LABOR MARKET ISSUES FOR ADMINISTRATORS: EVIDENCE FROM PUBLIC SCHOOLS IN TEXAS

A Dissertation

by

ERIC JOHN MITCHEM

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2007

Major Subject: Economics

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ABSTRACT

Labor Market Issues for Administrators:

Evidence from Public Schools in Texas. (August 2007)

Eric John Mitchem, B.A., Virginia Polytechnic Institute and State University

Co–Chairs of Advisory Committee: Dr. Manuelita Ureta
Dr. Donald Deere

This dissertation examines three labor market issues regarding public school administrators in Texas using personnel records from the 1994-95 school year until the 2003-04 school year. The first essay explores promotion rates of men and women to school principal, a position that requires certification. I find ignoring gender differences in desire for promotion yields results similar to the existing literature: men hold an advantage in the promotion process. However, restricting the analysis to only those individuals who have expressed interest in an administrative position, those who became trained and certified as a principal, I find men and women face no statistically significant difference in the probability of promotion. Duration analysis shows that although men are most often promoted four years after they become certified and women are most often promoted six to seven years after becoming certified, women face a much higher hazard of promotion than men. This cannot be explained by a higher exit rate from the education sector by men.

The second essay examines the effect of restrictive licensing on the quality of the entrants into a profession. Theory suggests that requiring minimum competency standards truncates the low end of the quality distribution, however, increased costs of entry encourage talented potential entrants to pursue outside opportunities. Using the public school principal profession in Texas and measuring teacher quality by

changes in student achievement, I find evidence that lower entry costs increase the quality of entrants. As a robustness check, I categorize observations geographically into control and treatment groups to ensure the estimated effect is a result of reduced entry costs and not unobserved factors.

The third essay examines the effect of increased school choice on the earnings and abilities of school administrators. I find an overall positive effect of competition on administrators' earnings suggesting that productivity gains from hiring talented managers outweigh the pressure to reduce costs by cutting salaries. However, the results are sensitive to the level of competition, the type of labor market, and the administrators' position. I control for possible endogeneity both mechanically and with outside instruments and my conclusions are largely unchanged.

This dissertation is dedicated to my father: Johnny E. Mitchem.

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CHAPTER I

INTRODUCTION

Many people have studied teacher labor markets, interested in factors that may increase the quality of education within a state or country. Few, however, have considered issues facing school administrators. This dissertation attempts to broaden our knowledge of public school administrators, some of the choices they make, and some of the factors that influence those choices.

In Chapter II, I explore differences in promotion rates between men and women in Texas public schools. In the late 1990's and the early 2000's approximately 22% of the teachers in Texas public schools were men yet more than twice as many, 48%, of the state's public school principals were men.[1] Joy (1998) using the Schools and Staffing Survey of the National Center for Education Statistics from the late 1980's points out that as much as 86% of the teachers were female yet women comprised as little as 22% of the principals. This paper aims to further investigate this difference.

That women are under-represented in the higher ranking positions is not a new discovery. Olsen & Becker (1983) using the 1993-97 Quality of Employment Panel conclude that women are held to higher standards than men and receive fewer promotions. While studying lawyers, Spurr (1990) and Spurr & Sueyoshi (1994) find that women are less likely than men to be promoted to partner after controlling for differences in productivity. For those in academics, McDowell et. al. (1999 & 2001), Ginther & Hayes (1999 & 2003), and Ward (2001) find similar results. Most recently, Pekkarinen & Vartiainen (2006) argue that women face a higher promotion threshold

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The journal model is *American Economic Review.*

[1]Based on the personnel records from the 1994-95 school year through the 2003-04 school year.

than men in the Finnish metalworkers market. The number of studies on this subject is daunting[2] but the conclusions are the same: women are less likely to be promoted than men.

Two main theories dominate the literature. While trying to explain the male-female earnings gap, many point to discrimination in the promotion process against women. The other explanation is that women have a comparative advantage in non-market production thus face a higher opportunity cost and are more likely to quit. If higher ranking professions within a firm require more firm-specific human capital accumulation, then the prediction that women are held to a higher promotion standard than men is reached.[3]

These theories could also apply to men. Given the 1984 Supreme Court ruling that women can pursue legal prosecution for promotion discrimination and the growing attraction in the United States to litigation as well as Affirmative Action[4], men could be the group that is out of favor. It is also feasible that men, having more labor market opportunities outside of the education sector, have higher opportunity costs and are more likely to quit, leading school districts to promote and invest in women more often than men.[5]

In the context of education, tastes for jobs may also differ between the sexes. Women could presumably get more satisfaction from working closely with children in

[2]Other studies include but are not limited to Johnson & Stafford (1974), Farber (1977), Weiss & Lillard (1982), Laband & Lentz (1993), McCue (1996), Hersch & Viscusi (1996), Jones & Makepeace (1996), Winter-Ebner & Zweimuller (1997), Pudney & Shields (2000), Booth et al. (2003), and Mixon & Trevino (2005).

[3]See Lazear & Rosen (1990).

[4]See Holzer & Neumark (2000)

[5]Figures in the appendix illustrate various labor market opportunities for men and women outside of education administration in Texas. The figures show that for men and women principals in Texas public schools, mean and median earnings are the same from 1995 through 2004. For managers outside of the education sector, however, men earn more than women.

the classroom and therefore would have a lower reservation wage for teaching than for an administrative position. There is though no reason to believe that men do not prefer the classroom.

The next chapter explores the promotion rates of men and women in Texas public schools from 1994-95 until 2003-04, specifically promotion to school principal, an administration position that requires certification prior to promotion. Given this requirement, I control for career aspirations and measure the gender gap in promotion to school principal. Joy (1998) uses a master's degree as an indication that an individual desires promotion to school administration. I use the principal certificate as indication of desire for promotion. In a probit regression, I find ignoring differences between the genders in desire for promotion yields results similar to the existing literature: men hold an advantage in the promotion process. However, restricting the analysis to only those individuals who have expressed interest in an administrative position, those who became trained and certified as a principal, I find men and women face no statistically significant difference in the probability of promotion. Duration analysis shows that although men are most often promoted four years after they become certified and women are most often promoted six to seven years after becoming certified, women face a much higher hazard of promotion than men. This cannot be explained by a higher exit rate from the education sector by men.

Chapter III examines the effect of licensing and certification requirements for public school administrators. Since licensing occurs most often in the rapidly growing service industry, the number of those impacted will only rise. Ideally, certification and licensing regulation restricts entry from the lowest quality potential entrants, those who do not meet the agreed upon minimum requirements.[6] The quality dis-

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[6]Restricting the supply of services can lead to higher earnings for individuals in the profession. Stigler (1971) shows that licensed occupations earned more than

tribution is effectively truncated thereby increasing the overall quality of the entrant pool. In turn, the talented entrants will provide a higher quality of service in the profession. Yet, high entry costs may cause the most talented individuals to seek other employment and studies show mixed results on the effect of regulation on the quality of received services. Kaine, Rockoff, and Staiger (2006) find certification status has a small impact on student test performance. Kleiner and Kudrle (2000) as well as Angrist and Guryan (2004) show that tougher licensing requirements do not raise the quality of services provided whereas Carroll and Gaston (1981) suggest that restrictive licensing may even lower received service quality.[7] This suggests that either licensing regulation doesn't increase the quality of the entrant pool or that the measures of quality used to certify and license individuals are poor predictors of high quality output after entry. This paper aims to address the first issue and leaves the latter for later discussion.

By studying school principals, I am able to identify the potential entrants into the profession, i.e. teachers. Little consideration has been given to school principals. The ability and performance of school administrators is important to the success of our school children. Some suggest that although the quality of a teacher is difficult to measure, the principal knows who the good teachers are. (These are proponents of merit based pay for teachers.) Given that a principal's job in part entails the direction of the teachers, training principals to identify the talented teachers and use that information for better development of the students is essential to improving our public education.

unlicensed occupations. Recently, Angrist and Guryan (2004) find that teacher testing increases teacher salaries.

[7]See Kleiner (2006) for a complete summary of the results of studies on the benefits of occupational regulation.

In 1999 and 2000, the Texas legislature enacted changes in the requirements needed to become certified as a principal in Texas. These changes are two-fold. Lifetime certification was abolished and alternative certification routes were opened. Before this change, the traditional route to becoming a principal was through academic training at a college or university level as well as obtaining substantial teaching experience. Now, less formal training is allowed and consideration of talent, ability, and relevant experience is taken in the certification process. These changes have relieved some of the barriers into school administration by introducing additional routes of obtaining the required certificates.

I provide a description of the certification system and detail the changes in the regulation in Texas. I also describe the differences between the traditional training programs and the alternative programs to understand selection into each in order to tease out answers to addressed questions. Using student test scores as a measure of quality, I find evidence that lower entry costs brought about by a certification regime change increase the quality of entrants into the principal profession. Two levels of student test scores are aggregated. First, I use campus level student test scores to measure the quality of individuals at each school. Then, I aggregate the scores by the grade level and the subject of the exam as well as the campus at which the students attend to measure the quality of the teachers. Test scores are also standardized in several different ways to compare across time. Results are robust to the measurement and standardization of the quality proxy, test scores.

With some concern about other unknown and unobserved factors that may have changed at or near the time certification costs changed, I exploit a quasi-natural experiment to further test the robustness of the results. Since the introduction of alternative training and certification programs constitutes the main argument for reduced entry costs, I divide rural schools into treatment and control groups based on geography. If a school is within 100 miles of a new alternative training facility, an individual working at that school is assumed to be treated by the regime change. Individuals working at a school that is more than 100 miles from a new alternative training facility compose the control group. Results agree with the other specifications. The reduction in certification costs brought about by the introduction of new alternative training programs increases the probability of entry by a high quality potential entrant.

Chapter IV explores the relationship between public school administrators' compensation and the level of school choice in an educational market. Charles Tiebout (1956) proposes that, unlike government spending at the federal level, local expenditure levels are more or less set. Households choose the community in which they reside within a reasonable market (based on their employment location) based on matching their preferences for public goods expenditures to the expenditure patterns of that local entity. The greater the number of local communities and the greater the variation between them within a market, the closer the household will come to a perfect match of its preferences. Since public school is financed at the school district level, the Tiebout choice model is applicable. The effect of Tiebout choice on schooling is directly relevant.

The studies of Tiebout choice and education are too numerous to list in full. Epple and Romano (1998) develop a theoretical and computational model that allows competition and choice through tuition-free public schools and tuition-financed private schools. Evans and Schwab (1995) also examines the relationship between private school and public school effectiveness. Stiglitz (1974), Ireland (1990), Eden (1992), Manski (1992), Rothschild and White (1995), Epple and Romano (1995) and Glomm and Ravikumar (1998) study choices in schooling by looking at the private sector. Hoxby (1999) develops a principal-agent model for schooling producers.

Hoxby (2000) attempts to measure the effects of Tiebout choice on student achievement, per pupil spending and school productivity by controlling for potential endogeneity of the observed level of choice. She argues that the level of choice observed in a school district is possibly affected by the productivity of that school district. For example, within a schooling market (a metropolitan area in her study), a school district that is successful for idiosyncratic reason will attract households with school aged children (households with a high demand for school spending). Also, other school districts will want to merge with the successful one to take advantage of its talented administrators, thus reducing the level of choice in that market. To address the endogeneity problem, she instruments the supply of jurisdictions with data on streams, a natural boundary for school districts.

