009).

Workforce. Considering the effect of professional licensing on clinical laboratory practitioner wages is important, because despite the strong and growing market for laboratory testing, Bennett, Thompson, Holladay, Bugbee, and Steward (2009) reported more than one-half of all clinical laboratories in the United States struggle to hire laboratory personnel, as evidenced by high vacancy rates (10.4%). In addition, Lacey and Wright (2009) confirmed the continued steady employment growth for clinical laboratory practitioners; specifically they reported the Bureau of Labor Statistics projected an estimated 13.9% increase with 107,900 total job openings due to growth and net replacements through 2018.

Bennett et al. (2009) warned a deepening workforce shortage is anticipated related to an aging workforce, because 13% of the current clinical laboratory workforce is projected to retire within the next 5 years and there is a decrease in the number of individuals entering the field. Increased competition for qualified staff and lower compensation for laboratory practitioners compared to other professions were cited as major contributory factors driving the workforce shortage (Bennett et al., 2009). For example, as reported by G-2 Reports (2007) electrical engineers, computer programmers, and registered nurses earned about 33% more than clinical laboratory practitioners.

The workforce shortage has not gone unnoticed by the industry, public health officials, or health care regulatory bodies. An independent health care industry firm, Washington G-2, identified this shortage as a primary risk factor to the clinical laboratory industry (G-2 Reports, 2007). State and local public health departments describe the workforce shortage as a long-term challenge to preparedness efforts (U.S. General

Accounting Office, 2004). The Joint Commission reported to Congress that underlying failures in laboratory quality performance were related to the growing shortage of laboratory practitioners and inadequacy of training related to weak national personnel standards (U.S. Government Accountability Office, 2006). Even the news media began to notice the threat to patient care and public health when the 2009 swine flu outbreak focused attention on the impending crisis. In separate reports, Kaplan and Burgess (2010) and Landro (2009) observed that many laboratories did not have sufficient clinical laboratory staff to handle flu testing, forcing many to work double shifts and use untrained personnel to perform these tests.

Clinical laboratory practitioner licensing. The benefit of professional licensing in general is professed to be enhanced public safety through increasing quality and avoidance of negative externalities from poor service (Arrow, 1963; Leland, 1979). As with other forms of regulation, the public interest is often passionately invoked to justify professional licensing. Alternatively, for as long as there has been economic thought, others including Adam Smith (1776/2005), Carroll and Gaston (1983), and Friedman (1962), have argued equally as ardently professional licensing reduces the labor supply through entry barriers that served primarily to raise the incomes and fees of the professionals and have little to do with the public interest.

Although professional licensing proponents and opponents both may be motivated by public safety related to quality, “there is virtually no study documenting the impact of accreditation, licensure, or certification on clinician performance or health outcomes” (Greiner & Knebel, 2003, p. 98). Furthermore, empirical tests of these economic theories of professional licensing have produced mixed results. The labor market and related economic effects of state professional licensing are discussed further in chapter 2, including those examining the effect on practitioner wages, that was the focus of this study of clinical laboratory practitioner licensing.

Wages

Human capital theory is often used to explain human behavior related to wage differentials (Marshall, 1998). Becker (1962) used a microeconomic approach to develop the general theory for determining the distribution of wages over time. Mincer (1974) developed the wage-human capital wage function specifying this relationship, particularly the return on education and experience. The costs of learning a skill or job is a very important component and led the economists, Becker (1962) and Mincer (1974) to assert that, *ceteris paribus* ("all else being equal"), wages vary according to the amount of investment in human capital, that is, the education, training, and experience of individuals or groups of workers.

A wage gap exists in the United States, with women earning less than men on average overall as well as for similar professions and within the same profession (Ellwood, Wilde, & Batchelder, 2009; U.S. General Accounting Office, 2003). This wage gap is not disputed in the literature, but the reasons why include that many women work part time (especially those with children at home), while men primarily work full time, and wages are often lower for part time work (Bardasi & Gornick, 2008). Married individuals generally earn more than unmarried individuals, all else being equal presumably because they may be perceived as more reliable than unmarried individuals

(DuMond, Hirsch, & Macpherson, 1999; Ellwood et al., 2009; Mincer, 1974; Moore, Pearce, & Wilson, 1981; Nelson, 1991; Polachek, 2008; Stoddard, 2005; Taylor & Fowler, 2006). Harkness and Waldfogel's (2003) study indicated the gender wage gap is especially large when comparing married men and married women and relatively small for single men and women.

Another aspect related to women's wages is childrearing often falls disproportionately on the mother. Childrearing is more likely to take the mother out of the workforce for significant time periods that may impact her experience level, thereby influencing the mother's wages in part according to the human capital theory of wages (Mincer & Polachek, 1974). Women with children also earn less than men with children, presumably because children utilize the mother's time and energy at home at the expense of effort at the workplace (Harkness & Waldfogel, 2003). However, according to Ellwood et al. (2009) and the U.S. General Accounting Office (2003), this explanation only partly accounts for the wage gap in even highly educated professional women's wages. To account for these factors, the present study controlled for gender, marital status, and childrearing as the number of children in the home.

Problem Statement

Legislation regarding clinical laboratory professional licensing is currently active in several states, ranging from adopting new state licensing, to expanding licensing requirements in licensed states, to attempting to repeal or limit the scope of licensing. According to Ogden-Grable and Watters (2004), licensing proponents argue either that higher wages will attract new entrants and retain experienced practitioners in this profession that is currently experiencing a workforce shortage or that there is no significant wage differential. On the other hand, those opposed to licensing warn wages will rise unnecessarily in a cost-conscious health care environment and exacerbate the workforce shortage due to licensing requirements that by nature restrict the eligible labor pool.

Economic theories of professional licensing have produced mixed results with respect to physicians, dentists, lawyers, radiologic technologists, clinical laboratory practitioners, barbers, cosmetologists, and manicurists. While a number of studies found increased wages related to state licensing (Federman, Harrington, & Krynski, 2006; Kleiner, 2000; Timmons & Thornton, 2008a, 2008b; White, 1978), others including (Steward & Schulze, 2005; White, 1980) concluded there is no significant impact.

Despite the rhetoric regarding the effect of clinical laboratory professional licensing on wages, the empirical literature on this subject was scant, incomplete, and provided conflicting conclusions. Only two studies were located that examined wages in the context of clinical laboratory practitioner licensing. White's (1978) study indicated as much as a 16% wage differential, however this study was more than 30 years old and did not include human capital and demographic wage factors, or all licensing states in the present study. In contrast to this earlier study, Steward and Schulze's (2005) more recent study concluded there was no significant wage difference related to licensing. Like White's study, Steward and Schulze's study suffered from important limitations in that it did not consider human capital and demographic factors related to individuals' wage differences, such as education, experience, and gender, described in the economics literature. Based an extensive review of the literature, I found no systematic attempt to analyze effects of state licensing using individual microdata for clinical laboratory practitioner wages and individual demographics affecting wages. The scarcity of information on clinical laboratory licensing and wages is problematic because this information would be of great value to the stakeholders to achieve an accurate understanding of wages in the current clinical laboratory licensing legislation debate.

Nature of the Study

This nonexperimental relational study used the Mincer (1974) wage regression equation based on human capital theory in data analysis and interpretation of wages of clinical laboratory practitioners in states that do and do not require licensing and clinical laboratory practitioners in those states that do not require licensing. The U.S. Decennial 2000 Census 5% Public Use Microdata Sample was used to identify clinical laboratory practitioners by state based on occupation (SOC code 29-2010) and place of work state. Data extracted from this sample for the present study included associated individual clinical laboratory practitioner wages (annual wages, weeks worked, hours per week worked), and human capital and demographic characteristics data including educational attainment years, age (used with educational attainment in years to calculate potential experience in years), gender, marital status, and number of own children in the home.

Research Questions and Hypotheses

This present study answered the following research questions by testing their associated hypotheses. Research Question 1 (RQ 1) was based on the Mincer wage regression model that controls for major individual characteristics generally considered to affect worker wages. Specifically, the control variables were potential experience and its square, education attainment, gender, marital status, and number of own children under 18 years old in the home.

RQ 1. To what extent does clinical laboratory practitioner licensing affect wages after controlling for education, potential experience, potential experience squared, gender, marital status, and number of own children under 18 years old in the home?

Null hypothesis: (H_{01}): There is no significant relationship between licensing and clinical laboratory practitioner wages over and above what is predicted by education, potential experience, potential experience squared, gender, marital status, and number of own children under 18 years old in the home ($R^2_{change} = 0$).

Alternate hypothesis: (H_{11}): Licensing will significantly predict clinical laboratory practitioner wages over and above what is predicted by education, potential experience, potential experience squared, gender, marital status, and number of children under 18 years old in the home ($R^2_{change} > 0$).

The following wage regression model was used:

$$\ln(\text{wage}) = \beta_0 + \beta_1(\text{education}) + \beta_2(\text{potential experience}) + \beta_3(\text{potential experience}^2) + \beta_4(\text{gender}) + \beta_5(\text{marital status}) + \beta_6(\text{number of children}) + \beta_7(\text{licensing}) + \mu \quad (1)$$

In this equation, ln wages is the natural log of wages, βi are standardized regression coefficients, and μ is the randomly distributed normal error term that contains omitted variables affecting wages (Wooldridge, 2003).

Research Question 2 (RQ 2) was based on the gender wage gap, specifically that women earn less than men even in similar or the same professions. For example, even within the same profession, Timmons and Thorton (2008a) found wage differences for licensed and unlicensed married female radiologic technologists. Therefore, effects of marital status and the number of children in the home on female clinical laboratory practitioner wages were controlled.

RQ 2. To what extent does clinical laboratory practitioner licensing affect female wages after controlling for education, potential experience, potential experience squared, marital status, and number of own children under 18 years old in the home?

Null hypothesis: (H_{02}): There is no significant relationship between licensing and clinical laboratory practitioner wages specifically for women over and above what is predicted by education, potential experience, potential experience squared, marital status, and number of own children under 18 years old in the home ($R^2_{\text{change}} = 0$).

Alternate hypothesis: (H_{12}): Licensing will significantly predict clinical laboratory practitioner wages specifically for women over and above what is predicted by education, potential experience, potential experience squared, marital status, and number of own children under 18 years old in the home ($R^2_{\text{change}} > 0$).

The following female wage regression model was estimated:

$$\text{Female } \ln(\textit{wage}) = \beta_0 + \beta_1(\textit{education}) + \beta_2(\textit{potential experience}) + \beta_3(\textit{potential experience}^2) + \beta_4(\textit{marital status}) + \beta_5(\textit{number of children}) + \beta_6(\textit{licensing}) + \mu \quad (2)$$

A more detailed discussion of the nature of this quantitative nonexperimental study including research questions, hypotheses, and methodology is provided in chapter 3.

Purpose of the Study

The purpose of this quantitative study was to determine the empirical effect of state professional licensing on the wages of clinical laboratory practitioners. The public policy of licensing clinical laboratory practitioners was informed for legislators, public health officials, clinical laboratory and health care professional and trade organizations, practitioners, and the public.

Determining any effects on wages is particularly important as health care costs are rising and the clinical laboratory workforce shortage is expected to worsen as baby-boom practitioners retire, threatening access to laboratory testing upon which 70% of medical diagnoses are based (Forsman, 1996). In 2006, New York adopted state licensing, and more recently a number of state legislatures including Massachusetts, Minnesota, Missouri, and Texas considered adopting clinical laboratory practitioner licensing bills (McCarty, 2009). Considering this recent resurgence in legislative activity, it is important to empirically determine the effect on wages in states requiring licensing compared to wages in those states that do not require licensing to practice.

Theoretical Framework

The study was grounded in the overarching economic theory of supply and demand (Smith, 1776/2005). In the context of state licensing, supply and demand is expected to affect wages because licensing limits labor supply through education, experience, licensing examination, and other requirements such as state residency and moral character. Several licensing studies (Carroll & Gaston, 1983; Friedman, 1962; Gellhorn, 1976; Gross, 1986; Kleiner, 2006; Kleiner & Kudrle, 2000) asserted that limiting entry into a profession results in a restricted labor supply or monopoly and thus increases wages through enhanced wage/service price competition.

The Mincer (1974) wage regression model was used to estimate effects. The model was based on the human capital theory that incorporates education and potential experience, and other control variables that affect wages as the framework for this study. Wages, education, potential experience, and other individual characteristics influencing wages, including gender, marital status, and the number of own children in the home, were included in the data collection, analysis, and interpretation. In addition, a female only wage model was included to study the effect of licensing on female clinical laboratory practitioner wages.

Definitions of Terms and Variables

Terms

Comparable Wage Index (CWI): The CWI reflects systematic, regional variations in the salaries of college graduates who are not educators. A state's CWI is a weighted average of the local wages within its borders (Taylor & Fowler, 2006).

Licensing/licensure: Licensing/licensure refers to the right bestowed by a governmental agency or entity to engage in a legally defined occupational scope of practice; a form of occupational regulation mandatory to practice an occupation; requirements often include education, experience, and licensing examination **(Minnesota Legislature. Office of the Legislative Auditor., 1999)**.

Medical and clinical laboratory technologist: Medical and clinical laboratory technologist are personnel who perform complex medical laboratory tests for diagnosis, treatment, and prevention of disease. May train or supervise other laboratory staff.

Variables

The data for all study variables were obtained from the U.S. Census 2000 5% Public Use Microdata Sample (5% PUMS) with the exception of the designation of licensing state and nonlicensing state.

Dependent variable. The dependent variable was the natural log hourly wages derived from the individual's annual wages and number of hours worked in 1999. Hourly wages are adjusted for systematic regional variations in salaries reflecting cost of living differences among different states in the United States using the CWI (Taylor & Fowler, 2006).

Independent variable. The independent variable was state licensing and represents a state that requires clinical laboratory practitioners to hold a license to practice clinical laboratory technology. As of 1999, licensing states included: California, Florida, Hawaii, Louisiana, Montana, Nevada, North Dakota, Rhode Island, Tennessee, West Virginia, and Puerto Rico* (Puerto Rico was excluded in this study).

Control variables. The control variables were educational attainment, potential experience and its square, gender, marital status, and number of own children in the home. Data for the control variables were obtained directly from the 2000 5% PUMS microdata with the exception of potential experience and its square. Potential experience (years) was a calculated value from age in years and years of education as follows: (age – years of education – 6), as suggested by Mincer (1974, p. 86).

Assumptions

The data extracted from the 2000 Decennial U.S. Census 5% PUMS were assumed to reflect honest Census respondent answers to questions regarding wages, number of hours worked/week, and the number of weeks worked in 1999. Like other licensing and wages studies, it was assumed the labor pool was limited to some extent due to licensing requirements that both restrict entry into the profession as well as experienced professionals' mobility from state to state due to non-uniformity in state licensing statute and regulation.

Limitations

A general weakness of this study was the nonexperimental design that limits establishing causation; however, this design was the only viable method as experimental design was not possible. The independent variable of interest, the policy intervention of state licensing, was predetermined and nonmanipulable by the researcher as clinical laboratory practitioner licensing is required by law in order to practice in states that are licensing states. Nonexperimental research design methodology is used extensively in the social behavioral sciences econometric studies including those on occupational wages.

Plausible rival explanations include that wages are regionally mediated based on cost of living of the area. Cost of living differences have been described elsewhere and various methods to account for these differences have been described (Berry, Fording, & Hanson, 2000; Council for Community and Economic Research (C2ER), 2008;

McMahon & Melton, 1978; Nelson, 1991). Because of cost of living differences, wages were adjusted according to the CWI assigned to the practitioners' state place of work. Further limitations are discussed in chapter 3.

Scope and Delimitations

This study sample contains those identified as clinical laboratory practitioners working in the United States in the 5% PUMS 2000 Census. The 5% PUMS is a stratified random sample of those responding to the 2000 U.S. Census long form. The study sample includes clinical laboratory practitioners working full time (at least 35 hours per week for 52 weeks) in 1999 in the 2000 U.S. Census 5% PUMS that attained a bachelor's or master's degree education. Washington, DC, although not a state, was included as a nonlicensing state; the United States territory Puerto Rico requires clinical laboratory practitioner licensing but was excluded as a licensing state for reasons elaborated in chapter 3.

A strength of the present study was that there was a sample of approximately 4,000 clinical laboratory practitioners selected from the 2000 Decennial U.S. Census 5% PUMS. Of these, approximately 1,000 practitioners are from licensing states and 3,000 are from states that do not require licensing to practice. The sample also contained approximately 72% women, exactly reflecting the proportion of 72% women vs. 28% men in this female-dominated profession (U.S. Department of Labor, 2004). Each sample member was an individual with wage data matched to individual characteristics such as gender, years of education attained, marital status, the number of own children in the home, as these individual characteristics are expected to influence wages as described in the literature.

The Mincer-based wage regression equation was used for data analysis. The economic theory of supply and demand and the human capital theory was used in interpretation. A detailed discussion related to the study methodology, validity, reliability, statistical power, data collection, and data analyses follows in chapter 3.

Significance of the Study

This study filled the gap in the licensing literature by empirically determining whether state licensing significantly affects clinical laboratory practitioner wages. This research extends the broader professional licensing literature as well as expands the much more limited literature regarding licensing effects on women's wages within the same profession, and professions not uniformly licensed across the 50 states.

Clinical laboratories are experiencing a workforce shortage, and the Bureau of Labor Statistics projected by 2018, the United States will require nearly 108,000 additional clinical laboratory practitioners to fill newly created positions and replace retiring staff (Lacey & Wright, 2009). The challenges to fulfilling this need are enormous because of the considerable supply and demand imbalance. Wolcott, Schwartz, and Goodman (2008) asserted the imbalance is the consequence of increased demand for clinical laboratory testing including development of newer genetic tests, inadequate supply driven by an aging workforce, insufficient new recruits, and limited educational capacity as many professional education programs closed.

Clinical laboratory state licensing has been offered as a key foundational element to improve workforce retention and recruitment. Social change recently occurred within the profession as the two major clinical laboratory professional organizations issued policy statements strongly favoring the expansion of state licensing, whereas previously both opposed (American Society for Clinical Pathology, 2005; College of American Pathologists, 2008). Both organizations attributed the abrupt policy shift to addressing the looming workforce crisis as it is thought licensing could raise the profession's stature and recognition and thus encouraging potential recruits to the field as well as supporting educational institutions in expanding professional education programs.

This study has the potential for positive social change related to state clinical laboratory professional licensing policy development, implementation, and analysis. The research provided timely and much needed wage data as there has recently been a good deal of state licensing legislative activity and a scarcity of empirical data available for legislative decision makers to reach informed conclusions on the potential costs and benefits to adopting clinical laboratory professional licensing legislation. If the wage data indicate no significant wage differential, then a major argument in opposition to licensing is nullified. An expansion of licensing would likely benefit the clinical laboratory profession by advancing professional status recognized by sociologists including Freidson (1983) and Weber (1946/2002) as an important milestone toward professionalization of an occupation.

On a larger scale, a more robust clinical laboratory practitioner workforce would benefit the United States health care system by assuring access to high quality laboratory testing and better ensure public health preparedness related to infectious disease and disaster management. Whereas a workforce shortage can negatively impact patients in receiving both a timely and accurate diagnosis, and monitoring treatment regimes that can exacerbate acute and chronic illness further contributing to increased health care costs. Levit, Smith, Benz, and Ferrell (2010) revealed such a dire scenario regarding the cancer care crisis related to the insufficient oncology workforce that included clinical laboratory practitioners who performed testing to diagnose, select the most effective treatments, and monitor cancer recurrence.

Summary

The literature on clinical laboratory practitioner licensing and wages is scarce, at odds, and has not been empirically examined using individual microdata with wage regression modeling. This research question needs an update as the clinical laboratory practitioner licensing debate continues and licensing legislative activity is surging in the absence of relevant wage empirical data. Chapter 2 provides the literature review and gaps in the literature. Chapter 3 presents the research methodology for the study. Chapter 4 presents the study results and data analyses. Chapter 5 provides an overview of the study with a literature-based interpretation of the findings, and concludes with recommendations for action and further studies, implications for social change, and a plan for dissemination of the study findings.

Chapter 2: Literature Review

Introduction

The literature review describes previous nonexperimental quantitative research studies on the determinants of wages related to individual characteristics. Other empirical studies reviewed specifically considered the influence of state policy requiring professional licensing in order to practice within the state on wages for a variety of professions. Several of these wage studies considered methods to compare wages within a profession for workers in different geographic locations related to local cost of living. The review also addresses the key methodologies, including U.S. Census 2000 5% Public Use Microdata, wage regression analysis, and wage adjustments by the comparative wage index, used in the present study to determine effects of clinical laboratory practitioner state licensing on wages.

The organization of this literature review developed from the prominent theoretical framework of the human capital theory and supply and demand theory as emphasized in the economic literature on wages and wages determinants. Inclusion of seminal works by the economists Mincer and Becker on the conceptual framework for this study augments the literature review. Next, a synthesis of the major research themes including professional licensing’s effect on wages and gender-wage-related literature, including the gender wage gap, the motherhood wage gap, and marriage effects on wages, are described. Methods to adjust wages considering geographic cost of living differences followed by wage study research methods conclude the review.

The literature review strategy included database searches conducted using EBSCO, Academic Search Complete, EconLit, SocIndex, Business Source Complete, CINAHL, MEDLINE, Google Scholar, 1962-2010, and Google search engine that produced the research studies and pertinent theoretical publications. *Licensing*, *professional licensing*, *occupational licensing*, *occupational regulation*, and *clinical laboratory personnel licensing* were examples of the topic-related key terms used in the literature search on licensing. In addition, the term *licensing* was substituted for the alternative term *licensure*. Key terms were also combined for wages and licensing/licensure. *Wages* and *wage determinants* were example of the topic-related key terms used in the literature search on wage determinants. These key terms were also combined with wages, including *marriage*, *motherhood gap*, *fatherhood*, and *family gap*. *Gender wage gap*, *women's wages*, and *female wages* were examples of the topic related to gender. *Cost of living* and *cost of living index* were examples of the topic-related key terms used in the literature search on cost of living indexes and adjustments.

Of the approximately 60 articles, 20 were reports of research regarding professional licensing effects on wages and prices. Despite appeals for clinical laboratory practitioner state licensing and state legislative activity, the literature search yielded just two articles addressing this subject from the perspectives of wages in economic terms. Two others were pro and con articles and professional organization position statements. The remaining approximately 40 articles were empirical studies conducted by the authors regarding wage determinants that represented the control variables in the present study. Of these, 15 focused on the gender wage gap, 10 on the motherhood wage gap, and five on marriage. Additionally, there were nine articles on geographic cost of living variation and wages.

The present study of clinical laboratory practitioner state licensing effect on wages sought to address the knowledge gap in the professional licensing literature. The nonexperimental research design used quantitative data to determine the extent that clinical laboratory practitioner licensing affects wages over and above the amount predicted by individual human capital and demographic control variables. The clinical laboratory profession was and remains a female-dominated field, so this study also sought to determine the extent to which female clinical laboratory practitioner wages are affected by state licensing.

Professional licensing prompted debate and investigation into the factors affecting wages and wage differentials. Although many studies suggested that professional licensing increased wages and fees for the licensed group, only two studies evaluated this effect in clinical laboratory practitioners. These studies, conducted 30 years apart, produced conflicting results and conclusions. Specifically, White's (1978) study indicated a significant increase (16%), and the other no significant difference (Steward & Schulze, 2005). No previous study has directly or systematically examined the extent clinical laboratory practitioner licensing affects wages holding the common human capital and demographic wage determinants in control so the effect of licensing was determined as being above and beyond these effects. The scarcity of information on clinical laboratory licensing and wages was problematic, because this information would be of great value to the stakeholders to achieve an accurate understanding of wages in the current clinical laboratory licensing legislation debate.

The benefit of professional licensing was professed to be enhanced public safety through increasing quality (Arrow, 1963; Leland, 1979). As with other forms of regulation, the public interest was often passionately invoked to justify professional licensing. Alternatively, the purported costs included reduced labor supply and higher wages for the license holder (Carroll & Gaston, 1981; Friedman, 1962; Smith, 1776/2005). As a result, licensing laws may actually cause more public harm than good. Carroll and Gaston (1981) found a relationship between strict licensing requirements for electricians, dentists, and optometrists and a high incidence of poor outcomes including accidental electrocutions, poor dental hygiene, and blindness (respectively). These findings suggested that, as licensing requirements increased, fewer practitioners sought or could attain a license. Carroll and Gaston concluded strict licensing requirements led to fewer patients/customers serviced, and may increase the probability someone would perform the service themselves or forgo it altogether.

Major Theoretical Foundations

Licensing and Wages – Supply and Demand

Previous studies of the effect of state licensing on wages were grounded in the overarching economic theory of supply and demand (Smith, 1776/2005). Accordingly, researchers explained a rise in wages related to licensing due to a labor supply constrained by requisite minimum education, experience, licensing examination, and other requirements such as state residency and moral character (Carroll & Gaston, 1981; Friedman, 1962; Gellhorn, 1976; Gross, 1986; Kleiner, 2006; Kleiner & Kudrle, 2000).

Carroll and Gaston (1981) suggested, based on a review of a large number of studies across professions that in general, licensing was related to the availability of fewer practitioners as a result of barriers to entry. Weeden (2002) concluded significant supply side restrictions were generated through educational credentialing, mandatory certification, and licensing that raised mean wages by 20%, 12%, and 9%, respectively.

Licensing of health care professionals was no exception. Gaumer (1984) asserted, based a review of health profession occupational regulation practices, that the professional groups benefit from higher fees and wages through limiting competition without evidence of improving quality. Other studies on licensing that suggested sginficantly raised earnings as a result included Timmons and Thornton's (2008a) study of radiologic technologists; White's (1978) study of clinical laboratory practitioners; and Kleiner's (2000) study of dentists, lawyers, barbers and cosmetologists.

Although these studies suggested state licensing resulted in increased wages, others concluded there was no significant effect. Pfeffer (1974) studied men within the same professions across states and found mixed results. There was no correlation found between regulation and mean earnings of real estate brokers, insurance agents, plumbers, but a positive correlation was found between earnings and examination failure rates and the composition of licensing boards. Pfeffer asserted professional licensing regulation was not the source of increased wages, but rather it was the extent of occupational professionalization. White's (1980) study of nurses wages and Steward and Schulze's

(2005) more recent survey of clinical laboratory practitioner wages did not reveal a significant wage effect.

Clinical laboratory practitioner licensing wages studies. Only two published studies were located that examined the effect of clinical laboratory practitioner state licensing on wages. White (1978) found a 16% wage premium in the older, more stringent licensing states of California and Hawaii, whereas there was a small but not significant impact on wages and labor supply in the more recently licensed states. Although this study controlled for education and gender through the sample selection criteria (women with college degrees), it did not control for experience. In contrast, Steward and Schulze (2005) concluded that there was no significant wage premium associated with state licensing. This study suffered from important limitations in that it did not control for human capital and demographic factors related to individuals' wage differences, such as education, experience, and gender, described throughout the economic literature as related to wages. Based on an extensive review of the literature, there appears to have been no systematic attempt to determine the effects of state licensing on clinical laboratory practitioner wages that used individual microdata and controlled for human capital and individual demographics affecting wages.

Women's wages and licensing studies. Women earn lower wages than men on average including within the same profession (Blau & Kahn, 2000; Bowler, 1999). Moore, Pearce, and Wilson (1981) investigated the quantitative relative effects of licensing and certification on the mean wage rates of women across occupations and observed that licensed women earned about 20% more per hour compared to unlicensed women; no statistically significant wage premium was found for certified women compared to licensed women. To control for the gender wage gap in licensing studies reviewed, White (1978, 1980), Moore et al. (1981) and Federman, Harrington, and Krynski (2006) restricted their study population to women, whereas Timmons and Thornton's (2008a) study of radiologic technologists used gender as a variable in the wage regression equation.

Human Capital Theory

Human capital theory posits that an individual's wage is a function of human capital investments including years of education, experience, and various additional factors (Mincer & Polachek, 1974). Accordingly, the greater the worker's human capital, the greater productivity and thereby wages. In previous studies, various additional factors were independent variables, or alternatively controlled for and included a range of individual characteristics such as gender and marital status, and labor market imperfections such as state licensing.

Based on the human capital theory, Mincer (1974) first modeled wages derived from human capital investments; the Mincer wage model was widely adopted in wage studies including those that analyzed the effect of state licensing on professional wages (Federman et al., 2006; Kleiner & Kudrle, 2000; Thornton & Weintraub, 1979; Timmons & Thornton, 2008a, 2008b; White, 1978). The human capital theory and Mincer wage model were used as the theoretical basis of numerous studies of the gender wage gap and the motherhood wage gap (Anderson, Binder, & Krause, 2003; Antecol & Bedard, 2002; Bardasi & Gornick, 2008; Chun & Lee, 2001; Harkness & Waldfogel, 2003; Korenman

& Neumark, 1992; Mincer & Polachek, 1974; U.S. General Accounting Office, 2003; Waldfogel, 1997). Many of these wage studies are described later in this literature review.

Selected Wage Determinant Research Variables

The literature on wage determinants relied on the human capital theory and included variables controlling for education, experience, and demographic variables such as gender, the presence of children, and marriage.

Education

The influence of education level on wages was integral according to the human capital theory and was included in the Mincer (1974) wage equation and in the vast majority of empirical wage studies evaluated in the present study. Most of the studies account for education level directly as either a control variable or a main independent variable in Mincer's regression equation. A variety of methods have been used to control for education by selecting a study sample that met specified education attainment criteria. For example, Sweet, Nelson, and Moberg (2006) selected individuals with PhD degrees, and both Taylor (2008) and White (1978) selected those with bachelors degrees as a minimum. In addition, Ellwood et al. (2009) applied sample stratification in their study of the effects of the motherhood wage penalty on higher skilled versus lower skilled women.

Experience

The other key wage determinant was the experience control variable in the Mincer wage regression equation. Experience was often a constructed variable sometimes referred to as potential experience calculated from age and number of years of education

(Mincer, 1974). Potential experience was also operationalized using age as a proxy (Law & Marks, 2009; Taylor, 2008; Timmons & Thornton, 2008b). Potential experience was particularly predominant in wage studies using cross-sectional secondary data, as a directly obtained experience level was often not available in the data set such as the U.S. Census 5% PUMS and the Current Population Survey (CPS).

In some studies, experience was available from primary data, that is, wage and demographic surveys of professional organization's membership (Sweet et al., 2006; Timmons & Thornton, 2008a). The main weakness in these data sets were these only included members of organizations and thus omitted many professionals. Experience was available in certain longitudinal data sets used in a number of wage studies (Ellwood et al., 2009; Erosa, Fuster, & Restuccia, 2005; Loughran & Zissimopoulos, 2009).

Of note, Mincer (1974) described experience as a nonlinear U-shaped function, because wages rise quickly over the first 20 years of work until the tipping point of decline is reached and wages slow and then begin to decline as years of experience increase over a lifetime. Therefore, the control variable potential experience squared was included in addition to potential experience in wage studies that used the Mincer wage regression equation. Wage determinants outside of human capital studied in the literature included gender, marital status, children, state professional licensing status, and geography at the regional and state level.

Gender and Gender Wage Gap

There have been persistent findings of wage differences between men and women and between mothers and women without children under 18 years in the home. A significant body of research exists on the gender wage gap defined as the difference between average wages earned by men and women. According to the U.S. Bureau of Labor Statistics, women who were full-time hourly workers in 1999 earned 77% of the median income for men (U.S. Department of Labor, 2000). This is the year Census 2000 5% PUMS data is based upon and was used in the present study. According to the U.S. Department of Labor (2010b), the gap between women's and men's wages has been closing since the 1970s, but the gender wage gap continued to persist in 2009, as women who were full-time wage and hourly workers earned approximately 80% of the median for men despite increasing women's career aspirations and educational attainment that recently exceeded men's on average.

International studies (including United States data) also demonstrated a gender gap exists within and outside the United States labor market; results suggest that the United States had a higher gap than other industrialized countries studied (Bardasi & Gornick, 2008; Harkness & Waldfogel, 2003). Furthermore, Boraas (2003) concluded the overall gender wage gap remained and was still largely unexplained after controlling for human capital and occupational variables.

The gender wage gap was extensively described, and factors related to it have been analyzed in the literature using a human capital theoretical framework that includes the relationship between a worker's experience and education and wages earned. As women's education equals or exceeds men's on average, much of the recent scholarly discussion and research focused on the experience wage determinant to better understand the gender wage gap. Differences in experience between men and women existed, and there was clear evidence that women generally did not participate in the labor market continuously over their lifetime, tended to work fewer hours than men, and were much more likely to work part-time in the United States and internationally.

In the seminal paper on family investments in human capital and women's earnings, Mincer and Polachek (1974) attributed the gender wage gap to significantly different patterns of human capital investments between men and women. In their early study using the 1967 National Longitudinal Survey of Work Experience, Mincer and Polachek found women in 1967 spent less than one half their lives in the labor market and suggested this was due to demands of children and taking care of the household.

Mincer and Polachek (1974) also asserted the pattern of human capital accumulation for women was especially different for mothers as the presence of one or more children negatively affected women's wages by directly impacting accrual of work experience related to work interruptions as mothers tend to move in and out of the labor market. Additionally, because women anticipated having children, their prospective human capital investment was lower than men because incentives were fewer as returns to human capital investments were smaller overall. In summary, Mincer and Polachek argued the human capital theory predicted women's wages were lower than men's wages, and similarly, mothers' wages lower than women with no children's wages, because this latter group were more likely to be continuously employed.