In the design of the empirical specification, Hoxby (2000) assumes that the level of choice present in a given educational market has a positive effect on the reward that the district gives its administrators who improve productivity. Since nothing is observed on administrators' incentives for productivity, she estimates a reduced form of her specification where the level of Tiebout choice in the market has a direct effect on the measures of output and productivity.

Using a reduced for model, Hoxby (2000) finds that OLS estimates, which do not account for potential endogeneity bias, show no effect of school choice on either student achievement, spending, or productivity. She also finds using an instrumental variables approach that Tiebout choice raises school productivity. It does so by increasing the level of student achievement while simultaneously decreasing the level of per pupil spending. Also, where households have more choice, students are less likely to attend private schooling.

This chapter examines the effect of increased school choice on the earnings and abilities of school administrators. I use a rich dataset of personnel information for educators in the public schools in Texas and variation in the data across individuals and across time allows for a clear identification of the effect. I find an overall positive effect of competition on administrators' earnings suggesting that productivity gains from hiring talented managers outweigh the pressure to reduce costs by cutting salaries. However, the results are sensitive to the level of competition, the type of labor market, and the administrators' position. I control for possible endogeneity both mechanically and with outside instruments and my conclusions largely unchanged.

CHAPTER II

GENDER AND PROMOTION

A. Introduction

This chapter explores the promotion rates of men and women in Texas public schools from 1994-95 until 2003-04, specifically promotion to school principal, an administration position that requires certification prior to promotion. Given this requirement, I control for career aspirations and measure the gender gap in promotion to school principal. Joy (1998) uses a master's degree as an indication that an individual desires promotion to school administration. I use the principal certificate as indication of desire for promotion. In a probit regression, I find ignoring differences between the genders in desire for promotion yields results similar to the existing literature: men hold an advantage in the promotion process. However, restricting the analysis to only those individuals who have expressed interest in an administrative position, those who became trained and certified as a principal, I find men and women face no statistically significant difference in the probability of promotion. Duration analysis shows that although men are most often promoted four years after they become certified and women are most often promoted six to seven years after becoming certified, women face a much higher hazard of promotion than men. This cannot be explained by a higher exit rate from the education sector by men.

B. The Data

I utilize a set of data that was collected by the Texas Education Agency (TEA) through their Public Education Information Management System (PEIMS). The TEA is the statewide administrative unit that guides and oversees primary and secondary public education in Texas. Data was collected on public school system personnel demographics, education, gender, and other individual characteristics. The data available for this study cover the school years from 1994-95 to 2003-04.

In Texas, anyone who wants to pursue a career in administration must obtain a principal certificate. Certificate information was provided by the State Board for Educator Certification (SBEC). This data describes each certificate held, when the certificate was acquired, the type of certificate, and the institution that granted the certificate to each public school employee in the state.

In order to get an idea of the gender make-up in the data, I first present statistics for each school year for teachers and principals in Table 1. The number of teachers is increasing over this ten year period as is the number of male teachers. In fact, the percentage of teachers that are male remains relatively constant at 22%. In contrast, while the number of principals in Texas is increasing as the public school system expanded over time, the number of principals who were men is noticeably decreasing. In the 1994-95 school year there are 2,870 male principals yet in the latest year in the available data there were only 2,544 male principals. The fraction of principals who are male is therefore falling over this period not only because of the expanding school system but also because of the falling number of male principals. The percentage of principals in Texas fell from 54.2% in 1994-95 to only 42.3% in 2003-04.

Men are still over-represented as school principals, though. In the earlier years, while only 22% of the teachers are men, over 50% of the principals are men. In the later years, still 22% of the teachers yet around 42-44% of the principals are men. This could be evidence of discrimination or it could reflect the fact that for various reasons men enter the school principal market more than women. Men are often the main provider of a household and thus pursue careers in administration for the higher earnings. Women often choose education so they can have the same daytime schedule

Table 1. Men in Texas Public Schools

School Year	Teachers			Principals		
	Number	*Men*	*% Men*	*Number*	*Men*	*% Men*
1994-95	216,107	45,825	21.2%	5,297	2,870	54.2%
1995-96	228,803	50,153	21.9%	5,355	2,838	53.0%
1996-97	232,750	51,891	22.3%	5,430	2,758	50.8%
1997-98	241,960	53,766	22.2%	5,551	2,731	49.2%
1998-99	245,623	54,852	22.3%	5,551	2,644	47.6%
1999-00	254,179	56,272	22.1%	5,743	2,692	46.9%
2000-01	265,101	58,643	22.1%	5,895	2,707	45.9%
2001-02	272,234	60,523	22.2%	5,968	2,672	44.8%
2002-03	262,617	58,449	22.3%	6,008	2,592	43.1%
2003-04	264,153	58,942	22.3%	6,011	2,544	42.3%

Table 2. Texas Public School Labor Market

	Fraction Male		
School Year	Full Sample	Master's	Certified
1994-95	23.9%	26.5%	46.8%
1995-96	24.6%	26.5%	45.9%
1996-97	24.4%	26.5%	44.6%
1997-98	24.2%	26.0%	43.7%
1998-99	24.3%	25.9%	42.5%
1999-00	24.2%	25.6%	42.0%
2000-01	24.0%	25.6%	41.3%
2001-02	24.1%	25.4%	40.5%
2002-03	24.0%	25.0%	39.5%
2003-04	23.9%	24.9%	38.8%

as their children. School administrators are required to work longer into the day and over the summer. Thus, women may choose not to enter school administration until their children are older. Table 2 shows for each school year the percentage of school employees that are men in the full sample, those holding a master's degree, and those who are certified. The first column shows the percentage of men in the full sample. The fraction remains nearly the same, about 24%, over the ten year period. The other two columns show the percentage of those who obtained a master's degree who are men (often a measure associated with desire for promotion, see Joy (1998)) and the percentage of those who hold a principal certificate. Men are decreasing in both of these groups suggesting men are choosing this career path less often or women are choosing this path more often. This could explain the reduction in the number of male principals, however, I cannot identify the direction of causality here. Still, men are over-represented in the make-up of those who are certified. While around 24% of all full-time school employees are men, between 39 and 46% of those who are certified are men suggesting that men do in fact enter administration at higher rates than women.[1]

Table 3 describes the variables that I use in the analysis. In addition to gender I use indicator variables for both educational attainment and race and/or ethnicity. Each individual's experience in Texas public schools is accounted for as well as their certification status. Other variables are constructed from the data to control for differences in supply and demand of principals. First, to measure differences in district level demand for principals, I calculate the number of open principal positions in each school district per 1,000 employees for each school year. To measure differences in the supply of potential principals, I calculate the number of individuals in each school district per 1,000 district employees for a given school year that are certified yet are not employed as a principal. I also construct demand and supply for principals by labor market, where a labor market is defined as the metropolitan or micropolitan statistical area[2] or the county for rural areas. Tables 4 and 5 summarize these variables.

Table 4 includes all full-time employees in Texas public schools that may be vying for a principal position including teachers, counselors, athletic directors, assistant principals, instructional officers, educational diagnosticians, teacher supervisors, and principals. Again, the percentage of these employees that are male is 24%. Twenty-nine percent hold a master's degree and 1% had a doctorate. Ten and 19% of this sample are African American and Hispanic, respectively. Asian Americans and Native

[1]If there is discrimination here it would have been through admissions into training and certification programs. Unfortunately, I do not have data on admissions.

[2]As defined by the U.S. Office of Management and Budget (OMB). A metro area contains a core urban area of 50,000 or more population, and a micro area contains an urban core of at least 10,000 (but less than 50,000) population.

Table 3. Variable Names and Descriptions

Variable Name	Description
Male	Equals 1 if the individual is a man; 0 of a woman.
Experience	The number of years of teaching experience in the Texas public school system.
Master's Degree	Equals 1 if the individual's highest degree is a master's degree; 0 otherwise.
Doctorate Degree	Equals 1 if the individual's highest degree is a doctorate; 0 otherwise.
Black	Equals 1 if the individual is African American; 0 otherwise.
Hispanic	Equals 1 if the individual is of Hispanic descent; 0 otherwise.
Asian	Equals 1 if the individual is Asian American; 0 otherwise.
Native American	Equals 1 if the the individual is a Native American; 0 otherwise.
Open Positions	The estimated demand for principals in the individual's school district or labor market for the given school year; calculated for each district-year or market-year as the number of principals employed in the district or market that were not employed in the district or market as a principal the previous year per 1,000 employees.
Number Certified	The estimated supply of principals in the individual's school district or labor market for the given school year; calculated as the number of certified individuals in a district or market for that school year per 1,000 employees.
Age of Certification	The number of calendar years since the individual obtained principal certification for those who hold a certificate; equals 0 for if not certified.

Table 4. Descriptive Statistics for the Full Sample

Variable	Mean	St. Dev.	Min.	Max.
Male	0.24	0.43	–	–
Teaching Experience	12.1	9.6	0	64
Master's Degree	0.29	0.45	–	–
Doctorate Degree	0.01	0.09	–	–
Black	0.10	0.29	–	–
Hispanic	0.19	0.39	–	–
Asian	0.006	0.080	–	–
Native American	0.003	0.051	–	–
Open Positions				
District	4	7	0	333
Labor Market	4	3	0	118
Number Certified				
District	70	20	7	571
Labor Market	69	11	0	286
Age of Certification	0.8	3.4	0	49

Notes: The sample consists of all full-time teachers, counselors, athletic directors, assistant principals, instructional officers, educational diagnosticians, teacher supervisors, and principals.

Americans represent less than 1% each of the full-time employees in Texas public schools. On average, individuals in the full sample have 12.1 years of experience, face 8.3 open principal positions in their district, and work with 241 people who held a principal certificate yet were not employed as a principal.

The full sample is not representative of those at risk for promotion to principal. It includes individuals who may not desire promotion. Both women who want a similar schedule as their children as well as men and women who would rather remain in the classroom to work directly with the school children are included in the full sample. Also, the full sample includes individuals who do not have the training

Table 5. Descriptive Statistics for Certified Individuals

Variable	Mean	St. Dev.	Min.	Max.
Male	0.42	0.49	–	–
Teaching Experience	20.0	8.6	0	64
Master's Degree	0.86	0.35	–	–
Doctorate Degree	0.05	0.22	–	–
Black	0.13	0.33	–	–
Hispanic	0.19	0.39	–	–
Asian	0.002	0.050	–	–
Native American	0.003	0.057	–	–
Open Positions				
District	4	7	0	333
Labor Market	4	3	0	118
Number Certified				
District	74	22	7.4	571
Labor Market	70	11	0	286
Age of Certification	9.6	7.6	0	49

Notes: The sample consists of all full-time teachers, counselors, athletic directors, assistant principals, instructional officers, educational diagnosticians, teacher supervisors, and principals who hold a principal certificate.

and certification required to be a principal, regardless of career aspirations. For this reason, I construct a second sample containing only those individuals who hold a principal certificate (See Table 5). This sample more accurately reflects the group of employees who have a chance for promotion to principal. Forty-two percent of this sample are male. Individuals are more likely to have a post-graduate degree than in the full sample. Eighty-six percent of the second sample hold a master's degree while 5% hold a doctorate. More African Americans and fewer Asian Americans comprise this group and on average individuals in this sample have 20 years of experience in the Texas public school system, face 4 open positions per 1,000 employees in their district, and have 70 competitors per 1,000 employees for those positions in their district. Also, individuals in this sample on average are certified to serve as principal 9.6 years prior to observation.