Indeed, like the BLS wage data for the general United States population described above indicated a gender wage gap, there was and still remains a gender wage gap among United States clinical laboratory practitioners where full-time women earned 83.7% and

85.5% what their male counterparts earned in 1999 and 2009, respectively (U.S. Department of Labor, 2000, 2010b). However this unadjusted occupational wage data did not account for individual differences in human capital including experience and education expected to affect wages according to the human capital theory. Although White's (1978) study of clinical laboratory licensing and wages controlled for education and gender by selecting women with a college degree in the study sample, no other clinical laboratory practitioner licensing studies were located that controlled for both major human capital variables education and experience, as well as demographic variables such as gender, and no studies included the presence of children. Occupation was also controlled for in the present study as only those employed in the clinical laboratory profession were included in the sample.

Gender division of labor. Becker (1985) extended Mincer and Polachek's (1974) human capital theory explanation of the gender wage gap in another seminal work and posited specialized investments in human capital produced increased returns and thus provided strong incentives for the division of labor among otherwise equal individuals. In the context of the household, the presence of children reinforced the sexual (gender) division of labor between the mother and father whereby mothers take primary charge of childrearing and the home and fathers take primary charge of wage earning. Furthermore, according to Becker's (1985) work effort hypothesis, it was not merely that women worked fewer hours than men, but the heavy energy demands of children and the household meant women had less energy available for the labor market and resulted in less work effort by women and occupational segregation based on gender. Taken together, fewer hours worked, less effort, and occupational segregation resulted in wage penalties for women in general, and even larger wage penalties for mothers. In contrast, these same factors driven by gender division of labor resulted in wage premiums for fathers.

Gender work pattern differences. In the past, mothers generally withdrew completely from the workplace; however, recently they are returning. In order to return to work with children at home, mothers adapted to accommodate the new dual role of parent in addition to worker. Accordingly, family and children still dominated over work with work effort diminished compared to men and women without children (O'Neill, 2003). Both O’Neill (2003) and the U.S General Accounting Office (2003) studies posit that to balance duel roles, women substituted financial rewards for benefits including flexible work schedules and less unpredictable or less stressful work that resulted in lower wages.

Consistent with Mincer and Polachek (1974) and Becker (1985), Bowler (1999) argued much of the gender wage gap found in Bureau of Labor Statistics wages data for 1998 was explained by differences in women’s and men’s work patterns. Bowler reported women generally worked in lower paying occupations, worked less including holding part-time versus full-time employment status more often than men, and earned less than men within the same occupation. In addition to the number of hours worked, Bowler also observed that women’s earnings in 1998 varied by age, occupation, and education. Because of their importance, these were among the variables selected for inclusion in the present study in order to examine the effects of state licensing on clinical laboratory practitioner wages while controlling for these variables.

Overall, the gender wage gap related to occupation remains largely unexplained even when occupational controls were included in wage studies. In addition, wage studies within professions consistently revealed a gender wage gap and even when women take male dominated occupation jobs, they still earned less than men while controlling for education and experience.

Part time versus full-time work. Bowler (1999) found women were more likely to work less than 40 hours per week. This part-time work pattern was associated with negative wage effects for both hourly and salary workers. In marked contrast to women, men typically did not work part-time. In line with these findings, O'Neil (2003) reported 19% women in the United States worked part-time versus 5% of men based on the CPS (2001) conducted by the U.S Census for the Bureau of Labor Statistics. Similarly, these cross-sectional study findings were supported in a longitudinal study conducted by the U.S. General Accounting Office (2003) using the U.S. Panel Study on Income Dynamics (PSID) 1983-2000 of U.S. women's earnings. Specifically, the U.S. General Accounting Office reported 33% women worked part-time versus 12% of men.

Similarly, international studies of part-time work and wages were consistent with United States wage studies and reached the same conclusion: those working fewer hours were paid a lower hourly wage. Bardasi and Gornick (2008) studied wage penalty consequences associated with part-time employment among women across six industrialized countries including the United States. Bardasi and Gornick found the part-time work force was 80-95% women and determined these women part-time workers earned 17.5% less than their full-time counterparts, even when measurable worker and job-related characteristics were controlled.

Certainly, lower wages for part-time workers was partially explained by the human capital approach, as part-time workers accrued less experience and therefore less human capital. Although Bardasi and Gornick (2008), Bowler (1999), the U.S. General Accounting Office (2003) and O'Neil (2003) consistently reported part-time work patterns contributed in important ways to the continued earnings disparity between men and women, this explanation did not account for all of the difference.

To gain some insight into the residual unexplained gender wage gap, the U.S. General Accounting Office (2003) study method included interviews with employers and experts in wages and workplace issues. With this supplementary data, further explanations offered included such factors as negative effects to career and advancement, because some employers viewed part-time workers as less than "ideal" workers, as they offered less "face-time" in the workplace. Overall, the authors concluded some employers perceived part-time workers as less valuable because part-time workers appeared less committed, productive, and available than full-time workers.

In summary, wage differences for part-time work compared to full-time work was consistently recognized in the literature as an important wage determinant and was especially important when women's wages were considered. In the present study, part-time clinical laboratory practitioners were excluded from the sample to avoid possible negative effects of part-time workers wages, following (White, 1978). Harkness and Waldfogel (1999) suggested a relationship between the gender gap and the motherhood wage gap found in the United States and internationally. Specifically they concluded those countries like the United States that had high negative effects of children on women's wages tended as well to have the larger gender gap in wages.

Children: Motherhood Wage Gap, Fatherhood Wage Premium

It has been well documented in the literature that mothers earned less than women without children, *ceteris paribum*. According to Boraas and Rodgers (2003), this finding has been referred to as the motherhood wage gap and the family wage gap. The motherhood wage gap was defined as the difference in the average wages between women with children under 18 years of age and women without children. Mothers also earned less than fathers, whereas fathers earned more than men without children, the latter was referred to as the fatherhood wage premium.

Women with children under 18 years old present in the home who worked full time earned approximately 66% of the median for men with children in 1999, the year that Census 2000 data were collected (U.S. Department of Labor, 2000). Based on BLS data for year 1999, mothers compared to non-mothers experienced a motherhood wage penalty of 6%, whereas fathers earned a 19% fatherhood wage premium compared to men without children under 18 (U.S. Department of Labor, 2000). In separate studies of multiple industrialized countries, Bardasi and Gornick (2008) and Harkness and Walfogel (2003) documented the motherhood wage penalty in the United States and internationally.

Work effort hypothesis and mother-friendly jobs. Similar to the gender wage gap, the motherhood wage gap literature generally attributed the motherhood wage gap to differences found in patterns of human capital accumulation by mothers compared to women with no children. Bardasi and Gornick (2008) asserted the presence and age of children were crucial factors in women's employment choices in that motherhood increased the probability of working part-time or exiting the labor force altogether. Overall women, and especially mothers, worked fewer hours, took breaks from the labor market, worked part-time vs. full-time, and selected less demanding women's occupations or mother-friendly jobs, that affected wages compared to men and women with no children. Women's occupations and mother-friendly jobs both refer to type of jobs that makes it easier to combine the duel role of motherhood and working outside the home. According to Becker's (1985) work-effort hypothesis, mothers and prospective mothers may choose jobs requiring less energy due to high energy demands at home, or those jobs with characteristics such as flexible hours, the option to work part time, few demands for travel, and regular work hours (no mandated overtime).

Motherhood and labor market attachment. The motherhood wage gap literature encompassed many detailed aspects such as the effects of short versus longer breaks from the labor market and their timing in the women's life cycle. Two British cohort studies of women in their 30s who became mothers and maintained continuous employment were found to be paid as well as non-mothers (Joshi, Paci, & Waldfogel, 1999). Likewise, Lundberg and Rose (2000) found no significant wage penalties for mothers returning to work within one year. Finally, Antecol and Bedard (2002) found breaks in work surrounding childbearing and childbirth were associated with previously full-time women earning less than women with no children, and these women incurred an estimated 4.5% wage penalty for each year of absence from the labor market.

Erosa, et al. (2005) extended the motherhood wage gap literature as they integrated the timing of children in a women's life cycle with the Mincer life cycle of wages. Mincer's (1974) life cycle of wages theory predicted that wages rose fastest during the first 20 years of work life, about doubling between 20-40 years old, and this intersected with the same time period women typically had children and were out of the labor market or decreased their labor market participation by working part-time. Consequently, human capital accumulation in hours worked and also unmeasured human capital accumulation became lowered and was reflected in lower wages. Erosa, et al. (2005) reported on average, men worked 40% more hours worked than women so by age 40 women had 9% less human capital compared to men. In contrast, women without children had similar (but fewer) hours worked compared to men.

Ellwood, et al., (2009) observed the longitudinal consequences of childbearing on mothers' wages and wage trajectories (wage growth) and found wage trajectories differed by skill level and timing of motherhood. They concluded that wage penalties associated with childbearing were much higher in high-skilled as compared with low-skilled mothers and that these wage penalties persisted. Loughran and Zissimopoulos (2009) concluded as well that delaying childbearing increased wages for women compared to not delaying childbearing.

Whereas the literature on wages and human capital differences between mothers and women without children is consistent, Becker's (1985) work effort hypothesis as applied to the motherhood wage gap and mother-friendly jobs was challenged. Budig and England (2001) reached a different conclusion and argued that mother-friendly job characteristics explained very little of the motherhood wage gap. Alternatively, Budig and England suggested mothers with lower education levels had significantly lower wages because low skill jobs typically required the worker's presence during normal business hours and were thus less likely to have options to telecommute, work at home, or have flexible work time. Similarly, Anderson, et al., (2003) also raised doubt on the work effort hypothesis explanation of the motherhood wage gap and concurred with Budig and England that the motherhood wage gap was likely due to trade-offs permitting work time flexibility rather than less energy demanding work.

Number of children. A number of authors estimated the average wage penalty for the presence of children on women's wages ranged from 4%-9% for one child, and 7%-15% for two or more children in cross-sectional and longitudinal studies. Specifically, Korenman and Neumark (1992) observed a 4% motherhood wage penalty for one child, 7% for two children and argued children had a direct negative effect on women's wages and that mothers decreased their labor supply further as a result, which further negatively impacted experience and tenure.

In a later study, Anderson, et al., (2003) found a 9% penalty for one child, 15% for two or more children in a longitudinal and cross-sectional study that used 1968-1988 National Longitudinal Survey of Young Women data and controlled for human capital variables, part-time work, occupational group, and marriage, Anderson, et al. concurred with Korenman and Neumark's (1992) assertion the experience gap between potential and actual experience was significant (3 years for mothers compared to 1.5 months for non-mothers). Anderson, et al. also noted the size of their motherhood penalty was similar to the 11% penalty for women aged 14-44 years in the March 1999 CPS. This was the same year of the Census 2000 5% PUMS data collection used for the present study. Waldfogel (1997) found a 4% penalty for one child and a 12% penalty for two or more children in a longitudinal and cross-sectional study that controlled for part-time work, marriage, and human capital. Harkness and Waldfogel (2003) found a 2.5% penalty for one child, 4.8% for two children, and 10.2% for three or more children. Erosa, et al., (2005) and Budig and England (2001) found a 5% motherhood wage gap for each child; these findings are consistent with other estimates reported in the literature.

Fatherhood wage premium. Although the motherhood wage penalty was consistently demonstrated, there was not a similar family wage penalty found for men. In contrast, the literature suggested a well established fatherhood wage premium, estimated as 10-15% by Korenman and Neumark (1991). Additionally, Lundberg and Rose (2000) found the birth of the first child associated with a a 9% increase in fathers' wage rates and a concomitant 5% reduction in mothers' wage rates. Paradoxically, fathers' wages increased in spite of a 7% reduction in work hours. Lundberg and Rose attributed the motherhood wage gap and fatherhood wage premium to gender specialization in the household, and suggested the gender specialization effect on wages appeared to be decreasing among younger cohorts.

To summarize the motherhood wage gap, work patterns for mothers with children less than 18 years of age, including part-time work, breaks from work, and employment in mother-friendly jobs, were described. No studies were found that addressed these issues in terms of clinical laboratory practitioner wages that examined as a main effect (or controlled for) part-time work or the number of children in the home. The present study design controlled for occupation and part-time work by selecting only those working full-time as clinical laboratory practitioners in the sample. The presence and number of children in the home was a control variable in the wage regression equation. The number of children was a control variable in the female wage regression because time outside the labor force impacts experience. Women spending more time than men outside the labor force because child rearing is often cited as a major factor in explaning why women earn less than men. Finally, there was wage literature exploring whether marriage affects wages.

Marriage

A number of authors noted married individuals generally earned more than unmarried individuals all else being equal (Chun & Lee, 2001; Ellwood et al., 2009; Korenman & Neumark, 1991; Mincer, 1974; Moore et al., 1981; Polachek, 2008). There was compelling evidence of the male marriage premium in the literature. In their often cited seminal paper on the male marriage premium, Korenman and Neumark (1991) found on a longitudinal study that married men earned higher wages compared to unmarried men.

Male marriage premium: Productivity vs. selection. The two main mechanisms offered by the literature on the male marriage premium were the productivity hypothesis and the selection hypothesis. The productivity hypothesis was based on Becker's (1985) assertion that marriage makes men more productive through gender specialization in the household. In this model, the husband reduces his responsibilities in the household and shifts these to his wife, thus allowing the husband to be more productive at work and thereby earn higher wages. On the other hand, the selectivity hypothesis proposed by Nakosteen and Zimmer (1987) asserted married men were more productive *prior* to marriage and were preferentially selected into marriage.

As there was little or no debate related to the male wage premium *per se*, a number of authors subsequently examined the productivity (gender division of labor) and selectivity hypotheses. Chun and Lee (2001) used CPS 1999 data and found a 12.4% wage premium for married men compared to never married men. Equally important, the wage premium ranged 3.4%-31.4% and was inversely related to the number of hours their respective wives worked. This finding provided support to the productivity hypothesis, but this still left about one-half of the male marriage premium residual unexplained. A longitudinal study by Hersch and Stratton (2000) also supported a male marriage wage premium but did not support either the productivity or the selectivity hypotheses. They concluded it was something else that made married men more productive. Reasons offered included improved stability as a worker (factual or in the employer's perception), but they also left it open that fathers may receive preferential treatment in the workplace.

Female marriage premium or penalty. It was not entirely clear how marriage affected women's wages, as the empirical findings in the literature have been mixed. A number of different authors reported female marriage premiums ranging from 2-6%, but there were studies that indicated a female marriage wage penalty. Harkness and Waldfogel (2003) found in a longitudinal study focusing on the motherhood wage gap that married women had a 6% wage premium compared to unmarried women, consistent with an earlier study finding a 4-6% premium by Waldfogel (1997). Another longitudinal study by Budig and England (2001) used data obtained from the NLSY (1982-1993) and found a small but statistically significant marriage premium for women.

Conversely, Korenman and Neumark (1992) found married women had a 2% marriage penalty and concluded that marriage had relatively little or no association with women's wages. Timmons and Thornton (2008a) found a 2% wage penalty for marriage in their study of radiologic technologist state licensing wage effects; however, the authors failed to explain or comment on this finding. Another recent study used 1979-2000 NLSY longitudinal data and found women's wages decreased by about 4% the year following marriage (Loughran & Zissimopoulos, 2009). Taken together, the male marriage premium literature clearly suggested married men earned more than unmarried men all else being equal. Just as important however, were wage studies that yielded conflicting conclusions on married women's earnings; some studies indicated wages were less than unmarried women, some more, and others little no association. The present study controlled for marital status using a dummy control variable in the wage regression equation. In addition to these individual based wage determinants, methods that compared wages in different geographic locations by cost of living indexes were sometimes employed.

Geography (Location) Cost of Living Indexes

Another wage determinant described in the literature was worker's location. Some empirical wage studies operationalized the location determinant by taking into account the worker's location as census region, state, city, or whether the residence was suburban or rural. To aid in systematizing wage comparisons across different locations, state cost of living indexes were developed by McMahon and Melton (1978), Nelson (1991), and Friar and Leonard (1998). Subsequently, Berry, Fording, and Hanson (2000) developed a state cost of living index for 1960-1995 for the continental United States based on the McMahon and Melton (1978) index. Berry, Fording, and Hanson (2004) updated this COL index for 1960-2003.

The most widely used cost of living reference is the Consumer Price Index (CPI) based on the cost of a selected basket of goods and services and is generally used as an price inflation or deflation indicator. The CPI only covers major metropolitan areas so it provides accurate comparisons longitudinally, but is not useful for comparing one city to another or one state to another. For example, one can trend the cost of living for Minneapolis, MN from year to year, or the nation as an average, but not compare the cost of living in Minneapolis, MN to San Diego, CA. The CPI is limited because the index was set to a value of 100 at its inception in the 1960s despite the fact that cost of living was not the same in all areas.