C. Estimation and Results

To investigate the differences in promotion rates between men and women and outline differences in conclusions obtained when using the two different samples, Table 6 reports the results of probit regressions for the probability of promotion for the full sample and the restricted sample. An indicator for an individual's gender is included in each model and is equal to 1 when male. Other variables that may influence promotion decisions are included to control for differences between men and women. These include the amount of experience in Texas public schools, education[3], race and ethnicity, the number of open positions for principal in the district and labor market, the number of individuals who are certified in the district and labor market, and the age of the certification if the individual is certified. Coefficient estimates are reported in the first column, estimated marginal effects in the second column, and the standard error is reported below each estimate.

The probit model, using the full sample, leads to a conclusion about male-female promotion differences commonly found in the economics literature. Men are more likely to be promoted than women and the estimated difference is statistically significant. Here, results suggest that men have a 0.001 higher probability than women to be promoted to principal controlling for observable differences in characteristics. Although the magnitude of this result seems low, the overall probability of promotion

[3] Sicherman & Galor (1990) find that investment in human capital leads to higher probabilities of occupational upgrading, within or across firms.

Table 6. Probability of Being a Principal, Probit Regressions

Variable	Full Sample		Certified as a Principal	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Male	0.140***	0.001***	-0.001	0.000
	0.005	0.000	0.006	0.002
Teaching Experience	-0.001***	0.000***	0.006***	0.002***
	0.000	0.000	0.000	0.000
Master's Degree	1.032***	0.021***	0.264***	0.068***
	0.007	0.000	0.012	0.003
Doctorate Degree	0.901***	0.030***	0.117***	0.034***
	0.014	0.001	0.017	0.005
Black	0.029***	0.000***	-0.092***	-0.025***
	0.008	0.000	0.010	0.003
Hispanic	0.109***	0.001***	0.037***	0.011
	0.006	0.000	0.008	0.002
Asian	-0.313***	-0.002***	-0.195**	-0.050**
	0.046	0.000	0.065	0.016
Native American	0.061	0.001	-0.046	-0.013
	0.040	0.000	0.051	0.014
Open Positions	0.013***	0.000***	0.015***	0.004***
	0.000	0.000	0.001	0.000
Number Certified	-0.005***	0.000***	-0.008***	-0.002***
	0.000	0.000	0.000	0.000
Age of Certification				
1 to 5 years old	1.865***	0.095***	0.988***	0.302***
	0.009	0.001	0.025	0.008
6 to 10 years old	2.320***	0.198***	1.536***	0.510***
	0.009	0.002	0.025	0.008
11 to 15 years old	2.338***	0.205***	1.615***	0.549***
	0.010	0.003	0.026	0.008
16 to 20 years old	2.232***	0.179***	1.560***	0.542***
	0.011	0.003	0.026	0.009
21 to 25 years old	2.096***	0.149***	1.476***	0.526***
	0.014	0.003	0.028	0.010
More than 25 years	1.830***	0.096***	1.289***	0.464***
	0.019	0.003	0.031	0.011

Notes: This table shows estimated probit models for the probability of promotion to school principal. The Full Sample consists of 3,222,624 observations and the restricted sample consists of 252,321 observations. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level.

in this sample was only .017, thus men are about 6% more likely to be promoted to principal.

The full sample does not capture the group of school employees that are at risk of promotion. If men seek careers in administration more often than women, the conclusion I find using the full sample may simply reflect that fact. As mentioned before, the second sample contains only those individuals who are certified for the job. The probit regression for this sample shows no statistically significant difference in the likelihood of promotion to principal for men and women, controlling for individual characteristics and differences in supply and demand of principals at the district or labor market levels. This is consistent with the decline in male principals observed in the data (Table 1). If men are initially over-represented, and men and women are promoted at the same rate over the ten year period, then the number of male principals must decline since women outnumber men in Texas schools.

As expected, experience and education aid a person's promotion prospects. The supply and demand of principals in the school district significantly influence promotion rates as does the amount of time elapsed since certification was obtained. African Americans and Asian Americans are promoted less often than whites while there is no significant difference in the probability of promotion for Hispanics and Native Americans compared to whites, controlling for other factors.

Probit regressions are a useful tool for an overall understanding of promotion rates between men and women. However, most of the observations in the sample are right censored. That is, there are individuals in the data that have not yet been promoted to principal but may get promoted. The probit regressions ignore this censoring.

To address the censoring in the data and to explore when in a person's career promotion is most likely to occur, I estimate a Cox proportional hazard model. The hazard of promotion is assumed to be

$$h(t) = h_0(t)exp(\beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k), \tag{2.1}$$

where $h_0(t)$ is the baseline hazard of promotion after t years have passed since certification which is common to all individuals in the school system, $x_1, x_2, \ldots, x_k$ are k variables that affect the hazard of promotion proportionally over the entire time at risk, and $\beta_1, \beta_2, \ldots, \beta_k$ are the k model coefficients to be estimated.

Duration analysis generally is used to analyze time until an event occurs. In this study, I analyze the time until a school employee is promoted to principal.[4] Each individual is considered at risk of promotion only when he or she becomes certified as a school principal. Therefore, the time until promotion is measured in school years since certification.

Table 7 reports the results of the estimated proportional hazard models. The estimated hazard ratio is reported with its standard error below. The first column reports the results of a proportional hazard model estimated with a pooled sample of men and women, with an indicator for men and controls for other variables possibly influencing promotion rates. The estimated hazard ratio for men is 0.863 and is statistically significantly different from 1 at a 1% level suggesting that men, controlling for other observed characteristics, face a hazard of promotion 13.7% lower than women. Another interesting conclusion from the pooled hazard model is that Hispanics face a hazard 19.8% greater than whites. Although no statistically significant difference exists between the promotion rates of whites and African Americans, Native Americans, and Asian Americans, the magnitude of the results suggest African Americans face a hazard of promotion 3.4% greater than whites, Asian Americans face a hazard rate

[4]The appendix shows that once promoted to principal, educators rarely return a teaching position. Only about 1.5% of the principals each year return.

Table 7. Time to Promotion to Principal

Variable	Pooled	Stratified	Separate Models	
			Men	Women
Male	0.863***	—	—	—
	0.024	—	—	—
Teaching Experience	1.013*	1.015**	0.989	1.049***
	0.007	0.007	0.010	0.011
Experience Squared	0.998***	0.998***	0.998***	0.997***
	0.000	0.000	0.000	0.000
Master's Degree	0.660***	0.662***	0.666***	0.691***
	0.030	0.030	0.044	0.043
Doctorate Degree	0.304***	0.298***	0.213***	0.406***
	0.026	0.026	0.031	0.044
Black	1.034	1.031	1.209***	0.960
	0.045	0.045	0.086	0.053
Hispanic	1.198***	1.198***	1.068	1.294***
	0.040	0.040	0.058	0.056
Asian	1.097	1.093	1.163	1.036
	0.305	0.304	0.522	0.367
Native American	1.250	1.219	1.559	0.981
	0.288	0.281	0.472	0.348
Open Positions	1.035***	1.034***	1.033***	1.039***
	0.001	0.001	0.001	0.001
Number Certified	0.982***	0.982***	0.983***	0.980***
	0.001	0.001	0.001	0.001
Observations	172,366	172,366	70,383	101,983

Notes: The regressions fit a Cox proportional hazards model in which the dependant variable is time until promotion to school principal measured in years after certification. Standard errors appear under the estimated hazard ratios for each covariate. *Open Positions* and *Number Certified* are measured as the number of individuals per 1,000 school district employees. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level.

9.7% greater than whites, and Native Americans face a hazard rate 25% greater than whites. The lack of statistically significant evidence may be due to few observations in these groups.

The key assumptions in the proportional hazard model are that the effects of the covariates on the baseline hazard is proportional over the range of analysis time. In this study, the assumption is that men's and women's hazards differ by the same proportion over time. This may not be true if women become certified at the same time in their career as men, yet delay pursuit of a job as an administrator until their children are older. To this end, I test the null hypothesis that men and women can be combined in the same sample and the hazard rate of promotion for men relative to women is constant. Using the Schoenfeld (1982) residuals approach, I reject the null hypothesis that the hazard rate for men is proportional to the hazard rate for women with a p-value less than 0.001.

I then use a stratified proportional hazard model where the underlying baseline hazard function is allowed to differ between men and women, yet the effect of the other variables are constrained to be the same for both sexes. That is, the hazard of promotion is assumed to be

$$h_i(t) = h_{0i}(t) exp(\beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k), \tag{2.2}$$

for a subject in group i, where the two groups are men and women. The results of this stratified model are presented in the second column of Table 7. The effect of each covariate is similar to the estimated effects for the pooled sample, yet further testing is warranted because the stratified model assumes each of the other factors affecting the hazard of promotion are the same for men and women. Experience, for example, may affect promotion in different ways for men and women if women often leave the labor force for childbearing. Also, there may be great differences between the genders within a particular race. Therefore, I test the hypothesis that the other factors of promotion shift men's hazards and women's hazards the same. I reject the null hypothesis with a p-value less than 0.001 using a likelihood ratio test.[5]

In the final specification I estimate a proportional hazard model separately for men and women. The last two columns of Table 7 report the results. Interestingly, African American men face a hazard of promotion that is 22.2% larger than white men and Hispanic women face a hazard of promotion 23.2% larger than white women.[6] Experience affects the hazard of promotion differently for men and women. For both men and women, obtaining a master's or doctorate degree is associated with slower promotion rates. Most of those who are certified, approximately 90%, eventually get a master's degree. In fact, those who do not have a master's degree are near the beginning of their administrative career, 1 to 5 years since obtaining certification. Obtaining a doctorate takes longer. Less than 2% of those certified have a doctorate within the first few years after becoming certified as a principal. Yet, over 8% of those certified have a doctorate 18 years after becoming certified.[7]

A nice feature of the Cox proportional hazard model is that an estimate of the hazard function is available. Figure 1 illustrates those hazard functions for white men and women with a master's degree, the typical individual in the data.[8] The most notable result illustrated in Figure 1 is that women have a higher hazard rate

[5]An auxiliary stratified model with interaction terms included is estimated where the indicator for men is interacted with all of the other variables in the model to obtain the full model for the likelihood ratio test. The nested model is the one presented in the second column of Table 7.

[6]Among African American educators in Texas, 25% are men compared to 23% male overall. Among Hispanic educators in Texas, only 71% are women, while 77% of all educators are women.

[7]See tables in the appendix.