Another frequently used measure of cost of living is the American Chamber of Commerce Research Association (ACCRA) cost of living index (COL index) published quarterly since 1968 that provided a method to compare cost of living differences among selected metropolitan areas based on market basket of goods and housing costs (Council for Community and Economic Research (C2ER), 2008). A limitation of this COL index is that participating areas vary over time; therefore, the ACCRA COL index did not provide comparative measurements that could be compared longitudinally. Additionally, DuMond, Hirsch, and Macpherson (1999) criticized the ACCRA method, arguing that it would overcompensate workers in high cost areas; they also recognized that the absence of any cost adjustment would likely undercompensate these workers. DuMond, Hirsch, and Macpherson developed a metropolitan area COL index. Another type of method used to account for wage differentials related to geographic variation was those that considered geographic or area related amenities.

Area amenities and disamenities. Area related amenities refers to unique immobile advantageous features offered by the geography and climatic features. An area amenity of warm climate would attract workers preferring a warm climate and they would be willing to accept the higher costs of living (Cebula & Toma, 2008; Eberts & Schweitzer, 1994). Other amenities include area specific recreational opportunities such as skiing and boating. Conversely, area disamenities (or low amenities) refer to those negative features including climate that is too hot or too cold, high crime rates, high taxes, pollution, and poor local government services (Cebula & Toma, 2008; Eberts & Schweitzer, 1994). Recently, Cebula and Toma (2008) further extended the literature on geographic wage differentials by studying interstate wage determinants by amenities and disamenities. Cebula and Toma suggested factors tending to raise demand in a geographic area, were also those tending to raise overall pricing levels in that area. In addition to variables that measured state general demand and supply conditions, Cebula and Toma operationalized amenities/disamenities by integrating quality of life and environmental factors that affected cost of living across states. Examples included amount of coast line relative to land in the state, heating days, and the amount of toxic chemicals released into the environment.

Stoddard (2005) argued for adjusting salaries based on area amenities and opportunities, rather than just cost of living to compare wages across states. Stoddard asserted that cost of living indexes incorrectly adjusted for wage differences and thus result in misleading conclusions about the relative welfare of workers across states and the relationship (or more accurately the lack of relationship) of wages and quality outcomes. Stoddard warned "rather than controlling for variation. . . cost of living adjustments exacerbate these differences" (p. 324). Stoddard emphasized such analyses can lead to substantially altered policy interventions.

Taylor (2008) used U.S. Census individual microdata (5% PUMS) to assess the relative earnings of teacher compared to other college graduates. In addition to accounting for geographic cost of living, this study also included location related characteristics, because teachers are more likely than other college graduates to work in a rural community or low wage metropolitan area.

Comparative Wage Index (CWI). Taylor and Fowler (2006) synthesized aspects of amenities and regional cost of living and constructed a CWI. The basic premise of CWI is that all types of workers demanded higher wages in areas with a higher cost of living, lack of amenities, or presence of disamenities, for example, a very high crime rate.

Taylor and Fowler argued that the CWI represented an important advance over other wage comparison methods like the CPI and ACCRA cost of living index, because the CWI provided a more complete picture of labor costs as it reflected not only differences in housing and goods prices but also any wage influences due to differences in location characteristics such as climate, crime rate, and cultural amenities. In addition, the CWI was in part formulated from existing data (Bureau of Labor Statistics Occupational Employment Statistics) that are updated annually so it would timely.

A variety of other methods to account for state to state or regional wage differences included the state gross domestic product per capita (Timmons & Thornton, 2008a), state per capita income (Cebula & Toma, 2008), state median income (Pfeffer, 1974), regional median income (Buesa, 2008; Sweet et al., 2006), census region (Kleiner & Kudrle, 2000). Wages were adjusted for cost of living in this study using the Taylor and Fowler (2006) comparable wage index (CWI) to account for interstate wage variations.

KAM Pilot Study

In KAM 7, I conducted a pilot study comparing the wages of clinical laboratory practitioners in one licensing state, namely California and one nonlicensing state Washington (Hotaling, 2010). The pilot study was conducted under Walden IRB approval number 02-05-10-0327408. The dataset was the 2000 Census 5% PUMS (U.S. Census Bureau, 2000). The Data Ferret (Federated Electronic Research, Review, Extraction, and Tabulation Tool) Browser made available by the U.S. Census Bureau was used to select clinical laboratory practitioners working in California and Washington from the 2000 Census 5% PUMS (U.S. Census Bureau, 2000). Data extraction was accomplished by selecting the occupation variable standard occupational code (29-011) and place of work state variable, California and Washington states respectively. Wages and key wage differential variables demonstrated to affect wages in the literature that included human capital variables: educational attainment, potential experience; and individual characteristics including gender were also extracted.

Because wages vary by worker geographical region, wages were adjusted according to the clinical laboratory practitioner's reported state location of employment using the CWI. The CWI uses the observed variation in wages across states to assess necessary variation in wages for different costs of living (see variable definition below for full explanation).

Unadjusted and CWI adjusted wage regression equations were analyzed by multiple regression analysis, these pilot study results are provided in Tables 1 and 2 respectively. On analysis of unadjusted wages, California clinical laboratory practitioners earned significantly higher wages (13%) compared to those working in Washington ($p < .05$).

Table 1

Pilot Study Unadjusted Wages: California Versus Washington

Regression Statistics	
Multiple *R*	.434
R square	.188
Adjusted *R* square	.180
Standard error	.2842
Observations	519

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	9.5988	1.9198	23.76255	.000***
Residual	513	41.444742	0.0808		
Total	518	51.0435			

	b Coefficients	*Standard error*	*t*	*p-value (2 tailed)*	*p-value (1 tailed)*
Intercept	2.053	.3138	6.542	.000	.000
State licensing	-.105	.0345	-3.040	.003**	.001††
Gender	.046	.0267	1.714	.087	.044†
Education (yrs)	.043	.0194	2.195	.029*	.014†
Experience (yrs)	.025	.0052	4.895	.000***	.000†††
Experience squared	-.000	.0001	-2.766	.006**	.003††

Note. N = 519. Dependent Variable = Natural log CWI adjusted wages/hour, CWI = Comparative Wage Index. Adapted from *Effect of Clinical Laboratory Practitioner State Licensing on Wages: California versus Washington*, by M. Hotaling, 2010, p. 96.
* $p < .05$, two-tailed, ** $p < .01$, two-tailed, *** $p < .001$, two-tailed,
† $p < .05$, one tailed, †† $p < .01$, one tailed, ††† $p < .001$, one tailed.

However, as can be seen in Table 2, after wages were adjusted by the Comparative Wage Index (CWI), California clinical laboratory practitioner wages were higher by 2.3% compared to those working in Washington, but the regression coefficient using one-tailed test on the state licensing variable was not significantly different from zero ($p > .05$).

Male clinical laboratory practitioners earned 4.6% more than female clinical laboratory practitioners; this difference was significantly different than zero ($p < .05$) for a one-tailed test. The regression coefficients using a one-tailed test on potential experience and education were also significant ($p < .05$) and of the expected sign (+).

Table 2

Pilot Study CWI-Adjusted Wages: California Versus Washington

Regression Statistics	
Multiple *R*	.415
R square	.173
Adjusted *R* square	.165
Standard error	.2842
Observations	519

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	8.6446169	1.7289	21.40049	.000***
Residual	513	41.444742	0.0808		
Total	518	50.089359			

	b *Coefficients*	*Standard error*	*t*	*p-value (2 tailed)*	*p-value (1 tailed)*
Intercept	1.956	.3138	6.235	.000	.000
State licensing	-.023	.0345	-0.6538	.514	.257
Gender	.046	.0267	1.714	.087	.044†
Education (yrs)	.043	.0194	2.195	.029*	.014†
Experience (yrs)	.025	.0052	4.895	.000**	.000††
Experience squared	-.000	.0001	-2.766	.006**	.003††

Note. N = 519. Dependent Variable = Natural log CWI adjusted wages/hour, CWI = Comparative Wage Index. Adapted from *Effect of Clinical Laboratory Practitioner State Licensing on Wages: California versus Washington* , by M. Hotaling, 2010, p. 96.
* $p < .05$, two-tailed, ** $p < .01$, two-tailed, *** $p < .001$, two-tailed,
† $p < .05$, one tailed, †† $p < .01$, one tailed.

A noteworthy finding of the pilot study was that not adjusting wages for location by the CWI may have contributed to different conclusions regarding clinical laboratory practitioner wage differentials between the licensing state, California, and the nonlicensing state, Washington. Specifically unadjusted wage analysis would have yielded the inference that wages were significantly higher in the licensing state, California, compared to the nonlicensing state, Washington, whereas the adjusted wages indicate licensing state wages were higher, but not statistically different than zero.

Based on pilot study results indicating male clinical laboratory practitioners earned significantly higher wages ($p < .05$) compared to female clinical laboratory practitioners and a further review of the gender wage gap and licensing literature, an additional research question was addressed in this present study. This research question asked to what extent does clinical laboratory practitioner state licensing affect female wages after controlling for education, potential experience, potential experience squared, marital status, and number of own children in the home.

Research Methods

Nonexperimental Quantitative Research Design

The literature on wages and wage determinants revealed nonexperimental research methods were nearly universally employed using either cross-sectional and/or longitudinal design. Following nonexperimental methodology, the models were based on theory including the human capital and supply and demand economic theories. As these were nonexperimental methods in a natural environment, the Mincer wage regression equation was extensively used to simultaneously control for the common human capital and demographic variables that affected wages so the effect of the independent variable on the dependent could be reliably measured.

Variables, Data, Data Collection, Data Analysis

Variables. The costs of learning a skill or job was a very important component and led economists to assert that wages vary according to the amount of investment in human capital; that is, the education, training, and experience of individuals or groups of workers (Mincer, 1974). The dependent and the independent or control variables were often quantitative, such as annual or hourly wages, and hours worked, whereas categorical dummy variables were used for demographic data including licensing status, gender, geographic location. The wage studies reviewed universally used a Mincerian wage regression including using the natural log wages as the dependent variable and control variables for wage determinants such as experience, experience squared, and education.

Data, data collection, data analysis. Most studies in the licensing and wages and the wages and wage determinant literature used secondary data derived from United States government population surveys including the U.S. Census, Current Population Survey (CPS) and longitudinal surveys including the National Survey of Youth, National Survey of Households, and others. U.S. Census data were used by Mincer to develop the Mincer wage regression model, and this data set was used as a secondary data source in numerous wage and wage comparison studies including a number of those studying the effects of licensing on wages (Federman et al., 2006; Kleiner & Kudrle, 2000; Thornton & Weintraub, 1979; Timmons & Thornton, 2008b). U.S. Census data were used to study wage differentials associated with gender (Kleiner, 2000; Polachek, 2008). Census data were also used to develop a variety of methods to compare and adjust wages for location including cost of living indexes (Berry et al., 2000), comparable wage index (Taylor, 2004), and amenities (Stoddard, 2005) methods to compare wages across localities.

A few studies used primary data obtained from wage surveys administered by the profession's trade or professional organization (Sweet et al., 2006; Timmons & Thornton, 2008a). These were limited primarily because the samples are typically subsets of workers in the profession, and most professions do not require membership to practice. The vast majority of the studies used multiple regression analysis. The U.S. Census 2000 5% Public Use Microdata Set was selected for the present study because it is rich in individual human capital and demographic data including wages.

Data collection strategies in the reviewed literature were also typical of nonexperimental methodology in that surveys were the primary means of data collection. These surveys tended to be rich in demographic data to exploit the Mincer wage regression analysis while controlling for other recognized individual aspects related to wage differentials (gender, experience, marital status, children) in order to measure the effect of the independent variable (licensing or gender as appropriate for the study) in both licensing and wage effects, and gender and wage effects studies.

Summary

The literature review described previous nonexperimental quantitative research studies of the wage determinants related to human capital and individual characteristics including professional licensing. The literature review on wages and wage determinants included those studies based on human capital theory, which posits that an individual's wages depends on education and experience. Studies examining professional licensing affect on wages studies were primarily based on the premise that higher wages were demanded by a limited labor supply produced by the constraints imposed by licensing regulations. Wage studies that controlled for human capital variables that affected wages including experience and education, and individual demographic characteristics including gender, children, and marriage were described.

Empirical studies reviewed also specifically considered the influence of state professional licensing on wages for a variety of professions including clinical laboratory practitioners. Several studies utilized methods to compare wages within a profession for workers in different geographic locations related to cost of living. The licensing wage effect was not universal among professions, and the empirical evidence for the effect of licensing on wages of clinical laboratory practitioners was scarce, mixed, and did not account for the major human capital and demographic variables affecting wages. In summary, after a thorough review of the literature, there were no previous studies of clinical laboratory state professional licensing affect on wages that included human capital variables and demographic variables including work experience, education, gender, children, and marriage that were controlled for in the present study. Chapter 3 explains the research method for the study.

Chapter 3: Research Method

Introduction

The purpose of this study was to determine the effect, if any, of clinical laboratory practitioner state licensing on wages. This quantitative nonexperimental study compared the wages of clinical laboratory practitioners in licensing states versus nonlicensing states after controlling for major human capital determinants using control variables including potential experience, education, and individual characteristic variables including gender, marital status, and children.

Research and arguments regarding state policy often rely on estimating impact to one group or another, producing financial winners and losers. For example, raising workers' minimum wages by state or federal policy costs the employer group more money in operating expenses. State professional licensing is no different. Traditionally, state legislatures accepted the costs of professional regulation in favor of the public interest when they believe that society reduces its risks in cases where the potential for harm from incompetence is high. However, more recently, state legislatures have more closely evaluated the costs and benefits of professional licensure (Minnesota Legislature. Office of the Legislative Auditor., 1999). This study is also especially timely as health care costs are colloquially described as "spiraling out of control." It is more important than ever to have updated costs and benefits to assess. As previously noted, a systematic study of clinical laboratory wages controlling for human capital and individual characteristics that affect wages has not been undertaken. In addition, there has been no study of clinical laboratory practitioner wages that considered gender-related issues.

This chapter includes descriptions of the study's research design, setting and population, statistical power, instrumentation, data collection and analysis, and protection of participant rights.

Research Design and Approach

A quantitative methodology was used for this study to analyze the hypothesized correlational relationship of state licensing on clinical laboratory practitioner wages. The research questions involve understanding whether wages are significantly different for clinical laboratory practitioners in licensing states and nonlicensing states, and if so, by how much. Empirical data were used to test the null hypothesis that the wage differential related to licensing after controlling for education, potential experience, potential experience squared, gender, marital status, and number of own children in the home was not significantly different from zero.

Research Questions and Hypotheses

This study answered the following research questions by testing their associated hypotheses. Research Question 1 (RQ 1) was based on the Mincer wage regression model that controls for major individual characteristics generally considered to affect worker wages. Specifically, the control variables are potential experience and its square, education level, gender, marital status, and number of own children in the home.

RQ 1. To what extent does clinical laboratory practitioner licensing affect wages after controlling for education, potential experience, potential experience squared, gender, marital status, and number of own children in the home?

Null hypothesis: (H_{01}): There is no significant relationship between licensing and clinical laboratory practitioner wages over and above what is predicted by education, potential experience, potential experience squared, gender, marital status, and number of own children in the home ($R^2_{\text{change}} = 0$).

Alternate hypothesis: (H_{11}): Licensing will significantly predict clinical laboratory practitioner wages over and above what is predicted by education, potential experience, potential experience squared, gender, marital status, and number of children ($R^2_{\text{change}} > 0$).

The following wage regression model was estimated:

$$\ln(\mathit{wage}) = \beta_0 + \beta_1(\mathit{education}) + \beta_2(\mathit{potential\ experience}) + \beta_3(\mathit{potential\ experience}^2) + \beta_4(\mathit{gender}) + \beta_5(\mathit{marital\ status}) + \beta_6(\mathit{number\ of\ children}) + \beta_7(\mathit{licensing}) + \mu \tag{1}$$

In this equation, ln wages is the natural log of wages, βi are standardized regression coefficients, and μ is the error term that contains omitted variables affecting wages (Wooldridge, 2003).

Research Question 2 (RQ 2) was based on the gender wage gap, specifically that women earn less than men even in similar or the same professions. For example, even within the same profession, Timmons and Thorton (2008a) found wage differences for licensed and unlicensed married female radiologic technologists, so I controlled for marital status and the number of children in the home on female clinical laboratory practitioner wages (Equation 2).

RQ 2. To what extent does clinical laboratory practitioner licensing affect female wages after controlling for education, potential experience, potential experience squared, marital status, and number of own children in the home?

Null hypothesis: (H_{02}): There is no significant relationship between licensing and clinical laboratory practitioner wages over and above what is predicted by education, potential experience, potential experience squared, marital status, and number of own children ($R^2_{\text{change}} = 0$).