[8]The appendix provides 95% confidence bands for the hazard function of men and women illustrated in Figure 1. Bootstrapping is used to calculate standard errors for these estimates. The data is sampled 100 times with replacement.

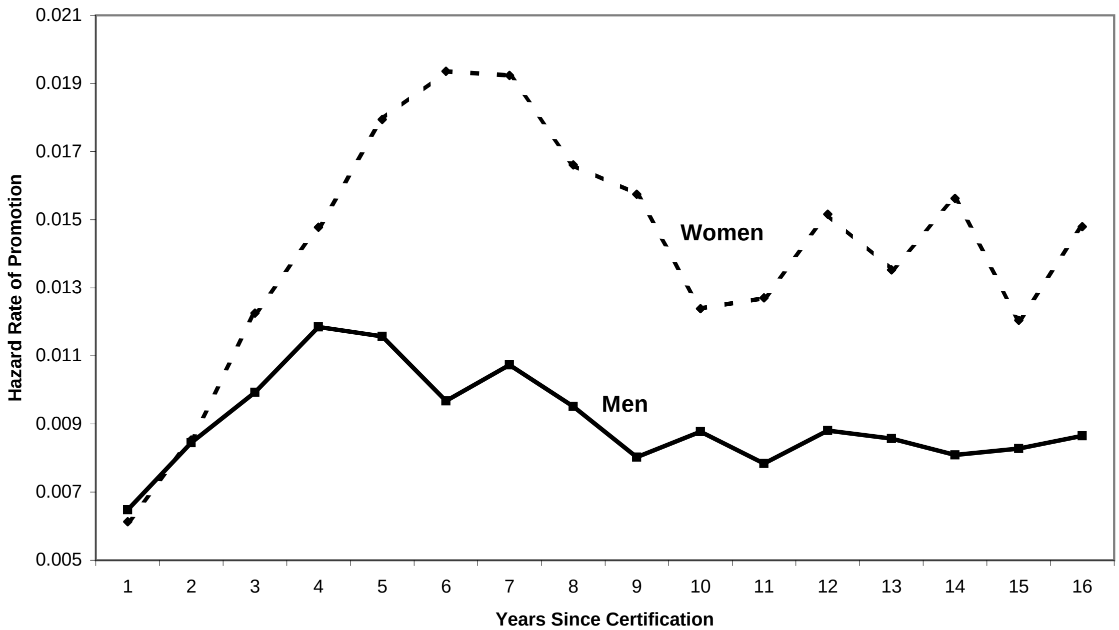

Fig. 1. Estimated Hazard Rate of Promotion to Principal, Evaluated for a White Individual with a Master's Degree

of promotion than men, with exception of the first few years after certification where the hazards are nearly the same. This is a finding not normally reached for gender differences in promotion rates. In fact, the hazard of promotion for women is double that for men for some periods across the analysis time. Figure 2 shows the estimated hazard rates for African American men and women with a master's degree. Men and women have similar hazard rates for the first four years with men having a slight advantage. After four years, the hazard rates for African American women are larger than for men. Figure 3 shows the hazard rates for Hispanic men and women with a master's degree. Hispanic women hold a definitive advantage over Hispanic men.

Another finding is that the shape of the hazard functions over time is similar for both men and women, regardless of race. The hazard increases sharply for the first few years after certification, peaks, and then declines. This may suggest that at first, it takes a few years for employees and schools to find a match, but after

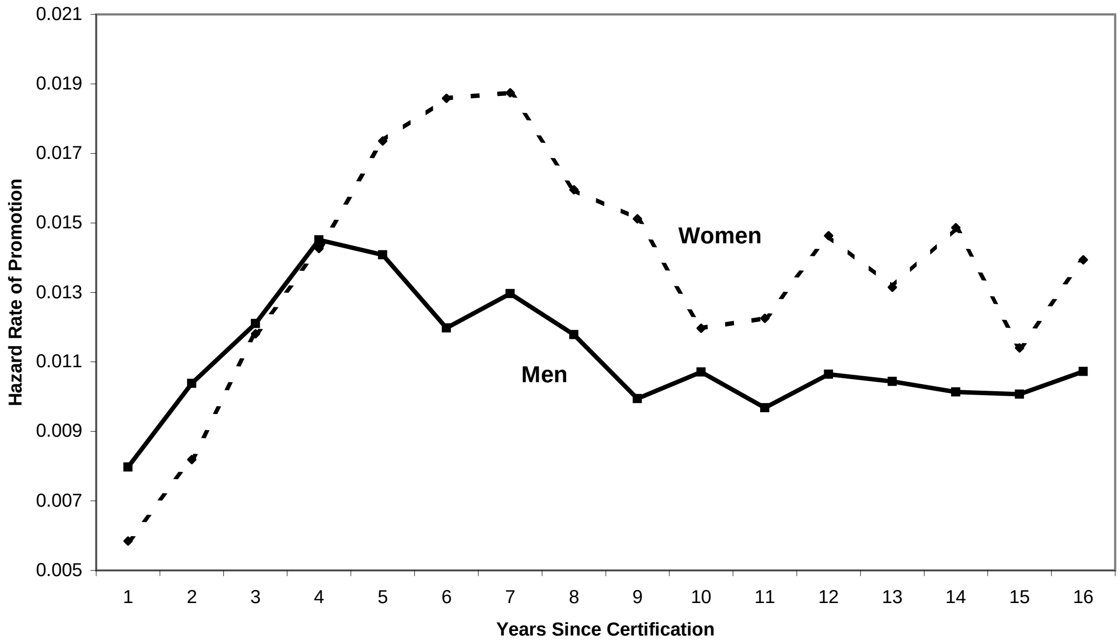

Fig. 2. Estimated Hazard Rate of Promotion to Principal, Evaluated for Black Men and Women with Master's Degrees

a few years has passed, the chances for those not yet promoted decrease. [9] The hazard function for men peaks earlier than for women, for whites, Hispanics, African Americans. In fact, Figure 1 suggests that for white men, the period of time at which promotion is most likely is about four years after certification. Men not yet promoted after four or five years face ever declining prospects. The hazard rates for African American and Hispanic men also peak at four years after certification. For women, however, promotion is most likely six or seven years after certification, after which rates sharply decline until ten years after certification where they remain relatively unchanged thereafter. This is true regardless of race.

[9]This may also help explain the finding that holding an advanced degree is correlated with slower promotion. Since it takes time to receive an advanced degree, especially a doctorate degree, and promotion occurs more often shortly after certification, holding a degree is negatively correlated with promotion. This does not suggest, however, a causal relationship where an advanced degree somehow hurts your chances of promotion.

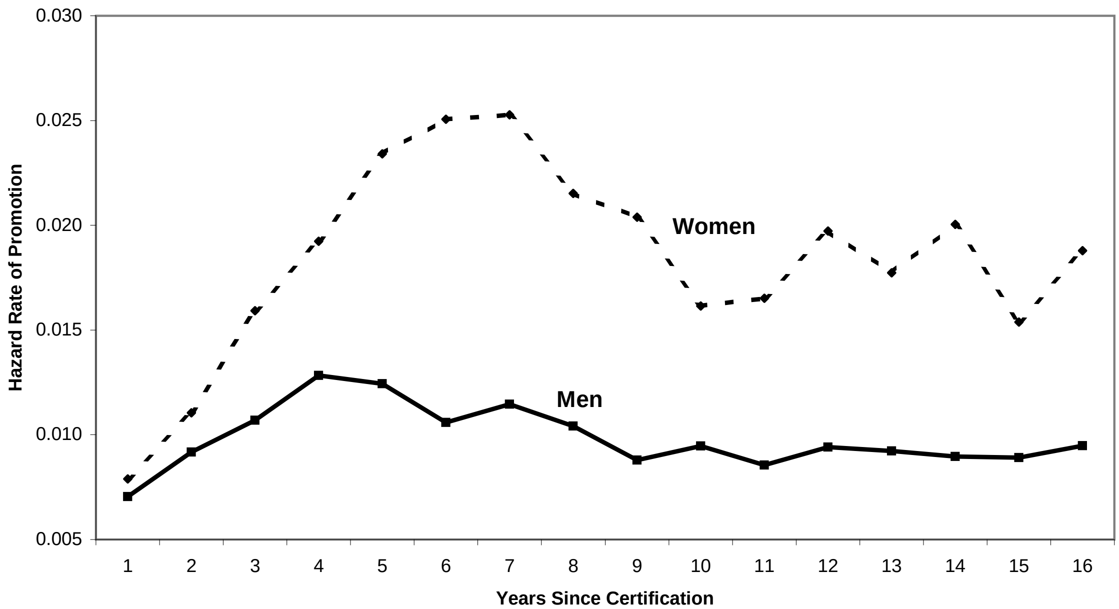

Fig. 3. Estimated Hazard Rate of Promotion to Principal, Evaluated for Hispanic Men and Women with Master's Degrees

D. The Hazard of Leaving Education

One explanation for the differences in promotion rates between men and women five or more years after certification shown in Figure 1 is that men begin to leave public education if not promoted whereas women stay and patiently take the principal jobs. This may especially be true in urban areas where there are more opportunities outside of education. I use the Cox proportional hazard model to examine the hazard of leaving Texas public schools separately for men and women in both urban and rural areas.[10]

[10]A competing risks model (CRM) with two events, leaving and promotion, was also considered. The CRM was not used because while the baseline hazard function is allowed to differ the effect of each covariate is assumed to be the same for both events. That assumption is unacceptable because leaving education before promotion and promotion to school principal are two opposing events. The effect of each covariate is more likely the opposite for each event. More experience is expected to lead to higher promotion rates but may lead to lower leave rates, for example. The CRM also assumes that once an event occurs, it is possible that the other event could

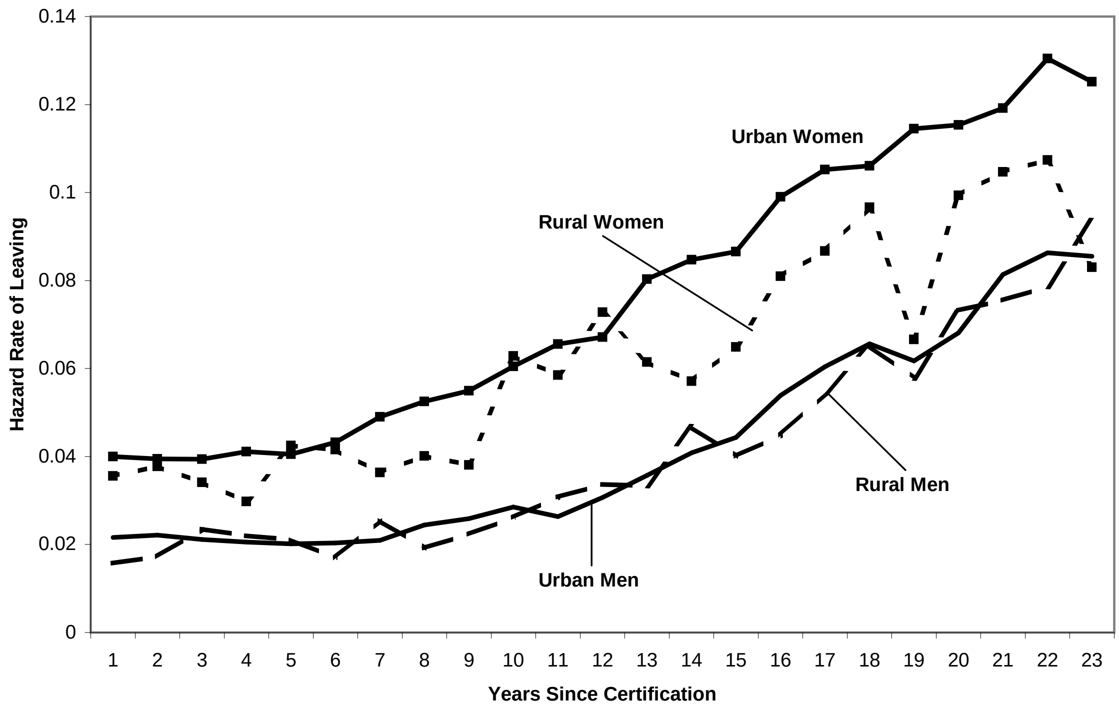

Fig. 4. Hazard of Leaving Texas Public Schools

I assume that if an individual is in the data one year and is not in the data the next year and doesn't reappear in the data for any subsequent year, that the individual has left Texas public schools.[11] If an individual leaves and reappears in the data, he or she is considered a multiple failure. This could occur, for example, if a woman leaves to have a child and then returns later, missing at least one full school year.

Four models are estimated and Figure 4 shows the estimated hazard functions

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occur afterward. This assumption is not defendable because once a person leaves Texas public schools before getting promoted he or she cannot be promoted to school principal. Also, once an individual is promoted to school principal, he or she cannot leave before getting promoted.

[11]Recall the data is not a survey, but rather included comprehensive personnel data.

for urban men, rural men, urban women, and rural women.[12] Like in Figure 1, Figure 4 shows the estimated hazard function evaluated for white individuals holding a master's degree.[13] Interestingly, men and women do appear to have different leave rates, regardless of urban or rural status. Women, however, have a higher hazard of leaving education before getting promoted than men. For both men and women, the hazard rates are nearly the same for individuals living in urban and rural areas. There is no sharp increase in the hazard of leaving four or five years after certification for either urban or rural men that might account for the decline in promotion rates found in Figure 1. Likewise, there is no sharp increase in the hazard of leaving for women seven years after certification to explain the decrease in promotion rates shown in Figure 1.

E. Conclusion

Over a ten year period from 1994 until 2004 the gender composition of teachers and principals in Texas public schools suggests that men are over-represented in the administrative ranks comprising 48% of the principals and only 22% of the teachers. The number of principals, however, declines over this period. In this study I analyze the promotion process for men and women to the position of school principal in Texas public schools.

Since specific training and certification is required to serve as a principal in Texas, I identify those individuals who desire advancement and are qualified for the job.

[12]Urban is defined as living in a metropolitan or micropolitan statistical area.

[13]Experience, the square of experience, indicators for a master's and doctorate degree, indicators variables for race and ethnicity, the number of open principal positions per 1,000 employees in the district, the number of certified individuals per 1,000 employees in the district, and an indicator equal to one if the individual is a principal are included as covariates in the Cox proportional hazard models.

Using a sample of employees from the state's personnel files that includes individuals certified as a principal, I show that there is no statistically significant difference in the probability of promotion between men and women over this time period. When using the full sample of employees, I find that men are more likely to be promoted but point out that this conclusion is misleading because the sample does not accurately reflect those at risk for promotion.

I further show using duration analysis that women in fact face a higher hazard of promotion to principal than men in Texas public schools. Men face their highest hazard of promotion four years after becoming certified. Women's hazard rates peak at six or seven years after certification. This result is consistent with Affirmative Action for women as well as the theory that men face more opportunities outside of education and are less committed to the education sector. Further analysis shows however that men do not leave Texas public schools more frequently than women. In fact, women are more likely to leave if they are not promoted.

Other conclusions have resulted from the empirical findings. African American men face a hazard rate of promotion 22.2% larger than their observationally equivalent white male counterparts. Also, Hispanic women face a hazard of promotion to school principal 23.2% larger than white women. These findings are also consistent with Affirmative Action but raises the question as to why African American women and Hispanic men are not also given preference.

CHAPTER III

OCCUPATIONAL REGULATION AND QUALITY

A. Introduction

This chapter examines the effect of restrictive licensing on the quality of the entrants into a profession. Theory suggests that requiring minimum competency standards truncates the low end of the quality distribution, however, increased costs of entry encourage talented potential entrants to pursue outside opportunities. Using the public school principal profession in Texas and measuring teacher quality by changes in student achievement, I find evidence that lower entry costs increase the quality of entrants. As a robustness check, I categorize observations geographically into control and treatment groups to ensure the estimated effect is a result of reduced entry costs and not unobserved factors.

By studying school principals, I am able to identify the potential entrants into the profession, i.e. teachers. Little consideration has been given to school principals. The ability and performance of school administrators is important to the success of our school children. Some suggest that although the quality of a teacher is difficult to measure, the principal knows who the good teachers are. (These are proponents of merit based pay for teachers.) Given that a principal's job in part entails the direction of the teachers, training principals to identify the talented teachers and use that information for better development of the students is essential to improving our public education.

In 1999 and 2000, the Texas legislature enacted changes in the requirements needed to become certified as a principal in Texas. These changes are two-fold. Lifetime certification was abolished and alternative certification routes were opened.

Before this change, the traditional route to becoming a principal was through academic training at a college or university level as well as obtaining substantial teaching experience. Now, less formal training is allowed and consideration of talent, ability, and relevant experience is taken in the certification process. These changes have relieved some of the barriers into school administration by introducing additional routes of obtaining the required certificates.

I provide a description of the certification system and detail the changes in the regulation in Texas. I also describe the differences between the traditional training programs and the alternative programs to understand selection into each in order to tease out answers to addressed questions. Using student test scores as a measure of quality, I find evidence that lower entry costs brought about by a certification regime change increase the quality of entrants into the principal profession. Two levels of student test scores are aggregated. First, I use campus level student test scores to measure the quality of individuals at each school. Then, I aggregate the scores by the grade level and the subject of the exam as well as the campus at which the students attend to measure the quality of the teachers. Test scores are also standardized in several different ways to compare across time. Results are robust to the measurement and standardization of the quality proxy, test scores.

With some concern about other unknown and unobserved factors that may have changed at or near the time certification costs changed, I exploit a quasi-natural experiment to further test the robustness of the results. Since the introduction of alternative training and certification programs constitutes the main argument for reduced entry costs, I divide rural schools into treatment and control groups based on geography. If a school is within 100 miles of a new alternative training facility, an individual working at that school is assumed to be treated by the regime change. Individuals working at a school that is more than 100 miles from a new alternative training facility compose the control group. Results agree with the other specifications. The reduction in certification costs brought about by the introduction of new alternative training programs increases the probability of entry by a high quality potential entrant.

B. Institutional Framework

A typical career path for a public school administrator in Texas involves, after teaching students in the classroom, several job titles with varying levels of authority. The first promotion from teacher to administration is to either a teacher supervisor, an instructional officer, or an educational diagnostician. The roles of these lower tier administrators include instructional decision making, program planning and assessment, supervision of small groups of personnel, and selection of appropriate curricula for individual special needs students. The next progression in one's career is advancement to assistant principal[1] and the final progression within the school is to principal. The principal's role in the school is to provide overall leadership and management of all aspects of the education process within a campus. The principal must oversee and facilitate the curricula and strategic plans that enhance teaching and learning, manage the staff, resources, and financial resources of the campus, and apply organizational, decision-making, and problem solving skills to ensure an effective learning environment. I focus on the decision to become a principal and consider potential entrants to be all individuals working in Texas public schools and not currently certified as a principal.[2] A teacher enters the profession when he or she becomes certified

[1]There is a separate certification that is required to serve as an assistant principal. Holding a principal certificate does allow you, however, to serve as an assistant principal.

[2]I do not include staff level employees such as teacher's aides, custodians, cafeteria workers, etc.

as a principal.

The State Board for Educator Certification (SBEC) facilitates and monitors the certification process. The SBEC was created to grant educators the authority to govern their own profession. The Board is comprised of 14 members; four members are teachers in public schools, two members are administrators, one school counselor, four citizens not employed in public schools, and three non-voting members consisting of a dean of education in Texas, a representative of the commissioner of education, and a representative of the commissioner of higher education. The SBEC regulates and oversees all aspects of certification in the state.[3]

In 1999 and 2000, significant changes to the certification process of principals were adopted in Texas. In the old certification regime[4], licensure was guaranteed for life. In the new regime however, certificates must be renewed every five years by participating in acceptable continuing education activities. The list of activities is broad and unspecific[5] and proof of completion is self reported[6]. Therefore, I assume the renewal requirements in the new certification regime impose little or no additional costs on the certificate holders.

[3]Kleiner (2000) points out that regulatory boards for licensed occupations generally control entry, enforce the standards of the practice, examine applicants' credentials, accredit schools and training facilities, and revoke a license when warranted. Regulatory boards usually consist of members of the trade.

[4]The old certification regime is the period before September 1, 1999 and the new certification regime is the period after September 1, 1999.

[5]The list of continuing education activities includes participation in institutes, workshops, seminars, conferences, in-service or staff development, completion of undergraduate courses, graduate courses, or training programs, participation in interactive distance learning, video conferences, or on-line activities, independent study, development of curriculum, development of continuing professional education training materials, serving as an assessor, teaching or presenting a continuing education activity, or providing professional guidance.

[6]The renewal process consists of a certified individual logging onto the SBEC website, following the appropriate links for certificate renewal, and checking a box attesting to having completed the required continuing professional activities. There is a fee of $20 for renewal.

The traditional training programs consisting of coursework and accumulated semester hours are no longer the only means for evaluating candidates for certification. Alternative training programs where preparation is based on the standards, knowledge, and skills demonstrated by the candidate are now allowed by the SBEC. The entity providing training determines how training is offered. However, the SBEC requires the entity to develop and implement criteria that allow an individual to substitute experience for part of the preparation program requirements.

All principals must have a master's degree. The traditional training programs always lead to a master's degree whereas the alternative programs may or may not.[7] If a teacher already holds a master's degree before entry into a principal certification program, he or she could pursue an alternative program which is cheaper, faster, and usually held at night.[8] If a potential principal does not hold a master's degree, alternative programs leading to the required degree cost nearly the same as a traditional program. The opportunity costs remain lower as alternative programs are designed to be more accessible and courses are usually held at night. I therefore assume the barrier costs to entry are reduced in the new certification regime.

Traditional university based programs have responded to the introduction of alternative programs. Texas A&M University began offering classes in the evenings in the late 1990's on a limited bases. Night classes began around 2001, thereby allowing teachers to remain in the classroom and become certified for school administration. Thus, the new certification regime brings lower opportunity costs in traditional routes

[7]Online programs are available through the University of Phoenix, Walden, and others. They are however quite expensive and lead only to graduate degrees and not to certification as a principal.