Alternate hypothesis: (H_{12}): Licensing will significantly predict clinical laboratory practitioner wages over and above what is predicted by education, potential experience, potential experience squared, marital status, and number of own children ($R^2_{\text{change}} > 0$).

The following female wage regression model was estimated:

$$\text{Female } \ln(\textit{wage}) = \beta_0 + \beta_1(\textit{education}) + \beta_2(\textit{potential experience}) + \beta_3(\textit{potential experience}^2) + \beta_4(\textit{marital status}) + \beta_5(\textit{number of children}) + \beta_6(\textit{licensing}) + \mu \quad (2)$$

This present study relied on the Mincer (1974) wage model as represented by a multiple regression equation where the mean Y (dependent variable) value is predicted for each X (independent variable) value and testable conclusions are derived. (Blalock, 1972). This research method followed an econometric approach to causation that is typically based on nonexperimental, observational data and involves identifying and measuring statistical associations among putative causal factors and their outcomes. Blalock (1972) and Teddlie and Tashakkori (2009) suggested that in this approach, if the associations between the measured variables are observed repeatedly while controlling for other alternative explanations, there is evidence to support a causal relationship consistent with a given model.

Because there were multiple determinants of wages and wage differentials to be measured in a natural setting, multiple regression was used to control for these effects simultaneously. The multiple regression equation included an error term to account for effects of possible missing variables as well as variation and inaccuracy in variable measurement. This econometric approach was used in many of the wage studies including those that have examined the effect of state licensing on women's wages reviewed in chapter 2 (Federman et al., 2006; Kleiner & Kudrle, 2000; Polachek, 2008; Thornton & Weintraub, 1979; Timmons & Thornton, 2008a, 2008b; White, 1978). The approach used in this present study is described below.

Wage Model

The framework for this study relied on the human capital theory that an individual's wages (WAGE) is a function of human capital investments including years of education (ED), potential experience (EXP), and various additional factors (Z).

$$\text{WAGE} = f(\text{ED}, \text{EXP}, Z). \qquad (3)$$

According to the theory, the greater the worker's human capital, the greater productivity and thereby the greater the wages. The Z vector of variables has been used to represent various individual characteristics affecting wages such as gender, marital status, and intelligence to name a few. The Z vector of variables has also been used to represent various market imperfections (also referred to as market failures) whereby the allocation of goods and services by the free market is not efficient, especially from the society's point of view. One example is a monopoly. Alternatively, governmental policy responses to correct market imperfections such as wage controls like the minimum wage law and regulation such as state professional licensing are also used as Z vector variables. Such analysis of market imperfections and governmental response to market imperfections plays an important role in public policy decisions and analysis.

Mincer (1974) first modeled wages derived from human capital investments; the Mincer wage model has been widely adopted in studies analyzing the effect of state licensing on professional wages. (Federman et al., 2006; Kleiner & Kudrle, 2000; Thornton & Weintraub, 1979; Timmons & Thornton, 2008a, 2008b; White, 1978). In this study, (ln) wages was the outcome, state licensure status the main independent variable, and educational attainment, potential experience and its square, gender, marital status, and number of own children in the home were entered as covariates. The female wage regression equation included the same variables except gender and only included female clinical laboratory practitioners aged 25-44 years old. The variables and their rationale for each are described in the Variables section.

Limitations

A general weakness with nonexperimental designs is that such designs are limited in establishing causation; however, a nonexperimental design was the only viable method as experimental design was not possible because the independent variable of interest, state licensing status, was predetermined and nonmanipulable by the researcher. Clinical laboratory practitioner licensing was required by law in order to practice in states that are licensing states. In addition, control variables including gender, educational attainment were nonmanipulable but are observable and were controlled for by directly placing them in wage regression equations. However any multiple regression estimation is imperfect due to unobservable variation that was not accounted for in the equation.

Work experience cannot be directly measured using the Census 5% PUMS data set because this question was not included in the survey. Rather *potential experience* was the variable used to estimate experience and was calculated from years of education and age. Mincer's (1974) potential experience variable was based on the assumption people complete their education and work immediately after graduation. Therefore, if an individual does not work after completing his or her degree, or takes time out of the workforce for other reasons, his or her potential experience overestimates actual work experience. For this study, working immediately after graduation was assumed as according to Stuart and Fenn (2004) and Stuart and Utz (2007) new graduates are in high demand and often receive more than one job offer due to an ongoing workforce shortage. Another example of the possible limitation with potential experience control variable was that women may leave the workforce or work fewer hours during child rearing. Child rearing was accounted for in this study by including the number of children in the home under 18 years of age as a control variable.

Another possible limitation related to potential experience was that the regression equation also included education as a control variable so multicollinearity may have been present. Multicollinearity between the potential experience and education variables was statistically assessed and rejected. Another limitation was that those that did not work in

1999 were not included in the study sample. Clinical laboratory practitioners may not have worked in 1999 due to direct influence of the number and ages of their own children in the home. However, previous studies indicated child rearing had a smaller effect on labor force participation in the United States compared to European countries, especially in Germany and the UK (Bardasi & Gornick, 2008). Despite these limitations on establishing causation, nonexperimental quantitative research design with multiple regression equation estimation has been used extensively in econometric studies including occupational wages.

Setting and Sample

The data were gathered from the 2000 Decennial U.S. Census 5% Public Use Microdata Sample (5% PUMS) released by the U.S. Census Bureau. Data included respondent annual earnings, occupation, demographic and socioeconomic characteristics (Ruggles et al., 2008). The use of the 5% PUMS as a secondary data source was justified because the fit between the research questions and variables was strong. No other known data set includes as many individual observations of clinical laboratory practitioners as the 5% PUMS aside from the 100% Census data that is held confidential by the U.S. Census Bureau.

Not only were Census data used by Mincer to develop the Mincer wage regression model, but this data set has been used as a secondary data source in numerous wage and wage comparison studies including some of those studying the effects of licensing on wages described in chapter 2 (Federman et al., 2006; Kleiner & Kudrle, 2000; Thornton & Weintraub, 1979; Timmons & Thornton, 2008b). Furthermore, census data have been used to develop and investigate a variety of methods to compare and adjust wages for location such as cost of living index (Berry et al., 2000) and a comparable wage index (Taylor, 2004); as well methods using amenities/disamenities to compare wages across localities (Stoddard, 2005). Lastly, in separate studies, Kleiner (2000) and Polachek (2008) used census data to study wage differentials associated with gender as previously described in chapter 2.

Research Population and Sample Population

The research population was clinical laboratory practitioners working in the United States in 1999. The sample population was clinical laboratory practitioners identified by standard occupation code (SOC 29-2011) in the 2000 Decennial U.S. Census 5% PUMS. From the 5% PUMS data set, a sample of approximately 4,000 clinical laboratory practitioners meeting the inclusion criteria described below was selected.

Inclusion/Exclusion Criteria

States: Licensing and Nonlicensing designation. In this study, licensing states included: California, Florida, Hawaii, Louisiana, Montana, Nevada, North Dakota, Rhode Island, Tennessee, and West Virginia. Washington, DC although not a state, was included as a nonlicensing state for several reasons. Washington, DC is a large municipality that licenses many health care practitioners. In addition, wage and data were available for Washington, DC in the 2000 U.S. Decennial Census 5% PUMS, and wages can be cost adjusted using the CWI. In contrast, although the U.S. territory Puerto Rico requires clinical laboratory practitioner licensing, and 2000 U.S. Decennial Census 5% PUMS wage and data were available, it was excluded because it is not included in the CWI. Consequently there was no wage adjustment for location possible for Puerto Rico using the CWI methodology. New York was included as a nonlicensing state as this designation represents the state licensing status at the time of data collection for the 2000 Census (the licensing law became effective in New York in 2006).

Individuals. The sample selected from the 5% PUMS included those identified as clinical laboratory practitioners based on the standard occupational code (SOC) code 29-2010 (Medical and Clinical Laboratory Technologists and Technicians). The individuals were extracted according to the Census place of work state as identified in the 5% PUMS. If the individual's place of work state was a licensing state, for example, California, the independent variable licensing was coded to a one. Similarly, if the place of work state was a nonlicensing state, such as Pennsylvania, the independent variable licensing was coded to a zero. This sample was limited to those 25-65 years of age, working full time 35 or more hours per week for at least 52 weeks in 1999. Following White (1978) the sample was further limited by selecting those with education of bachelor's and master's degrees required for clinical laboratory technologists.

This sample selection criteria helped ensure individuals included were clinical laboratory technologists and not phlebotomists, technicians, consultants, or directors; these are not separate occupational categories in the Census. Those earning an Associate's degree or less typically represent clinical laboratory technicians, whereas those earning a Doctoral degree typically represent doctoral level laboratory scientists serving as laboratory directors and clinical consultants rather than as clinical laboratory practitioners. This criterion mitigated the rival explanation that state differences reflect variation in the mix of clinical laboratory personnel rather than variation in wages.

The female wage regression included women ages 24-44 years to represent those with their own children less than 18 years in the home. Clinical laboratory practitioners older than 44 years of age are excluded as they likely had children in the home that subsequently left as they became independent. Following Harkness and Waldfogel (2003), this sample upper range age inclusion criterion was selected because including women older than age 44 may confound wage comparisons of women with children and women without children. In addition, several other motherhood wage gap studies used an upper age sample inclusion criterion ranging from age 43 to 45. Specifically, Anderson et al. (2003) used age 44, Erosa, et al. (2005) used age 43, Lundberg and Rose (2000) used age 45. Futhermore these age 43 to age 45 cutoffs for college graduates were supported by data from the CPS tabulated by Ellwood and Jencks (2006). CPS data indicated 20% of college graduates had their first child by age 25, 50% by age 30, and 74% by age 40.

Sample Size

From the United States clinical laboratory practitioner population, the 2000 5% PUMS contains a sample of approximately 4,000 practitioners working at least 35 hours/week with approximately 1,000 from licensing states and 3,000 from nonlicensing states. The sample also precisely reflected the percent of female vs. male clinical laboratory practitioners (72% women and 28% men) in this female-dominated profession (U.S. Department of Labor, 2004; Wolcott et al., 2008). The female only subsample contained approximately 1,600 women.

Statistical Power

An a priori statistical power analysis using G*Power 3.1 power analysis software (Faul, Erdfelder, Buchner, & Lang, 2009) was used to determine the minimum sample size required to reject the null hypothesis with respect to R^2_{change}. The calculated minimum necessary sample size was N = 400 to achieve a power (1 - β) of .80, and N = 650 for power of .95 using a linear multiple regression with the following parameters: a) number of tested predictors = 1; b) the total number predictors = 7; c) α error probability = .05; and d) small effect size f^2 = .02 (Cohen, 1992). Considering the sample size of approximately 4,000 clinical laboratory practitioners, of which about 3,000 are women in this group, the study had a very high probability (power > .95) of rejecting both null hypotheses even if a small effect (f^2 = .02) actually existed.

Instrumentation

5% Public Use Microdata Sample (5% PUMS)

The U.S. Census is an instrument to collect self-reported demographic information administered by the federal government every 10 years since 1790 as required by law. This study used the 5% PUMS of the 2000 U.S. Census which is a stratified random sample of the 15% of households that completed the census long form used to collect full demographic data (Siegel, Swanson, & Shryock, 2004). The 5% PUMS contains detailed demographic information on earnings, occupation, educational attainment, age, state place-of-work, and personal characteristics of individuals including marital status, number of own children present in the home.

The 2000 5% PUMS contains detailed data on 14 million people and 5 million households (U.S. Census Bureau, 2003). Such a large data set permits study of relatively small population subgroups including particular occupational groups and associated demographics (Ruggles, 2000). The U.S. Census PUMS play an indispensible role in social science research including demography, economics, sociology, and history and is an essential resource for policy analysts because of “three key strengths: broad chronological scope, large sample populations and fine detail” (Ruggles, 2000, p. 5). Despite these strengths, the 5% PUMS as a sample is subject to nonsampling and sampling errors.

Nonsampling errors affect both sample and complete count data, and are due to data collection and processing errors. Nonsampling errors include undercounting persons and housing units during data collection and respondent errors such as the underreporting income, and errors during data editing, reviewing, and handling. Many steps were taken by the U.S. Census Bureau (2003) to minimize nonsampling error including follow up respondent interviews assessing accuracy of data collection.

The 5% PUMS is by nature a sample based on the 100% census data and therefore suffers to some extent from sampling error due to sample selection of households. The sample estimate of any particular sample could differ from other samples of households and people. The U.S. Census Bureau (2003) states that the estimated standard errors measuring variation (precision) of all possible sample estimates and associated confidence intervals for the 5% PUMS are included in the technical documentation.

The 2000 5% PUMS data represents five randomly selected 1% sub-samples of housing units and people within the occupied units merged together. The 5% PUMS contains individual weights (person weight and housing weight) used for all person and housing characteristics in that record. The person weight variable is used with person characteristics, likewise the housing weight variable is used for housing characteristics. The U.S. Census Bureau (2003) advises when tabulated results are desired for data analysis, these may be created using the individual weights applied to individual microdata records, thereby expanding the sample to the appropriate total under study, for example, the entire United States population, state population, et cetera.

Variables

Data for all variables were obtained from the 2000 5% PUMS with the exception of the designation of licensing state and nonlicensing state. The 5% PUMS variable definitions were adapted from Ruggles et al. (2008). Individual microdata collected for this study represented the study variables and data used to derive study variables. The dependent variable was the natural log of hourly wages, the independent variable was state licensing, and the control variables included educational attainment, potential experience and its square, gender, marital status, and number of own children in the home.

Dependent variable. The dependent variable was the natural log hourly wages. The 2000 5% PUMS wages and salary data includes total pretax wage and salary income for the previous calendar year, therefore for the 2000 U.S. Census, workers were asked to report their 1999 earnings. Wage and salary income includes not only wages and salaries but also commission, cash bonuses, tips, and other money income received from an employer. In contrast, wage and salary income does not include payments-in-kind or reimbursements for business expenses, or fringe benefits. Hourly wages were constructed using reported annual wages, weekly hours worked, and the number of weeks worked, all variables for which there was information in the dataset.

Hourly wages are determined by:

$$\frac{\text{Annual Wages}}{\text{Number of Hrs Worked Weekly} * \text{Number of Weeks Worked}} \tag{4}$$

The number of hours worked in weeks and hours per week usually worked includes time worked and paid vacations and other paid absences. It also includes any hours worked in secondary occupations. The U.S. Bureau of Labor Statistics defines a full-time worker as an individual that works 35 hours or more per week. Besides being used to calculate hourly wages, the numbers of weeks worked and hours worked were sample inclusion criteria for clinical laboratory practitioners working at least 35 hours per week for at least 52 weeks.

The individuals in the sample have reported 1999 annual wages that were adjusted for state cost of living by the Comparative Wage Index (CWI) and the hourly wage based on number of hours worked was calculated. Wages is a non-linear function because early career wages are characterized by rapid growth, followed by slower growth at mid-career, and subsequently plateaus (Becker, 1962; Mincer, 1974). Therefore, the CWI adjusted hourly wages were transformed to the dependent variable, the natural logarithm of the CWI adjusted 1999 hourly wage.

Independent variable. Licensing was the independent variable of interest for RQ 1 and 2 used to capture any effect of state licensing on the dependent variable wages in the wage regession equations. A licensing state was a state that requires clinical laboratory practitioners to hold a license to practice clinical laboratory technology. As of 1999, licensing states included: California, Florida, Hawaii, Louisiana, Montana, Nevada, North Dakota, Rhode Island, Tennessee, West Virginia, and Puerto Rico* (Puerto Rico was excluded in this study). Licensing was a dichotomous dummy variable coded as zero if the state does not require licensing, one if the state requires licensing according to the individual's census place of work state from the 2000 5% PUMS.

Whether a state was a licensing state or nonlicensing state was obtained from the Professional and Occupational Licensing Directory, 2nd ed, (Bianco, 1996) and the U.S. Department of Labor searchable database of licensed occupations (U.S. Department of Labor). Data on licensing/nonlicensing state designation were supplemented with information on clinical laboratory practitioner licensing from professional association websites including the American Society for Clinical Pathology's *Policy Statement on State Personnel Licensing* (2005), and a variety of state government websites including licensing boards, licensing statutes, and licensing regulations.

Control variables. The study control variables represented important human capital variables and individual characteristics covariates that may affect wages and include educational attainment, potential experience and its square, and individual characteristic variables gender, marital status, and number of own children under 18 years in the home.

Educational attainment. The educational attainment variable was coded as a dichotomous dummy variable zero/one with a value of zero representing a bachelor's degree, and a value of one representing a master's degree. The expected sign on the coefficient was positive as it was anticipated that higher educational attainment is correlated to higher wages. Educational attainment (years) was also used to construct the potential work experience variable (see below).