[8]The actual costs of a traditional certification programs are between $7,000 and $10,000 (based on 2005-2006 tuition rates) and require full-time enrollment in a two-year graduate program at a college or university. Alternative training programs costs approximately $4,000 and are completed after 18 months of evening and night classes.

as well.

C. Occupational Choice

Traditional models of occupational choice assume the expected starting salary solely influences the decision to enter training for that career. Zarkin (1985) develops a model that treats career training much like investment in long-lived physical capital. The forward looking model proves to be useful, at least in labor markets where future demand conditions are easily forecasted. Hanushek and Pace (1995) investigate the determinants of entering teacher training by combining data on individuals with state-wide variation in certification requirements and show that certification requirements do influence a person's decision to study education. They find that teacher salaries do not have as large an impact on one's decision to enter the education field as does certification requirements and a person's gender, race, and ethnicity also play an important role. Brewer (1996) studies the education profession while considering a worker's quit decision may be related to later career opportunities. Brewer illustrates that a teacher's decision to leave the sector is affected by the prospect and availability of administration positions and the earnings in those positions. Most importantly, Brewer finds that increases in the salary of administrators relative to teachers, in the number of new administrators relative to teachers (a measure of administrator turnover), and in the total number of administrators relative to teachers all reduce the probability that a teacher quits.

Teachers decide whether to acquire the additional training required to enter the administrative side of the education labor market. In fact, a teacher decides between two alternatives: remain a teacher (k=0), or enter administration training (k=1).[9]

[9] A teacher could also leave the education sector completely in search of outside

Assume teachers are risk-neutral and form rational expectations. Then, the expected lifetime utility from working in the classroom for individual i, employed by school district d, at time t is

$$U^c_{idt} \quad = \quad E_t\left[\sum_{t=1}^{T_i}\beta^t u_{idt}(w^c_{idt}, r^c_{idt})\right], \tag{3.1}$$

where u_{idt} is the utility from the monetary rewards, w^c_{idt}, and non-monetary rewards, r^c_{idt} , of teaching in the classroom. T_i is the expected number of years remaining until individual i retires. β is a discount factor ($0 < \beta < 1$), and E denotes the expectations operator.

The expected lifetime utility from working in school administration is

$$U^a_{idt} \quad = \quad E_t\left[\sum_{t=1}^{T_i}\beta^t u_{idt}(w^a_{idt}, r^a_{idt})\right], \tag{3.2}$$

where u_{idt} is the utility from the monetary rewards, w^a_{idt}, and non-monetary rewards, r^a_{idt}, of administration work.

In each period, a teacher makes the decision to remain in the classroom or to obtain certification and enter administration. Since promotion to principal is not guaranteed upon completion of the training and certification process, an individual's expected lifetime utility from entering the administration profession is

$$V_{idt} \quad = \quad \rho_{idt}U^a_{idt} + (1-\rho_{idt})U^c_{idt} \tag{3.3}$$

where ρ_{idt} is the probability individual i is promoted in school district d in year t, once certified.[10] Teachers compare the expected present value of lifetime utility from

opportunities. See the appendix for exit rates from Texas public schools. Teachers are most likely to leave the education sector within the first five years. The average experience, however, for an individual with a principal certificate is about 20 years. Therefore, the exit decision and the decision to obtain principal certification occur at different points in ones career.

[10] I assume that teachers once certified remain employed in the same school district.

the two career paths within education when deciding if they will enter into principal training. Let y^*_{idt} be the net gain from entering administration. Thus,

$$y^*_{idt} = (V_{idt} - C_t) - U^c_{idt}, \tag{3.4}$$

where C_t is the total cost, including opportunity cost, of attending a school principal training and certification program. Using equations (3.3) and (3.4),

$$y^*_{idt} = \rho_{idt}(U^a_{idt} - U^c_{idt}) - C_t \tag{3.5}$$

where $\rho_{idt}(U^a_{idt} - U^c_{idt})$ is the expected return of a principal certificate and C_t is the cost of obtaining the certificate.

Assume individual tastes and preferences, u_{idt}, are captured by a matrix of individual characteristics, X_{idt}, and a matrix of school district characteristics, Z_{dt}. Also, utility is additively separable in the following way:

$$U^c_{idt} \equiv U^c_{idt}(T_i, w^c_{idt}, X_{idt}, Z_{dt}) \approx \nu(w^c_{idt}) + r^c_{idt}(T_i, X_{idt}, Z_{dt}), \tag{3.6}$$

and

$$U^a_{idt} \equiv U^a_{idt}(T_i, w^a_{idt}, X_{idt}, Z_{dt}) \approx \nu(w^a_{idt}) + r^a_{idt}(T_i, X_{idt}, Z_{dt}). \tag{3.7}$$

Using equations (3.6) and (3.7), equation (3.5) becomes

$$y^*_{idt} = \rho_{dt}\left[\nu(w^a_{idt} - w^c_{idt}) + r^a_{idt}(T_i, X_{idt}, Z_{dt}) - r^c_{idt}(T_i, X_{idt}, Z_{dt})\right] - C_t, \tag{3.8}$$

where $\nu(w^a_{idt} - w^c_{idt})$ is the utility gained from an increase in earnings associated with

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Evidence shows that as much as 85% of teachers who obtain a principal certificate remain in the school district in which they taught. See the appendix for a detailed description of post-certification mobility rates.

a promotion from teacher to principal. The increase or decrease in non-wage rewards associated with a position in administration relative to teaching is $[r^a_{idt} - r^c_{idt}]$.

A certified individual i is chosen for promotion in district d in year t based on the available administration openings in the district as well as observable characteristics of the individual. The number of available positions in a district at a given time depends on administrator turnover. Let N_{dt} be the number of new or otherwise open principal jobs in school district d in year t. The likelihood of promotion once certified depends also on the number of *competitors* in the market, i.e. the number of others in the district that are certified for as a principal, yet have not been promoted. Denote M_{dt} as that sum. It follows then that

$$\rho_{idt} = \rho(N_{dt}, M_{dt}, X_{idt}, Z_{dt}). \qquad (3.9)$$

Using equations (3.8) and (3.9), assume the reduced form equation for the net gain of a principal certificate is

$$y^*_{idt} = h(C_t, \rho(N_{dt}, M_{dt}, X_{idt}, Z_{dt}), \nu(w^a_{idt} - w^c_{idt}), X_{idt}, Z_{dt}) + \varepsilon_{idt} \qquad (3.10)$$

where ε_{idt} are assumed to follow a normal distribution. In order to estimate equation (3.10), in addition to data on certification costs, individual characteristics, and district characteristics, I need an estimate for each individual, district, and time period for the probability of promotion, $\rho(N_{dt}, M_{dt}, X_{idt}, Z_{dt})$, and the wage premium, $\nu(w^a_{idt} - w^c_{idt})$.

D. Data

This study utilizes a rich set of data that is collected by the Texas Education Agency (TEA) through their Public Education Information Management System (PEIMS). The TEA is the statewide administrative unit that guides and oversees primary and

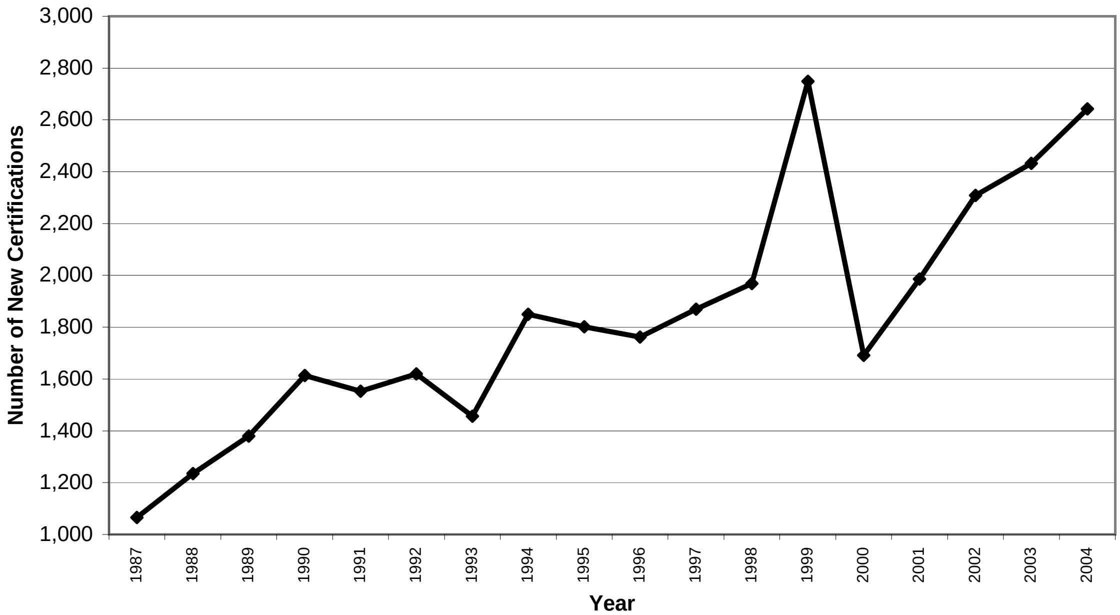

Fig. 5. Number of New Certificates Each Year, Mid-Management and Principal Certificates

secondary public education in Texas. Data is collected on public school system personnel salaries, demographics, education, gender, and other individual characteristics. Campus and district enrollment and student test scores are also available. In addition, certificate information is provided by the SBEC. This data describes each certificate held, when the certificate was acquired, the type of certificate, and the institution that granted the certificate to each public school employee in the state. Focus is placed on the certificate required to serve as school principal.

1. Descriptive Statistics

Figure 5 shows the total number of new principal certificates over time from the SBEC certificate data. There is a spike in the number of new certificates just before the new regime and a corresponding drop the following year. Likely, those individuals planning to attend a training program entered earlier in anticipation of lifetime certification

Table 8. Descriptive Statistics by Certification Status

Variable	Certified	Not Certified	T-stat
Experience	20.1	11.4	478.7
Male	42.3%	22.6%	194.3
Hispanic	19.0%	19.2%	-2.1
African American	12.7%	9.2%	50.9
Asian American	0.2%	0.7%	-37.8
Native American	0.3%	0.3%	6.6
Bachelors	8.6%	65.4%	-905.8
Masters	85.9%	24.2%	836.2
Doctorate	4.9%	0.5%	100.8
N	250,988	2,926,787	

Notes: The first column of the table shows the mean values of the variables for principal certificate holders, regardless of their job title. The second column shows the same statistics for teachers, counselors, assistant principals, athletic directors, teacher supervisors, and educational diagnostician who are not certified to work as a principal in Texas. The third column gives the t-statistic for the difference between the two means. Data reflects school years 1994-1995 through 2003-2004.

abolishment. In the years to follow, the flow of new principals adjusts and a gradual upward trend continues. This shows a reaction to the legislation, however, nothing about the quality of the newly certified is revealed.

Table 8 compares the characteristics of entrants and those who have not entered the principal profession. The first column, labeled *Certified*, summarizes the characteristics of those who hold a principal certificate. In contrast, the second column, titled *Not Certified*, shows those not certified as a school principal. Notice certified individuals have more experience than those who are not certified. The average experience for certified and non-certified employees is 20.1 and 11.4 years, respectively.