Potential work experience. Potential work experience was a constructed control variable in units of years calculated from age in years and educational attainment in years as suggested by Mincer (1974, p. 86):

$$\text{Potential experience} = \text{age} - \text{education years} - 6. \tag{5}$$

Education years variable was defined as number of years of schooling; specifically a bachelor's degree = 12 + 4 = 16 years of schooling, and a master's degree = 12 + 4 + = 18 years. Potential experience was expected to have a positive effect on earnings, therefore the coefficient on potential experience was expected to be positive. However, the effect generally begins to decline as years of experience increase producing a nonlinear U-shaped function, also see potential experience squared control variable below.

Potential experience squared. Potential experience squared variable was the quadratic of potential experience and was included in the wage regression equation to account for the non-linear portion of the U-shaped work experience-wage function as described above for potential experience. The coefficient on potential experience squared was expected to be negative as wages plateau and begin to decline relative to the number of years of work experience over the lifetime as suggested by Mincer (1974).

Gender. Gender was dichotomous and an indicator variable assigned as zero for male and one for female. Gender was used in the overall wage regression equation that included male and female clinical laboratory practitioners. The coefficient on gender was expected to be negative as it was expected that women earned less per hour than men.

Marital status. Marital status was represented by an indicator variable of zero if not married, one if currently married. Not married included divorced, widowed, never married. Married included now married as well as separated (but still married) individuals.

Number and presence of own children under 18 years of age. The number of children under 18 years of age in the home was used to capture the effect of children on the wages of women. The number of children was a control variable in the female wage regression because time outside the labor force overestimates potential experience. Some attribute time outside the labor force as a major factor related to women earning less than males overall. The expected sign on the coefficient was negative as it was anticipated that any children lowers women's wages and more than one child further lowers wages.

Adjusting Wages for Location by Comparable Wage Index (CWI)

Plausible rival explanations included that wages were regionally mediated based on cost of living of the area. To control for differences in the cost of living across states, the comparable wage index (CWI) suggested by (Taylor & Fowler, 2006) was used to adjust wages according to the state where the individual worked.

The CWI is a weighted average of the observed wages of college-educated workers within a state's borders (Taylor & Fowler, 2006). The CWI for 1999 was constructed as the state wage level divided by the national average in 1999. The national average has a 1.000 index value and the index ranges from 0.748-1.155. The interpretation of a 1.122 index value for a state is that the wage level for college graduates in that state is 12.2% above the national average for college graduates. The CWI uses the observed variation in wages across regions to assess necessary variation in wages for different costs of living. For example, if wages for college educated workers such as lawyers, teachers, nurses, engineers, respiratory therapists, and librarians, are all about 12% higher in California than in Washington, it suggests that wages for clinical laboratory practitioners should also be 12% percent higher in California, assuming identical personal characteristics such as educational attainment and all else being equal.

Assessment of the validity of the CWI for wage adjustment for geographic location includes correlation with previous geographic cost indexes. For example, according to Taylor and Fowler (2006), the correlation of state CWI values between the General Wage Index (Goldhaber, 1997) is quite high, specifically 0.8305 for year 1999-2000.

Data Collection and Analysis

Data Collection Processes

Study data was extracted from the 2000 Decennial U.S. Census 5% PUMS using Data Ferret (Federated Electronic Research, Review, Extraction, and Tabulation Tool) Browser to the Data Web at http://www.thedataweb.org made available by the U.S. Census Bureau.

Data Analysis

The wage regression model based on Mincer (1974) was used for data analysis. Results were interpreted in the context of economic theory of supply and demand and human capital theory. The data was analyzed using PASW Statistics 18 software.

Multiple regression analysis. Multiple regression analysis by ordinary least squares (OLS) statistical techniques are often used in econometric research because like most realistic situations, there are more than one independent and/or control variables of importance (Blalock, 1972). Likewise, multiple regression analysis was used in this nonexperimental study to measure the relationship of the dependent variable (natural logarithm of wages) with the independent variable (state licensing) while the control variables controlled for the effects of various human capital and individual characteristics described in the literature to affect wages. According to Cohen and Cohen (1983), in order to make valid inferences based on the results of multiple regression, certain statistical assumptions including normality, linearity, homoscedasticity (equal variance), and the absence of excessive multicollinearity must be met. The outcome of multiple regression statistical assumption testing for this study is described below.

Multiple regression assumptions testing. A histogram of the sample dependent variable, log CWI adjusted hourly wages, and a histogram of the dependent variable standardized regression residuals, and normal P-P plot of standardized regression residuals all suggested normal distribution. The model overall goodness of fit test included testing the R^2 value for significance with the *F*-test statistic and associated *F*-test statistic *p*-value was performed (Cohen & Cohen, 1983, pp. 103-104). The *F*-test was used to evaluate whether a linear statistical relationship existed between the dependent variable and at least one of the control variables or the independent variable. The *F*-test statistic's associated *p*-value was significant ($p \leq .001$), indicating that one or more these variables was statistically important.

To determine homoscedasticity, the data was analyzed by constructing a scatterplot of the dependent variable regression studentized residual versus regression standardized predicted value, as well as a scatterplot of the dependent variable regression standardized residual versus regression standardized predicted value. These scatterplots revealed a cloud-like pattern indicating homoscedasticity (equal variance) across the range log CWI adjusted hourly wages used in the study. Lastly, the data was evaluated for the presence of multicollinearity of the independent and control variables using the PASW Statistics 18 collinearity diagnostics function. Eigenvalues and variance proportions were examined and indicated multicollinearity among these variables was not a concern.

Hierarchical multiple regression R^2_{change}. According to Cohen and Cohen (1983, p. 484), hierarchical regression analysis of one or more sets of independent variables requires a number of regression equations. In this study, hierarchical regression analysis was performed to determine the influence of the licensing independent variable on the R^2 over and above the R^2 of the control variables gender, education, potential experience, potential experience squared, marital status, and number of children.

Using PASW Statistics 18 linear regression functionality, all control covariates was entered as one block, and then the independent variable licensing was entered as a second block. This method represents two regression equations, the first one with the dependent and control variables, the second with the dependent, independent, and control variables.

Significance testing. After ascertaining that the statistical assumptions of multiple regression were satisfactorily met, the R^2_{change} test was interpreted. The R^2_{change} test indicates the amount the R^2 value increases/decreases when a variable is added to or deleted from the regression equation. To determine if the R^2_{change} was significant an incremental *F* test was performed. For the second hypothesis involving female clinical laboratory practitioner wages, the hierarchical multiple regression analysis was analyzed by the same statistical treatment as above. Examination of the regression coefficients' positive or negative directionality and their associated *p*-values for significance was interpreted for each variable.

Protection of Participants Rights

Walden University IRB approval (# 11-22-10-0327408) was obtained and no risk to participants was anticipated. The 2000 5% PUMS is a publically available dataset that by law (Title 13, Section 9, the U.S. Census Bureau) is prohibited from publishing results in which an individual can be identified. To protect the identity of Census participants and minimize the risk of disclosure of confidential information, the U.S. Census Bureau makes the 2000 5% PUMS available for analyses and masks data through a variety of statistical techniques (U.S. Census Bureau, 2003; Winkler, 2004). In addition, the U.S Census 2000 5% Public Use Microdata Sample data was used in accordance with the requirements for research with human subjects of the IRB of Walden University. For U.S. Census data, no expressed permission was required, and all procedures were adhered to as set forth by the U.S. Census Bureau public site for the use of data collected and made available for public use (see Appendix: Permission to Use Data).

Summary

Chapter 3 presented the nonexperimental quantitative research design methodology that addressed the research questions. How data was collected and analyzed, including the design and description, setting and sample, and data analysis using multiple regression analysis and related inferential statistics including the R^2_{change}, and regression coefficients and significance testing for each was explained. The validity and justification for using the Census 2000 5% PUMS data was discussed. In addition, how Census 2000 participant rights are protected from personal data disclosure through re-identification was described.

Chapter 4: Results

Introduction

The purpose of the study was to determine if there is an effect of clinical laboratory practitioner licensing on wages while controlling for human capital and individual characteristic variables drawn from the literature that were expected to influence individuals' wages. Neither of the two previous studies of the effect of clinical laboratory practitioner licensing on wages used human capital or demographic control variables in multiple regression analyses. Data for this study were obtained from the U.S. Census 2000 5% Public Use Microdata Sample (5% PUMS) from the Internet using Data Ferret (Federated Electronic Research, Review, Extraction, and Tabulation Tool) Browser (U.S. Census Bureau, 2000). Data were analyzed using PAWS Statistics 18 software. This chapter begins with a description of the sample of clinical laboratory practitioners drawn from the U.S. Census 2000 5% PUMS. Results of the data analyses are organized by the two research questions, and a summary concludes the chapter.

Results

Sample Descriptive Statistics

I selected clinical laboratory practitioners by occupation code who were 25-65 years old and earned at least $5,000 annual wages. I excluded those reporting self-employment income as this was a study of wages earned as a clinical laboratory practitioner. Individuals earning more than $175,000 in 1999 were also excluded. The lower end cut-off of $5,000 annually was selected as these professionals attained either a bachelor's or master's degree and this threshold is below the federal minimum wage of the time period, approximately $9,000 annually (U.S. Department of Labor, 2010a). Timmons and Thornton (2008a) also used $5,000 as the minimum wages in their study of the effects of licensing on radiologic technologist wages. Annual wages greater than $175,000 were top-coded in the 2000 5% PUMS to protect those respondents earning high wages from re-identification. In all, only 15 clinical laboratory practitioners earning greater than $175,000 annually were excluded. The remaining sample included 4,118 clinical laboratory practitioners.

Clinical laboratory practitioners age 25-65 sample. The sample used to answer Research Question 1 (RQ 1) included both male and female clinical laboratory practitioners earning at least $5,000 and less than $175,000. From this study sample, potential outliers exceeding ±3 standard deviations (*SD*) were identified and removed. Before removing outliers, there were 4,118 cases; afterwards, the sample consisted of 4,051 cases that were used to answer RQ 1. The dependent variable, the log Comparative Wage Index (CWI) adjusted hourly wages was obtained by calculating hourly wage adjusted by the CWI according to the individual's place of work state, and transformed to the natural logarithm.

Table 3 provides summary statistics for this sample. Most clinical laboratory practitioners in the sample were female (n = 2,913, 72%), earned a bachelor's degree (n = 3,568, 88%), were married (n = 2,589, 64%), and worked in a nonlicensing state (n = 3,163, 78%). On average, clinical laboratory practitioners earned $19.38 per hour in 1999 U.S. dollars, were 42 years old, had 23 years of potential experience, and had 0.7 children under 18 in the home. A subsample of female clinical laboratory practitioners was also obtained.

Table 3

Summary Statistics for Clinical Laboratory Practitioners Ages 25-65

		n	*n* % / *M*	*SD*
Licensing	Nonlicensing state	3,163	78.1%	
	Licensing state	888	21.9%	
Gender	Male	1,138	28.1%	
	Female	2,913	71.9%	
Age (yrs)			42.2	9.78
Educational attainment	Bachelor's degree	3,568	88.1%	
	Master's degree	483	11.9%	
Potential experience (yrs)			23.1	9.74
Number of own children under 18 years in household			0.7	0.98
Marital status	Not married	1,462	36.1%	
	Married	2,589	63.9%	
CWI adjusted wages/hour			$19.38	5.88

Note. *N* = 4,051. CWI = Comparative Wage Index. All data from U.S. Census 2000 5% Public Use Microdata Sample. Potential experience = age – education years – 6, as suggested by Mincer (1974, p. 86).

Female clinical laboratory practitioners age 25-44 sample. Table 4 provides summary statistics for the clinical laboratory practitioner subsample containing 1,665 women aged 25-44. This subsample was used to answer Research Question 2 (RQ2). Most women aged 25-44 earned a bachelor’s degree (n = 1,525, 92%), were married (n = 1,010, 61%), and worked in a nonlicensing state (n = 1,347, 81%). On average, female clinical laboratory practitioners earned $18.06 per hour in 1999 U.S. dollars, were 35 years old, had 16 years of potential experience, and had 0.8 children under 18 in the home.

Table 4

Summary Statistics for Female Clinical Laboratory Practitioners Ages 25-44

		n	*n* % / *M*	*SD*
Licensing	Nonlicensing state	1,347	80.9%	
	Licensing state	318	19.1%	
Age (yrs)			35.4	5.91
Educational attainment	Bachelor's degree	1,525	91.6%	
	Master's degree	140	8.4%	
Potential experience (yrs)			16.3	5.90
Number of own children under 18 years in household			0.8	1.02
Marital status	Not married	655	39.3%	
	Married	1,010	60.7%	
CWI adjusted wages/hour			$18.06	5.26

Note. *N* = 1,665. CWI = Comparative Wage Index. All data from U.S. Census 2000 5% Public Use Microdata Sample. Potential experience = age – education years – 6, as suggested by Mincer (1974, p. 86).

Data Analysis

Hierarchical multiple regression data analysis was performed to answer RQ 1 and RQ 2 to determine the influence of the licensing independent variable on the dependent variable log CWI adjusted wages per hour, over and above the influence of the control variables. Using PASW Statistics 18 linear multiple regression functionality, a hierarchical entry procedure was conducted such that for each research question, all control covariates were entered as one block, and then the independent variable licensing was entered into the equation as a second block.

Research Question 1 (RQ 1)

RQ 1 of this study was “To what extent does clinical laboratory practitioner licensing affect wages after controlling for education, potential experience, potential experience squared, gender, marital status, and number of own children in the home?“ Regression analysis using the R^2_{change} test for hypothesis testing was used to evaluate the effects of licensing on clinical laboratory practitioner wages above and beyond the contribution of the control variables reflecting human capital and individual characteristics that influence wages. As described by Wooldridge (2003), where the variable’s unstandardized regression coefficient was statistically significant, the magnitude of the effect as a percentage was estimated to determine economic impact.

Results of the regression analysis are in Table 5. The Model Summary portion of the table shows Model 1 that contains only control variables. For Model 1, $R^2 = .155$, thus indicating 15.5% of the wage variance was explained by the control variables. Model 2 contains the independent variable, licensing, in addition to the control variables in Model 1. For Model 2, the $R^2 = .161$, such that 16.1% of the wage variance was explained by the independent variable and the control variables together. The R^2_{change} value = .006 and is significant (sig F change < .01). The significant R^2_{change} value supports the alternative hypothesis that state licensing predicted higher clinical laboratory practitioner wages above and beyond the effect of the control variables: gender, education, potential experience, potential experience squared, marital status, and number of own children in the home.

Table 5 also presents the regression coefficients for Model 2. Based on the licensing coefficient .058 and holding the other variables constant, the magnitude of the state licensing effect is 5.8% and is significant, $p < .01$ (Wooldridge, 2003). Of note, the .038 coefficient on gender was significant ($p < .01$) and implies women earned 3.8% less on average than men holding the other variables constant. Besides gender, the other control variable coefficients were statistically significant and had the expected sign with the exception of number of own children in the home and marital status. The number of own children in the home had the expected negative sign, but this variable was not statistically significant. Likewise, marital status had a positive sign, but was not significant.

The answer to RQ 1 is clinical laboratory practitioner licensing significantly predicted clinical laboratory practitioner wages over and above what was predicted by education, potential experience, potential experience squared, gender, marital status, and number of own children in the home. The size of the state licensing effect was estimated at 5.8% on average compared to those working in nonlicensing states holding the other variables constant. The gender wage gap is further explored in RQ 2 data analysis.

Table 5

Regression Results for Clinical Laboratory Practitioners, Aged 25-65

Model summary

Model	R	R^2	Adjusted R^2	Std. error of the estimate	Change statistics				
					R^2 change	F change	$df1$	$df2$	Sig. F change
1	.394[a]	.155	.154	.2858524	.155	123.858	6	4044	.000
2	.401[b]	.161	.160	.2848963	.006	28.188	1	4043	.000**

Regression coefficients – Model 2

Variable	Unstandardized coefficients		Standardized coefficients			95% Confidence interval for b	
	b	Std. error	Beta	t	p	Lower bound	Upper bound
Gender	-.038	.010	-.055	-3.779	.000**	-.058	-.018
Educational attainment	.034	.014	.036	2.466	.007†	.007	.062
Potential experience (yrs)	.036	.002	1.121	16.040	.000**	.031	.040
Potential experience squared (yrs)	-.001	.000	-.806	-11.410	.000**	-.001	.000
Marital status	.016	.010	.025	1.584	.113	-.004	.036
Number of own children < 18 yrs in household	-.001	.005	-.004	-.257	.797	-.012	.009
Licensing	.058	.011	.077	5.309	.000**	.036	.079
(Constant)	2.433	.024		99.793	.000	2.385	2.481

Note. Dependent variable: Natural log CWI adjusted wages/hour. CWI = Comparative Wage Index. $N = 4{,}051$.
[a]Model 1: Control variables only: Gender, educational attainment, potential experience, potential experience squared, marital status, number of own children under 18 years old in the household.
[b]Model 2: Licensing independent variable and control variables.
*$p < .01$, two-tailed. ** $p < .001$, two-tailed, †$p < .01$, one-tailed.