The fraction of males in administration (42.3%) is much larger than the fraction not in administration (22.6%) over the observed time period. African Americans represent 12.7% of those certified and 9.2% of those not. Hispanics are not under-represented in administration, representing about 19% of those certified and those not certified as a school principal. The difference in educational attainment between those certified and those not is unsurprising. Principal certificate holders are more likely to have a master's degree or doctorate and less likely to hold only a bachelor's degree at the time of certification.[11]

The new legislative regime introduced alternative training programs. Table 9 shows the number of new certificates issued in the two relevant certification regimes by the type of program attended. In the old certification regime (from school year 1994-1995) 9,661 new principals were certified. In the new certification regime (from school year 1999-2000 until 2003-2004) both traditional training programs and alternative programs were available. In this regime 10,409 individuals were certified using the traditional route and 647 were certified after attending an alternative training program.[12] Notice that the number of individuals attending traditional programs doesn't decrease after alternative programs were introduced. Instead attendance of

[11]In fact, individuals receive a master's degree at the time of certification. Table 8 shows 8.6% of those who are certified have only a bachelor's degree. Two things are causing this statistic. One, there are individuals in the data who were certified as a principal in the 1960's and 1970's when a master's degree was not required. Also, there are observations where the current year and the year of certification are the same. There are clearly timing issues with these observations regarding the master's degree. Either the degree was issued later than the certification or more likely, information about the individual's degree was not updated in the PEIMS data until the next school year.

[12]There are 30 alternative training programs in the data. All of these programs began issuing certificates in 2000 and 2001. The only exception if 21st Century Leadership which first appears in the data issuing a certificate in 2004. Only one individual, however, has been certified by this program. Thus, all of these programs opened just after the regime change.

Table 9. Type of Certificate

Year	Traditional	Alternative	Share
Old Certification Regime			
1995	1,753	—	—
1996	1,682	—	—
1997	1,797	—	—
1998	1,845	—	—
1999	2,592	—	—
New Certification Regime			
2000	1,565	85	5.2%
2001	1,819	96	5.0%
2002	2,124	138	6.1%
2003	2,194	160	6.8%
2004	2,405	161	6.3%

Notes: This table shows the number of new principal certificates issued in each certification regime by the type of program attended. Traditional refers to the standard university or college based principal training program whereas Alternative programs are more flexible and often require less time for completion. The share illustrated in the third row is the fraction of all certifications that are generated from an alternative training program.

both types of programs increases in the new certification regime.

2. Estimating the Wage Premium

In order to estimate equation (3.10), I need to first estimate the wage premium each individual faces. Earnings are observed in the PEIMS data. For principals, w^a, and for teachers, classroom earnings, w^c, are easily identified in the data. The wage premium, $WP \equiv (w^a - w^c)$, affects an individual's decision to enter the principal market. Since w^a is not observed for teachers and w^c is not observed for principals, I estimate the wage premium for each individual in each school district over time using a switching regressions framework.

Let w be an individual's wage and let A indicate whether the individual is an administrator or a teacher.[13] An individual's wage can be expressed as

$$w = (1 - A)w^c + Aw^a = w^c + (w^a - w^c)A. \tag{3.11}$$

The variable of interest is the wage premium, WP, and is a random variable that is specific to each individual. If each individual were randomly assigned a position within the school district to either teacher or administrator, then the wage premium is simply $WP = E(w^a - w^c)$. However, promotion to administrator is not random. So, assuming that promotion is based on observed characteristics, X, the conditional wage premiums are of interest, $WP = E(w^a - w^c \mid X)$.

It is useful at this point to decompose the outcomes into mean and stochastic parts,

$$w^a = \mu^a + \eta^a, \quad where \;\; E(\eta^a) = 0, \tag{3.12}$$

[13] A is an indicator variable equal to 1 if the individual is a principal and equal to zero if a teacher.

and

$$w^c = \mu^c + \eta^c, \quad where \;\; E(\eta^c) = 0, \tag{3.13}$$

which gives the switching regressions model,

$$w = \mu^c + (\mu^a - \mu^c)A + \eta^c + A(\eta^a - \eta^c), \tag{3.14}$$

and thus

$$E(w \mid A, X) = \mu^c + \alpha A + g_c(X) + A[g_a(X) - g_c(X)], \tag{3.15}$$

where $\alpha = WP(X)$, $g_a(X) = E(\eta^a \mid X)$, and $g_c(X) = E(\eta^c \mid X)$. The wage therefore can be modeled using a function of A, X, and the interaction of A and X. Assuming g_c and g_a are linear in the parameters,

$$E(w \mid A, X) = \mu^c + \alpha A + X\beta + A[X - E(X)]\delta, \tag{3.16}$$

where β and δ are vectors of unknown parameters.[14] Using a regression of an individual's wage on a constant, an indicator for principal, A_{idt}, a set of individual characteristics used in determining promotion, X_{idt}, and the interaction between the two, $A_{idt}(X_{idt} - \overline{X})$ I estimate the wage premium as $\hat{\alpha}$, the coefficient on A_{idt}. I calculate the wage premium for different groups using the characteristics, X, and therefore the wage premium that individual i employed in school district d at time t faces is

$$W\widehat{P(X_{idt}})= \hat{\alpha} + (X_{idt} - \overline{X})\hat{\delta}. \tag{3.17}$$

Using equation (3.17), I impute the wage premium that each individual faces within their own school district, given their characteristics. I calculate the wage

[14]Subtracting E(X) ensures that α, the coefficient on A, is the average treatment effect on earnings, or here, the wage premium, WP. See Wooldridge (2002).

premium using differences in the natural log of annual earnings for each individual. Thus, the imputed wage premium is measured as the log of the ratio of administrator earnings to classroom earnings. The average wage premium in Texas, $\widehat{\alpha}$, is 1.52, suggesting that in Texas principals earn 52% more than teachers on average. The wage premium increases if an individual obtains a higher degree or is older. Men face a higher wage premium than women. 64.9% of the variation in earnings is explained by the model.

3. Estimating the Probability of Promotion

Someone considering principal training who believes it highly probable he or she will be promoted to principal after obtaining the certificate is more likely to enter than someone who believes promotion will never be realized. To that end, I impute a measure of the expected probability of promotion after certification. Promotion within a school district not only depends on the need for new administrators due to turnover or expansion, but also individual characteristics. For example, a teacher with a graduate degree is more attractive than one without. Also, men may be more or less likely to get promoted than women. A person's experience, I propose, is related to probability of promotion. Near the beginning of one's career, promotion is unlikely. With more experience an individual becomes more likely to get promoted. Yet, near the end of a career, promotion remains unlikely because of a shorter expected time until retirement.

Using the subset of observations that are certified as a principal, I estimate a probit model of the probability of promotion once certified on the number of open positions in the school district, the number of available certified individuals[15] in the

[15] Those who are certified as a principal, but not currently employed as a principal.

Table 10. Predicted Probability of Promotion

Variable	Prob. of Promotion
All Employees	
Average	14.3%
Minimum	3.5%
Maximum	66.5%
Certified Employees	
Average	21.4%
Minimum	3.5%
Maximum	66.5%

Notes: The table shows statistics on the predicted probability of promotion to school principal. Data covers school years 1994-1995 through 2003-2004 in Texas.

school district, and individual characteristics. I predict, for all observations regardless of certification status, the probability of promotion for each individual to use as a measure of the expected probability of promotion if the individual becomes certified. The assumption is that someone who is deciding whether or not they should incur the costs associated with obtaining a principal certificate will consider how likely it is they will get promoted to principal once they are certified. They will look at those around them who are certified to estimate the likelihood of promotion. Therefore, I impute the probability of promotion based on the individuals who are certified only. I then use the estimated model to predict the expected probability of promotion for all individuals in the data to capture their perception of the likelihood of promotion. Results of the estimated probability of promotion model can be found in the appendix. Table 10 shows the average predicted probability of promotion if certified is 14.3%. The lowest predicted probability of promotion and the highest are 3.5% and

66.5%, respectively. For those who are certified, the average predicted probability of promotion is 21.4%.

4. Teacher Quality

I measure teacher quality using changes in student achievement. First, teachers are matched to student scores on the Texas Assessment of Academic Skills (TAAS) at the campus level.[16] Matching a teacher to the student in his or her class is optimal. However, this data does not provide that link. Each student is first matched to the school that he or she attended and in turn, each teacher is matched to the average of the student scores at the school where he or she taught.

Test scores are available for fourth through eight grades and tenth grade. Two exams, one measuring reading skills and one for math, are given to the students. Although most of the data used in the analysis covers school years from 1994-1995 through 2003-2004, student scores are only available from 1995-1996 through 2001-2002. This could constrain identification of a certification regime effect on the entry decisions of future principals.

Since the tests themselves can vary over time, I standardize the scores. Following Kirby et al. (2002), I first rank the schools' average student scores for each year. Next, I compute the percentiles of distribution of ranks by dividing each rank by

[16]The students' Texas Learning Index, or TLI, score on the TAAS is used. The TLI is a score that describes how far a student's performance is above or below the passing standard. The passing standard, for example, for Grades 3 through 8 is a TLI of 70. The TLI is not the percentage of questions correctly answered. A student may have answered all questions correctly on both the math and reading tests for 5th grade, for example, and receive a TLI score of 93 on the math exam and 100 on the reading exam. The TLI is therefore comparable across grade levels. If a student scores that same for two consecutive grade levels, then he or she has made typical progress from the one grade level to the other. If the student's score increased, then he or she progressed more than the typical student. If the student's score decreased, then he or she did not achieve the typical one year's learning progress.

the total number of schools. Finally, I standardize the percentiles for each school by computing z-scores. Changes in the rank based z-score from one school year to the following school year are linked to teachers. These rank based z-scores have a nice property. A teacher who increases low performing students' scores a distance of y, has a higher z-score than a teacher who takes average students the same distance. Also, a teacher who improves a high performing group of students' scores y units has a higher z-score than a teacher who increases average students' scores by y.

The second level of teacher to students matching is at the grade and subject level. Using information on the subject that each teacher taught combined with the different subjects and grade levels for TAAS exams, I link teachers more closely to the students they taught.[17] I again use changes in rank based z-scores but I also consider the percentile rank and the traditional z-score for robustness.

E. Estimation and Results

To examine the effect of certification requirements on an individual's decision to enter the principal profession, I estimate equation (3.10).[18] To capture the reduction

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[17]Using the service description for each individual, a grade level and a subject is assigned for 4th through 8th grade reading and math teachers. Teachers could service more than one subject-grade group in a given school year thus the fraction of their time spent servicing each group is considered. To calculate student performance measures for each subject-grade group, campus level math and reading TAAS scores are matched to teachers' service groups. The result is a teacher to student match at the campus, grade, and subject level. For example, a sixth grade math teacher is linked to the average of all sixth grade students' scores on the sixth grade math TAAS exam in that school. This matching is likely better for middle school teachers than elementary teachers as students at those campuses meet with several teachers each day for different subjects instead of seeing only one teacher all day.