Research Question 2 (RQ 2)

RQ 2 was based on the gender wage gap and the motherhood wage gap. The gender wage gap refers to the consistent finding that women earn less than men on average; whereas the motherhood wage gap refers to the consistent findings that mothers earn less than women without children under 18 on average. RQ 2 was, "To what extent does clinical laboratory practitioner licensing affect female wages after controlling for education, potential experience, potential experience squared, marital status, and number of own children in the home?

To further investigate the relationship between licensing and wages, I used a female only regression Equation 2. I used education, potential experience, potential experience squared, marital status, and the number of children in the home under 18 years old as control variables. Table 6 presents the results of this multiple regression analysis estimation.

Table 6

Regression Results for Female Clinical Laboratory Practitioners, Aged 25-44

Model summary

Model	*R*	R^2	Adjusted R^2	Std. error of the estimate	Change statistics				
					R^2 change	*F* change	*df*1	*df*2	Sig. *F* change
1	.344[a]	.118	.116	.2807813	.118	44.465	5	1659	.000
2	.350[b]	.122	.119	.2801806	.004	8.121	1	1658	.004*

(table continues)

Table 6 (continued)

Regression coefficients – Model 2

Variable	Unstandardized coefficients *b*	Unstandardized coefficients Std. error	Standardized coefficients Beta	*t*	*p*	95% Confidence interval for *b* Lower bound	95% Confidence interval for *b* Upper bound
Educational attainment	.017	.025	.016	.693	.489	-.031	.066
Potential experience (yrs)	.043	.008	.844	5.698	.000**	.028	.057
Potential experience squared (yrs)	-.001	.000	-.510	-3.483	.001*	-.001	.000
Marital status	.025	.015	.041	1.599	.110	-.006	.055
Number of own children < 18 yrs in household	-.019	.008	-.066	-2.486	.013[†]	-.035	-.004
Licensing	.050	.018	.066	2.850	.004*	.016	.084
(Constant)	2.165	.326		6.649	.000	1.526	2.803

Note. Dependent variable: Natural log CWI adjusted wages/hour. CWI = Comparative Wage Index. N = 1,665.
[a]Model 1: Control variables only: Educational attainment, potential experience, potential experience squared, marital status, number of own children under 18 years old in the household.
[b]Model 2: Licensing independent variable and control variables.
*p < .01, two-tailed. ** p < .001, two-tailed, [†]p < .01, one-tailed.

The Model Summary portion of the female regression presented in Table 6 indicates Model 1, which contains only control variables, resulted in R^2 = .118, indicating 11.8% of the wage variance was explained by the control variables. Model 2 consists of the independent variable, licensing, in addition to the control variables in Model 1. For Model 2, the R^2 = .122, such that 12.2% of the wage variance was explained by the independent variable and the control variables together. The R^2_{change} value = .004 and is significant (sig F change < .01). The significant R^2_{change} value supports the alternative hypothesis that state licensing predicted higher female clinical laboratory practitioner wages above and beyond the effect of the control variables namely education, potential experience, potential experience squared, marital status, and number of own children in the home.

Table 6 also presents the regression coefficients for Model 2. Based on the size of the state licensing coefficient .050 and holding the other variables constant, the magnitude of the state licensing premium for female clinical laboratory practitioners 25-44 years old is 5.0% and is significant $p < .01$. The control variable coefficients were statistically significant and had the expected sign with the exception of educational attainment. In contrast to the significant educational attainment coefficient for the male and female, 25-26 years old sample in RQ 1, the educational attainment coefficient for the female 25-44 age sample regression had the expected positive sign, but was not significant. This finding implies there was no statistically significant financial benefits to earning a master's degree over and above a bachelor's degree education in this profession for women within this age range.

Notably and as hypothesized, the number of children under 18 years old in the home had the expected negative sign and is significant for the female only regression. Based on the children coefficient .019, the size of the motherhood wage penalty is 1.9% for each child and was significant $p < .01$ (one-tailed). The marital status coefficient had a positive sign, and remained not significant as it was for the male and female combined sample used in RQ 1.

Therefore, the answer to RQ 2 is clinical laboratory practitioner licensing significantly predicted female clinical laboratory practitioner wages over and above what was predicted by education, potential experience, potential experience squared, marital status, and number of own children in the home. The size of the state licensing premium on female clinical laboratory practitioner wages was 5.0% on average compared to their female counterparts working in nonlicensing states holding the other variables constant.

Summary

In summary, I used wage regression to estimate the effect of clinical laboratory practitioner licensing on wages. Using the U.S. Census 2000 PUMS I consistently found evidence that state licensing predicted significantly higher clinical laboratory practitioner wages. I found that clinical laboratory practitioners working in licensing states earned 5.8% more on average than clinical laboratory practitioners working in nonlicensing states while controlling for education, potential experience, potential experience squared, number of children less than 18 years in the home, and marital status. When I focused my analysis on women, I found evidence that female clinical laboratory practitioners, aged 25-44 working in licensing states earned 5.0% more on average than their female counterparts working in nonlicensing states. I attribute higher wages predicted by clinical laboratory practitioner licensing to supply and demand where the supply of clinical laboratory practitioners is more restricted in licensing states compared to nonlicensing states as a result of statutory licensing requirements including passing a licensing examination.

In this chapter, I analyzed the effects of licensing on clinical laboratory practitioner wages using 2000 U.S. Census 5% PUMS data. I consistently found evidence that state licensing is related to significantly increased clinical laboratory practitioner wages. Specifically I found that clinical laboratory practitioners working licensing states earned 5.8% more on average than those working in nonlicensing states while controlling for human capital and individual characteristics. I also specifically focused on the earnings of women in this female-dominated profession and still found consistent evidence that state licensing is related to significantly higher clinical laboratory practitioner wages while controlling for human capital and individual characteristics. Chapter 5 is the final chapter of the study that summarizes and interprets the study findings, and offers social change implications and recommendations based on the research findings.

Chapter 5: Discussion, Conclusions, and Recommendations

Overview

Despite the large number of workers in the United States who must possess a license to practice a profession, the subject of state professional licensing has received comparatively little examination in research. As of February 2011, clinical laboratory practitioner licensing is required in 11 states and Puerto Rico, with New York being the most recent state adopting added licensing state in 2006. Clinical laboratory practitioner licensing effect on wages has received remarkably little attention as an extensive literature review located only two studies conducted more than 30 years apart---and these produced disparate conclusions. This study extended the broader licensing literature and filled the major gap in investigating the effects of clinical laboratory licensing on wages.

Clinical laboratory testing is a vital part of the health care system as it is estimated that laboratory testing impacts over 70% of medical decisions. A serious clinical laboratory workforce shortage exists despite a robust clinical laboratory industry of more than 200,000 federally certified laboratories performing 6.8 billion laboratory tests, generating revenues estimated at $52 billion annually (G-2 Reports, 2007). Lower wages compared to other health care professions with similar or lesser education requirements has been implicated as an important factor in the shortage. Clinical laboratory licensing proponents assert professional licensing would bolster recruitment and retention of a sufficient number of high quality workers in order to avert the looming workforce crisis; whereas licensing opponents typically raise the specter of prohibitively higher wages and diminished labor pool.

The implications of a clinical laboratory workforce crisis for the health care and public health systems are significant because an insufficient workforce could negatively impact patients in receiving timely and accurate diagnoses that can exacerbate illness further contributing to increased health care costs. Such a dire scenario has been tangibly and repeatedly described in the literature as well as in testimony to legislators at the federal and state level (Levit et al., 2010; U.S. General Accounting Office, 2004).

The results of this study of clinical laboratory licensing and wages may contribute to positive social change by providing much needed empirical wage information to clinical laboratory professionals, professional organizations, state health department officials, and legislators in the state licensing professional and legislative debate. If the results of the study can be used to dispel gloomy warnings of prohibitively higher wages related to licensing, this information would help mitigate the major obstacle to expanding licensing to all 50 states. State licensing would help to assure access to timely and more consistently high quality clinical laboratory testing results.

This study posed two research questions: to what extent does clinical laboratory licensing affect wages after controlling for human capital and individual characteristics related to wages; and to what extent does licensing affect female clinical laboratory practitioner wages. A human capital based wage regression was used to estimate the effects of licensing on clinical laboratory practitioner wages. The dependent variable was the natural logarithm wages adjusted by the Comparable Wage Index (Taylor & Fowler, 2006; U.S. General Accounting Office, 2004), and the independent variable was the licensing status of the state where the individual worked. The wage regression controlled for human capital and demographic individual variables that influence wages including educational attainment, potential experience and its square, gender, children, and marital status. The data for all study variables except state licensing status were extracted from the U.S. Census 2000 5% Public Use Microdata Sample (5% PUMS).

The empirical results of this study are summarized as follows. There is consistent evidence that clinical laboratory practitioner licensing is significantly correlated with higher wages. Based on the sample descriptive statistics there is a 8.5% difference in the mean CWI adjusted hourly wage for clinical laboratory practitioners in nonlicensing states compared to licensing states in 1999 ($19.03 versus $20.64 respectively). After controlling for the other wage related covariates, the magnitude of the effect estimated by hierarchical regression is 5.8% on average. Females 25-44 years old working in licensing states also earned significantly more on average than those working in nonlicensing states. Based on the female sample descriptive statistics, there is a 8.3% difference in the mean CWI adjusted hourly wage for clinical laboratory practitioners in nonlicensing states compared to licensing states in 1999 ($18.80 versus $20.35 respectively). After controlling for the other wage related covariates, the size of the licensing effect on female wages estimated by hierarchical regression analysis is 5.0% on average.

Interpretation of Findings

Research Question 1 (RQ 1)

According to the study findings there is consistent evidence that state licensing significantly increases clinical laboratory practitioner wages. The size of the licensing wage premium is relatively modest for additional time and effort required to become licensed. The 5.8% licensing wage premium found in this study is comparable to another study of the effect of licensing for a profession that does not require a graduate college degree. Timmons and Thornton (2008a) study of radiologic technologists found a 3.2% wage premium for workers in licensing states compared to workers in nonlicensing states. In contrast, Friedman and Kudnets (1945) and Kleiner and Kudrle (2000) asserted professions requiring an advanced graduate degree such as physicians and dentists have been associated with as much as 20% wage premiums.

The results of this study also indicated women earned on average 3.8% less than male clinical laboratory practitioners. The mean sample descriptive data indicated approximately a 4.5% wage gap. The apparent gender wage gap within the same occupation found in this study is also comparable to Timmons and Thornton (2008a) finding of a 4.6% gender wage gap among workers within the radiologic technology profession.

Research Question 2 (RQ2)

RQ 2 focused on women and found significantly higher wages for licensed women compared to unlicensed women is consistent with Moore et al. (1981) finding that licensed women earned significantly more than certified and non-certified women. The significant 1.9% motherhood wage gap for each child under 18 years old found in this study is lower but reasonably comparable to other studies of the motherhood wage gap. For example, Harkness and Waldfogel (2003) found a 2.5% penalty for one child, Erosa, et al., (2005), and Budig and England (2001) found a 5% motherhood wage gap for each child.

Overall the marital status literature was mixed for its influence on women's wages. The non-significant findings of this study of a slight but consistently positive effect of marriage on wages for the male and female data (1.6%) and for the female only aged 25-44 data (2.5%) are concordant with the findings of Korenman and Neumark (1992). However, the non-significant relationship of marital status and wages was discordant with Budig and England (2001), Harkness and Waldfogel (2003), and Waldfogel (1997) findings of a small but significantly increased wages for married women.

The educational attainment coefficient had the expected positive sign but was not significant for the female 25-44 age sample regression. This nonsignificant result may be related to the smaller sample size (1,665 vs. 4,051) or that women in this age group have not yet accrued significant financial benefits toearning a master's degree over and above a bachelor's degree education in this profession.

Meaning and Relationship of Findings to Theoretical Framework

Meaning

Although this study estimated a 5.8% licensing wage premium overall, and a 5.0% licensing wage premium for women, these are both relatively modest in a practical context, particularly considering the additional time and effort required to become licensed. To illustrate, when a 5.8% licensing premium is applied to the average unlicensed clinical laboratory practitioner CWI-adjusted hourly rate of $19.03, the new rate become $20.13/hr, which is $1.10 more per hour, and when annualized is approximately $2,000 in 1999 U.S. dollars. Likewise, when the 5.0% licensing premium for female clinical laboratory practitioners is applied to the average unlicensed female CWI-adjusted hourly rate of $18.80, the new rate becomes $19.74, which is $0.94 more per hour, and when annualized is approximately $1,700 in 1999 U.S. dollars.

Another way to consider the modest size of licensing premia is that the raw difference between these means based on sample descriptive statistics is 8.5% for the male and female sample 25-66 years old, and 8.3% for the female 25-44 years old sample. Both of these wage differences very closely approximate the 8.4% increase in the national minimum wage in the time period (1997-1998). This wage premium seems particularly nominal as it does not even consider additional expenses incurred by the licensee including initial license and renewal fees, and other license related fees including the application and examination fees, or costs related to mandatory continuing education requirements for some licensing states.

Relationship of Findings to Theoretical Framework

Human capital theory: Education and experience. The theoretical framework of the study was the human capital theory of wages that states the amount of human capital investment, namely education and experience is related to an individual's wages. In this study, experience was operationalized as potential experience and was significantly correlated to wages. As predicted by the human capital theory this relationship held true for the male and female aged 25-65 and the female aged 25-44 samples of clinical laboratory practitioners. For education, there were only bachelor's degree and master's degree individuals in the sample. The master's degree education was significantly positively correlated to higher wages for the male and female aged 25-65 sample. However for the females aged 25-44 years sample, the educational attainment coefficient had a positive sign, but the difference was no longer significant. This nonsignificant finding may be because the women in this age range did not yet accrue the full financial benefit to the additional years of education for this profession, but more study would be required to determine if this supposition is valid.

Gender division of labor: Gender and motherhood wage gap. The theoretical basis for the gender and motherhood wage gap found in this study is attributed to Becker's theory of gender of division of labor in the home where mothers still disproportionately bear childcare responsibilities as compared to fathers. Although the mother's responsibility for childcare has decreased over time, mothers still generally reduce labor hours and leave the workplace more often than men. The results of this study support the existence of the motherhood wage gap because the female 25-44 years old only sample indicated wages were significantly inversely related to the number of children under 18 years old in the home. In contrast, the results from the combined male and female sample failed to find a relationship between wages and the number of children in the home.

Implications for Social Change

The results of this study provided some important additions to the licensing literature and positive social change initiatives by empirically determining the extent that state licensing affects clinical laboratory practitioner wages. This research extended the broader professional licensing literature as well as expanded the extremely limited literature regarding licensing effects on women's wages within the same profession, and professions not uniformly licensed across the 50 states.

Clinical laboratories are experiencing a workforce shortage, and the Bureau of Labor Statistics projected by 2018, the United States will require nearly 108,000 additional clinical laboratory practitioners to fill newly created positions and replace retiring staff (Lacey & Wright, 2009). Wolcott et al. (2008) asserted the challenges to fulfilling this need enormous because of the considerable supply and demand imbalance as a consequence of increased demand for testing including development of newer genetic tests and inadequate supply driven by an aging workforce, insufficient new recruits, and limited educational capacity.

Clinical laboratory practitioner state licensing has been offered as a fundamental element to improve workforce retention and recruitment by the two major clinical laboratory professional organizations that historically opposed state licensing. The abrupt social change in support of licensing expansion across all 50 states is related to the strongly held belief it will raise the profession's stature and recognition thus encouraging potential recruits to the field as well as support educational institutions in expanding professional education programs.

The implications for positive social change are related to state clinical laboratory professional licensing policy development, implementation, and analysis. Firstly, the research provided much needed empirical wage data as there has recently been a good deal of state licensing legislative activity and a scarcity of empirical data available for legislative decision makers to reach informed conclusions on the potential costs to adopting clinical laboratory professional licensing legislation. There is currently much more polarized opinion than facts.

Although the empirical wage regression indicated there is a statistically significant wage difference related to state licensing, the average wage differential is relatively small at 5.8% that amounts to approximately $2,000 annually in 1999 dollars. Considering this nominal wage differential, a major argument in opposition to licensing can be when weighed against the many potential benefits. For example, health care professional licensing is recognized as a primary force in establishing both initial and ongoing practitioner competence (Greiner & Knebel, 2003). In addition, it has long been held that licensing sets minimum quality standards associated with increasing average practitioner quality (Leland, 1979). Many within the clinical laboratory profession believe an expansion of licensing would likely benefit the profession by advancing professional status recognized by sociologists such Freidson (1983) and Weber (1946/2002) as an important milestone toward complete professionalization of an occupation.

On a larger scale, a higher quality and more robust clinical laboratory practitioner workforce would benefit the United States health care system by better assuring access to high quality laboratory testing and improved public health preparedness related to infectious disease and disaster management. Whereas a workforce shortage can negatively impact patients in receiving both a timely and accurate diagnosis, and monitoring treatment regimes that can exacerbate acute and chronic illness further contributing to increased health care costs.

Recommendations for Action

I believe this empirical wage study strengthens clinical laboratory practitioner licensing advocates' case that the overall licensing costs are small and have a large potential return in terms of assuring timely access to consistently higher quality clinical laboratory testing for the public and more competitive wages for the professionals. The empirical results of this study indicating a small statistically significant licensing wage differential should be made available to clinical laboratory professional organizations and professionals, legislative decision makers, and those influencing state health policy including state departments of health officials and health care industry advocacy groups. These interested groups and individuals should take note of these wage results as they represent the best of both worlds, higher wages for relatively underpaid clinical laboratory practitioners compared to other similar health care professions. There is currently much interest in clinical laboratory practitioner licensing within the profession as well as in the state legislative arena. As a result of the heighten interest, the results of this study will be disseminated by presenting them at the American Association for Clinical Chemistry Annual Meeting in July 2011 and by publishing an article in a peer reviewed journal.

Recommendations for Further Study

These study findings raise several possible areas of further research. One question is whether the effects of clinical laboratory practitioner licensing on wages in 1999 will remain the same today. This question can be studied using the U.S. Census 2010 5% PUMS when it is published. Another question is whether the demographics of clinical laboratory professionals such as female gender predominance, average age, and whether women still earn less than mens on average changed over the last 10 years. Because there appeared to be a differential wage effect on of the number of children under 18 years old in the home based on gender, it would be interesting to study whether there is an interaction effect in terms of gender and children on wages and licensing. Previously, Loughran and Zissimopoulos (2004) demonstrated interaction effects of gender and marital status on wages.

Conclusion

The study findings supported the literature that the effects of licensing are smaller for professions with more moderate education requirements. It is likely that because lesser education requirements represent more modest entry barriers into such professions, these are not as challenging to overcome, and consequently are not as effective at increasing wages. Unlike other health care professions that are uniformly licensed in the 50 states, clinical laboratory practitioners may also be less effective in lobbying for licensing regulations that are more effective in limiting entry into the profession. Lastly, the results of this study of clinical laboratory practitioner wages concurs with the literature in regards to the existence of the gender and motherhood wage gaps in the United States even within the same profession.

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Appendix: Permission to Use Data

U.S. Census Bureau

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Helping You Make Informed Decisions

Curriculum Vitae

Mary Hotaling

Advanced degrees, honors, and awards

PhD Health Services-Health Management and Policy Concentration – Walden University, Minneapolis, MN – 2011

MS Medical Technology with Management Specialization – St. John's University, Jamaica, NY – 1992

Sigma Iota Epsilon – National Honorary and Professional Management Fraternity, Zeta Rho Chapter, Walden University – 2011

International Sharps Injury Prevention Award – International Sharps Injury Prevention Society – 2009

Outstanding Speaker Award, American Association for Clinical Chemistry – 2007 and 2008

Faculty Honor Award, Stony Brook University, Stony Brook, NY – 2007

Alpha Eta National Allied Health Honor Society, Stony Brook University Chapter – 1999

Book Chapters

1. Hotaling, M. (2005). Basic principles of instrumentation: Spectrophotometry, fluorometry, turbidimetry, and nephelometry. In K.M. Ward, C.A. Lehmann, L.E. Schoeff & R.H. Williams (Eds.), *Clinical diagnostic technology: The total testing process, Volume 2: The analytical phase* (pp. 77-104). Washington, DC: AACC Press.
2. Hotaling, M. (2004). Revised OSHA bloodborne pathogens standard. *In-service Reviews in Clinical Laboratory Science, Volume* 17, Number 1, 1-4. Birmingham, AL: Oakstone Medical Publishing.
3. Hotaling, M. (2001). Reproductive endocrinology and infertility testing. *In-service Reviews in Clinical Laboratory Science, Volume 14, Number 3*, 1-11. Birmingham, AL: Oakstone Medical Publishing.
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5. Hotaling, M. (1998). Carbohydrates. In C.A. Lehmann (Ed.), *Saunders manual of clinical laboratory science* (pp. 45-58). Philadelphia: WB Saunders Co.
6. Hotaling, M. (1998). Cardiac function. In C.A. Lehmann (Ed.), *Saunders manual of clinical laboratory science* (pp. 99-112). Philadelphia: WB Saunders Co.

Articles, Abstracts

1. Hotaling, M. (2009). Meeting OSHA's Bloodborne Pathogens Standard letter and intent: A retractable winged steel (butterfly) needle performance improvement project. *Joint Commission Journal on Quality and Patient Safet*y, 35 (2): 100-105.
2. Hotaling, M. (2008). Efficacy of a retractable safety winged steel needle (butterfly needle) to significantly reduce needlestick injuries in healthcare workers: A 21-month experience [Abstract]. *Clinical Chemistry*, 54(6) Supplement: A50
3. Hotaling, M., & Plaut, D. (2007). Results of a quiz evaluating clinical laboratory scientists' knowledge of statistics [Abstract]. *Clinical Laboratory Science*, 20(3): 138.
4. Hotaling, M. (2006). EPA's next enforcement target: Healthcare facilities and the laboratory. *Medical Laboratory Observer*, 38(9), 63-64.
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6. Hotaling, M. (2006). Hazardous waste management: Are you prepared? *Advance for Laboratory Professionals*, 18(16), 21-24.
7. Hotaling, M. (2006). The EPA is coming: What you need to know now about hazardous waste management. *Clinical Leadership & Management Review*, 20(5).
8. Lehmann, C., & Hotaling, M. (2005) Saving time, saving money: A time and motion study with contrast management systems. *Journal of Invasive Cardiology*, 17(2), 118-122.

National Oral Presentations

1. Hotaling, M. (2009, June). *Accidental Needlestick Injuries: Getting to Zero: A 6-year Sharps Injury Reduction Performance Improvement Project* . Association for Practitioners in Infection Control and Epidemiology. Annual Meeting, Fort Lauderdale, FL.
2. Hotaling, M. (2008, July). *Chemical hazards and hazardous waste management: Streamlining compliance with regulatory requirements among EPA, OSHA and*

JCAHO. American Association for Clinical Chemistry Annual Meeting, San Diego, CA.

3. Hotaling, M. (2008, July). *The EPA is coming: What you need to know now about hazardous waste management*. American Association for Clinical Chemistry Annual Meeting, San Diego, CA.
4. Hotaling, M. (2008, July). *Reducing sharps injuries: Where we are and where we need to be*. American Association for Clinical Chemistry Annual Meeting, San Diego, CA.
5. Hotaling, M. (2008, April). *Reducing sharps injuries: Where we are and where we need to be*. [Webinar]. Becton-Dickinson Webinar, Franklin Lakes, NJ.
6. Hotaling, M. (2007, September). *The EPA is coming: What you need to know now about hazardous waste management*. American Society for Clinical Pathology Fall 2007 Teleconferences, Chicago, IL.
7. Hotaling, M. (2007, July). *The EPA is coming: What you need to know now about hazardous waste management*. American Association for Clinical Chemistry Annual Meeting, San Diego, CA.
8. Hotaling, M. (2007, July). *Reducing sharps injuries: Where we are and where we need to be*. American Association for Clinical Chemistry Annual Meeting, San Diego, CA.
9. Hotaling, M. (2007, July). *Chemical hazards and hazardous waste management: Streamlining compliance with regulatory requirements among EPA, OSHA and JCAHO*. American Association for Clinical Chemistry Annual Meeting, San Diego, CA.
10. Hotaling, M. (2007, July). *The EPA is coming: What you need to know now about hazardous waste management*. American Society for Clinical Laboratory Science Annual Meeting, San Diego, CA.
11. Hotaling, M. (2007, July). *Oral research presentation: Results of a quiz evaluating clinical laboratory scientists' knowledge of statistics*. American Society for Clinical Laboratory Science Annual Meeting, San Diego, CA.
12. Hotaling, M. (2007, July). *Enhancing patient safety by assuring compliance with the CDC's hand hygiene guidelines: A case study approach*. American Society for Clinical Laboratory Science Annual Meeting, San Diego, CA.
13. Hotaling, M. (2007, March). *Nuts and bolts of performing periodic performance reviews.* Clinical Laboratory Management Association Annual Meeting, Houston, TX.
14. Hotaling, M. (2007, March). *Designing and implementing a robust performance improvement program for the laboratory*. Clinical Laboratory Management Association Annual Meeting, Houston, TX.
15. Hotaling, M. (2007, March). *Got waste? 5 steps to EPA compliance*. Clinical Laboratory Management Association Annual Meeting, Houston, TX.
16. Hotaling, M. (2006, March). *The EPA is coming: What you need to know now about hazardous waste management*. Clinical Laboratory Management Association Annual Meeting, Charlotte, NC.

17. Hotaling, M. (2001, October). *Clinical chemistry review and update.* ASCP-CAP Annual Meeting, Philadelphia, PA.

National Poster Presentations

1. Hotaling, M. (2008, July). *Efficacy of a Retractable Safety Winged Steel Needle (Butterfly Needle) to Significantly Reduce Needlestick Injuries in Healthcare Workers: A 21-Month Experience*. Poster session presented at the American Association for Clinical Chemistry Annual Meeting, Chicago, IL.
2. Hotaling, M., & Plaut, D. (2006, July). *A survey of clinical laboratory workers' knowledge of routinely encountered descriptive and inferential statistics*. Poster session presented at the American Association for Clinical Chemistry Annual Meeting, Chicago, IL.

National Workshops

1. Hotaling, M. (2010, October). *Clinical chemistry: Carbs, lytes, proteins, kidney and liver*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Dallas, TX.
2. Hotaling, M. (2009, September). *Clinical chemistry: Carbs, lytes, proteins, kidney and liver*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Indianapolis, IN.
3. Hotaling, M. (2008, November). *Clinical chemistry: Carbs, lytes, proteins, kidney and liver*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Phoenix, AZ.
4. Hotaling, M. (2008, October). *Clinical chemistry: Carbs, lytes, proteins, kidney and liver*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Atlanta, GA.
5. Hotaling, M. (2007, October). *Clinical chemistry: Carbs, lytes, proteins, kidney and liver*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Orlando, FL.
6. Hotaling, M. (2007, May). *Clinical chemistry: Carbs, lytes, proteins, kidney and liver*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Secaucus, NJ.
7. Hotaling, M. (2007, May). *Clinical chemistry: Carbs, lytes, proteins, kidney and liver*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Baltimore, MD.
8. Hotaling, M. (2006, September). *Clinical chemistry: Carbs, lytes, proteins, kidney, liver and lipids*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Chicago, IL.

9. Hotaling, M. (2006, September). *Clinical chemistry: Carbs, lytes, proteins, kidney, liver & lipids*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Minneapolis, MN.
10. Hotaling, M. (2006, May). *Clinical chemistry: Cardiac, bone and endocrine*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Chicago, IL.
11. Hotaling, M. (2006, May). *Clinical chemistry: Carbs, lytes, proteins, kidney, liver & lipids*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Chicago, IL.
12. Hotaling, M. (2005, September). *Clinical chemistry: Carbs, lytes, proteins, kidney, liver & lipids*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Anaheim, CA.
13. Hotaling, M. (2005, September). *Clinical chemistry: Cardiac, bone and endocrine*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Anaheim, CA.
14. Hotaling, M. (2004, September). *Clinical chemistry: Carbs, lytes, proteins, kidney, liver & lipids*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Kansas City, KS.
15. Hotaling, M., & Spitzer, S. (2004, May). *Molecular diagnostics.* American Society for Clinical Pathology Workshops for Laboratory Professionals, Chicago, IL.
16. Hotaling, M. (2003, March). *Clinical chemistry review and update.* American Society for Clinical Pathology Workshops for Laboratory Professionals, San Francisco, CA.
17. Hotaling, M. & Spitzer, S. (2002, May). *Molecular diagnostics.* American Society for Clinical Pathology Workshops for Laboratory Professionals, Baltimore, MD.
18. Hotaling, M. & Spitzer, S. (2001, March). *Molecular diagnostics.* American Society for Clinical Pathology Workshops for Laboratory Professionals, San Francisco.
19. Hotaling, M. (2000, November). *Clinical chemistry review and update*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Phoenix, AZ.
20. Hotaling, M. & Spitzer, S. (2000, November). *Molecular diagnostics.* American Society for Clinical Pathology Workshops for Laboratory Professionals, Secaucus, NJ.
21. Hotaling, M. (2000, November). *Clinical chemistry review and update*. American Society for Clinical Pathology Workshops for Laboratory Professionals, San Antonio, TX.
22. Hotaling, M. (2000, May). *Clinical chemistry review and update*. American Society for Clinical Pathology Workshops for Laboratory Professionals, Chicago, IL.
23. Prior to 2000 available on request

State Oral Presentations

1. Hotaling, M. (2007, December). *Impact of New York State Laboratory Personnel Licensure: Employers, Education Programs, and Professionals*. Greater New York Clinical Laboratory Management Association, Tarrytown, NY.
2. Hotaling, M. (2007, June). *Impact of New York State Laboratory Personnel Licensure*. SUNY Orange County Community College Conference, Middletown, NY.
3. Hotaling, M. (2007, April). *Impact of New York State Laboratory Personnel Licensure*. Stony Brook University Clinical Laboratory Sciences Meeting, Stony Brook, NY.
4. Hotaling, M. (2007, January). *Impact of New York State Laboratory Personnel Licensure*. Stony Brook University Clinical Laboratory Sciences Conference, New York, NY.
5. Hotaling, M. (2007, January). *Impact of New York State Laboratory Personnel Licensure*. Rochester General Hospital Conference, Rochester, NY.
6. Hotaling, M. (2005, October). *CDC's hand hygiene guidelines*. Clinical Laboratory Management Association Greater New York Conference, Tarrytown, NY.

Local Oral Presentations

1. Hotaling, M. (2007, May). *Impact of New York State Laboratory Personnel Licensure*. Nassau-Suffolk Hospital Council, Hauppauge, NY.
2. Hotaling, M. (2007, April). *Impact of New York State Laboratory Personnel Licensure*. Stony Brook University Clinical Laboratory Sciences Meeting, Stony Brook, NY.
3. Hotaling, M. (2007, January). *Impact of New York State Laboratory Personnel Licensure*. Stony Brook University Clinical Laboratory Sciences Conference, New York, NY.
4. Hotaling, M. (2006, January). *Hazardous waste management*. St. Charles Hospital, Port Jefferson, NY.
5. Hotaling, M. (2005, December). *Clinical chemistry: Proteins and liver function*. North Shore - Long Island Jewish Health Systems, New Hyde Park, NY.
6. Hotaling, M. (2005, December). *Clinical chemistry: Adrenal endocrinology, reproductive endocrinology*. North Shore - Long Island Jewish Health Systems, New Hyde Park, NY.
7. Hotaling, M. (2005, December). *Clinical chemistry: Carbohydrate metabolism, lipid metabolism*. North Shore - Long Island Jewish Health Systems, New Hyde Park, NY.

8. Hotaling, M. (2005, December). *Clinical chemistry: Cardiac markers, mineral metabolism*. North Shore - Long Island Jewish Health Systems, New Hyde Park, NY.
9. Hotaling, M. (2005, December). *Clinical chemistry: Electrolytes, kidney function*. North Shore - Long Island Jewish Health Systems, New Hyde Park, NY.
10. Hotaling, M. (2005, December). *Clinical chemistry: General endocrinology, hypothalmic and pituitary endocrinology, thyroid endocrinology*. North Shore - Long Island Jewish Health Systems, New Hyde Park, NY.
11. Hotaling, M. (2005, December). *Hazardous waste management.* St. Charles Hospital, Port Jefferson, NY.
12. Hotaling, M. (2003, November). *Regulatory update*. American Society of Phlebotomy Technicians. Stony Brook University, Stony Brook, NY.
13. Hotaling, M. (2003, November). *Vaccinia transmission*. Good Samaritan Hospital Medical Center, West Islip, NY.
14. Hotaling, M. (2003, October). *Vaccinia transmission*. Good Samaritan Hospital Medical Center, West Islip, NY.
15. Hotaling, M. (2003, January). *JCAHO Patient safety goals.* Good Samaritan Hospital Medical Center, West Islip, NY.
16. Hotaling, M. (2002, November). *OSHA's revised Bloodborne pathogens standard and beyond.* Good Samaritan Hospital Medical Center, West Islip, NY.
17. Hotaling, M. (2002, October). *OSHA's revised Bloodborne pathogens standard and beyond.* Good Samaritan Hospital Medical Center, West Islip, NY.