[18]Murphy and Topel (1985) point out that imputed unobserved regressors from auxiliary econometric models fail to account for the fact that the imputed regressors are measured with sampling error. Thus, hypothesis tests based on the estimated covariance matrix for this regression equation are biased. However, Murphy-Topel estimates of the standard errors for each probit model can be found in the appendix. No conclusions are altered using the Murphy-Topel standard errors.

Table 11. Principal Entry and Education, Models 1 and 2

Variable	Model 1 Estimate	Model 1 St. Error	Model 2 Estimate	Model 2 St. Error
New Regime	0.036***	0.001	0.035***	0.001
Bachelors Degree	0.028***	0.001	0.037***	0.001
[Bach.]*[New Regime]	-0.025***	0.001	-0.024***	0.001
Masters Degree	0.255***	0.006	0.420***	0.007
[Mast.]*[New Regime]	-0.021***	0.001	-0.020***	0.001
Doctorate	0.648***	0.011	0.901***	0.005
[Doc.]*[New Regime]	-0.019***	0.000	-0.018***	0.000
Male	0.019***	0.000	0.036***	0.001
Experience	-0.002***	0.000	-0.001***	0.000
Wage Premium	0.009***	0.003	0.177***	0.004
Prob. of Promotion	1.462***	0.006	1.642***	0.008
Ethnicity Controls	No		Yes	
Year Dummies	Yes		Yes	
Bachelors Degree	100.0%		99.0%	
Masters Degree	6.4%		6.4%	
Doctorate	3.8%		3.9%	

Notes: The top panel in the table shows estimated marginal effects from probit regressions where the dependant variable is the probability of entering the principal profession. Data covers school years 1994-1995 through 2003-2004 in Texas. *NewRegime* is an indicator variable equal to 1 after new alternative certification was introduced. Education measures are indicator variables for the highest degree attained. *Experience* is the total number of years experience in public education in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. The lower panel in the table shows the conditional effects of the certification regime change on the probability of entering the principal profession for those with different education levels expressed as a percentage change. The average probability of entry for holders of a bachelors degree, masters degree, and doctorate are 0.011, 0.233, and 0.442, respectively.

Table 12. Principal Entry and Education, Models 3 and 4

Variable	Model 3 Estimate	Model 3 St. Error	Model 4 Estimate	Model 4 St. Error
New Regime	0.035***	0.001	0.034***	0.001
Bachelors Degree	0.024***	0.001	0.031***	0.001
[Bach.]*[New Regime]	-0.024***	0.001	-0.023***	0.001
Masters Degree	0.313***	0.006	0.449***	0.007
[Mast.]*[New Regime]	-0.020***	0.001	-0.019***	0.000
Doctorate	0.824***	0.007	0.945***	0.003
[Doc.]*[New Regime]	-0.018***	0.000	-0.016***	0.000
Male	0.035***	0.000	0.049***	0.000
Exp. 6-10	0.027***	0.000	0.034***	0.001
Exp. 11-15	0.020***	0.001	0.033***	0.001
Exp. 16-20	0.010***	0.001	0.025***	0.001
Exp. 20+	-0.005***	0.000	0.008***	0.001
Wage Premium	0.160***	0.002	0.266***	0.002
Prob. of Promotion	1.356***	0.007	1.518***	0.008
Ethnicity Controls	No		Yes	
Year Dummies	Yes		Yes	
Bachelors Degree	100.5%		99.2%	
Masters Degree	6.6%		6.5%	
Doctorate	4.0%		3.9%	

Notes: See notes Table 11. $Exp.6-10$ is an indicator variable equal to 1 if the individual has between 6 and 10 years of experience. $Exp.11-15$ is an indicator variable equal to 1 if an individual has between 11 and 15 years of experience. $Exp.16-20$ is an indicator variable equal to 1 if an individual has between 16 and 20 years of experience. $Exp.20+$ is an indicator variable equal to one if an individual has more than 20 years of experience. Beginning teachers with 5 or fewer years of education is the omitted comparison group.

in certification costs resulting from the legislation change in Texas, I construct an indicator, $NewRegime$, equal to one in periods where the new certification regime is in effect.[19]

Tables 11 and 12 show results of estimating the model using educational attainment as a proxy for individual quality. Measures of education are interacted with the regime change indicator variable to allow the effect of quality on the teacher's decision to enter administration to differ between the two certification regimes. Model 1 controls also for the individual's sex, experience, expected increase in earnings after hired as a principal (wage premium), probability of promotion, and school year. Teachers with a bachelor's degree are 2.5 percentage points more likely to enter the principal profession in the new regime. Since entry by a teacher with only a bachelors degree is not highly probable, this represents a 100.0% increase in entry by this group. Teachers with a master's degree are 6.4% more likely to train to be a principal after the costs are reduced. For those with a doctorate, the regime change increases entry by 3.8%. The reduction in entry costs had a larger effect on those with less education. The estimation also shows that men are 1.9 percentage points more likely to enter administration than females. This is a large difference as the estimated probability that the average teacher enters administration is less than nine percent. More experienced teachers are somewhat less likely to become principals according to the results from estimating Model 1. This is an unexpected result that may change with more flexible model specifications.

Models 2, 3, and 4 include controls for different variables that may influence a teacher's decision to become a principal. Model 2 introduces controls for ethnicity.

[19]Although I assume that the new certification requirements represent lower costs of entry, one may also view this analysis as the effect of a change in legislation. Conclusions could then be framed as effects of the legislation change instead of responses to reduced entry costs.

Though magnitudes of the estimated effects change by a small amount, conclusions remain mainly the same. Teacher's with a bachelor's degree, master's degree, and doctorate are 99.0%, 6.4%, and 3.9% more likely to enter school administration after the certification costs are reduced through legislation, respectively. Models 3 and 4 allow for discontinuities in the effect of experience on principal entry. Experience groups are constructed for teachers with 6 to 10 years of experience, 11 to 15 years of experience, 16 to 20 years of experience, and more than 20 years of experience. Beginning teachers with 5 or fewer years of experience are the comparison group. Results generally show that more experienced teachers are more likely to enter. However, the size of this effect decreases with more experience. In fact, Model 1 predicts that teachers with more than 20 years of experience are less likely to enter the principal profession than teachers with 5 or fewer years of experience. This is not unexpected. Those with more than 20 years of experience are closer to retirement and have less time to recoup the costs of obtaining the principal certificate.

Like Models 1 and 2, Models 3 and 4 produce similar effects for each education level. Model 3 estimates that teachers with a bachelor's degree, master's degree, and doctorate are 100.5%, 6.6%, and 4.0% more likely to enter when costs are reduced, respectively. Model 4 finds that those with a bachelor's degree, master's degree, and doctorate are 99.2%, 6.5%, and 3.9% more likely to enter under the new regime, respectively. All are conclusions that suggest reducing the costs of entry have attracted those with less education.

Each of the four models presented have similar conclusions about the effect of the expected wage premium and probability of promotion. With the exception of Model 1, the models show that a 1% increase in the wage premium an individual faces leads to a 16.0 to 26.6 percentage point increase in the probability of entering administration. Also, the expected probability of promotion has a large effect on entry. A teacher in the top of the distribution who believes he or she has a 50% chance of promotion if certified is 65.7% more likely to attain certification than a teacher in the bottom of the distribution who believes he or she has only a 10% chance of promotion.[20]

Using the change in student test scores as a proxy for teacher quality, Tables 13 and 14 shows a selected portion of the estimation results for twelve test score measures.[21] The change in average TAAS scores are included in the model and interacted with the indicator for the *NewRegime*. Assuming a teacher associated with higher student test score improvements is a teacher of higher quality, a positive estimated marginal effect for the interaction term between *TestScore* and *NewRegime* suggests that reducing entry costs attracts high quality teachers to the principal profession more so than low quality teachers. A negative estimated effect would suggest the opposite.

Estimating the entry model using each grade level and subject test separately yields evidence supporting increased high quality teacher entry. Most estimations result in a positive estimated coefficient on the interaction term between the change in the test score and the regime change indicator and many are statistically significant. The only exceptions are the results of the regressions using tenth grade scores where the estimated quality effect of the certification regime change is negative and significant in one of the two regressions.

The lower grades, forth, fifth, and sixth, show much stronger results than the higher grades. Teachers are matched to all the students in the school for these regressions, regardless of the subject or grade level they teach. This creates some measurement error in the quality measure, the change in test scores, however, it is

[20]Statement uses the estimate results of Model 2 in Table 11.

[21]Reading and math scores for six different grade-levels are used. One each for forth grade, fifth grade, sixth grade, seventh grade, eighth grade, and tenth grade.

Table 13. Principal Entry and Student Test Scores, Grades 4, 5, 6, and 7

Variable	4th Grade Math	4th Grade Read	5th Grade Math	5th Grade Read
New Regime	0.0010***	0.0016***	0.0016***	0.0016***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Δ Score	-0.0005***	-0.0004***	-0.0003**	-0.0004***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
[Δ Score]*[New Regime]	0.0011***	0.0012***	0.0009***	0.0009***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)

	6th Grade Math	6th Grade Read	7th Grade Math	7th Grade Read
New Regime	0.0002	0.0002	0.0016***	0.0004
	(0.0004)	(0.0004)	(0.0005)	(0.0004)
Δ Score	-0.0005**	-0.0004	0.0002	-0.0002
	(0.0002)	(0.0002)	(0.0003)	(0.0003)
[Δ Score]*[New Regime]	0.0019***	0.0011***	0.0000	0.0005
	(0.0004)	(0.0004)	(0.0005)	(0.0005)

Notes: The table shows estimated marginal effects of probit regressions where the dependant variable is the probability of entering the principal profession. Regressions include controls for gender, education, experience, wage premium, the probability of promotion, and trends over time. Test scores are standardized using the rank based z-score method. Standard errors are shown in (·). An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Data covers school years 1995-1996 through 2001-2002 in Texas.

Table 14. Principal Entry and Student Test Scores, Grades 8 and 10

	8th Grade		10th Grade	
	Math	Read	Math	Read
New Regime	0.0016***	0.0004	0.0001	0.0026***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Δ Score	-0.0001	-0.0001	0.0009***	0.0004
	(0.0003)	(0.0003)	(0.0003)	(0.0004)
[Δ Score]*[New Regime]	0.0009*	0.0001	-0.0011**	-0.0001
	(0.0005)	(0.0005)	(0.0005)	(0.0005)

Notes: The table shows estimated marginal effects of probit regressions where the dependant variable is the probability of entering the principal profession. Regressions include controls for gender, education, experience, wage premium, the probability of promotion, and trends over time. Test scores are standardized using the rank based z-score method. Standard errors are shown in (·). An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Data covers school years 1995-1996 through 2001-2002 in Texas.

likely to effect elementary school teachers less than middle and high school teachers. Students tend to stay with the same teacher all day in the lower grades and thus are taught all or most subjects by the same teacher. In the higher grades students see several teachers throughout the day, each specializing in a subject.

Using a description of the tasks each teacher completes throughout the day as well as the amount of time they spent on each task, I match students more closely to the teacher who taught them each subject. I aggregate test scores by the grade level and the subject of the exam as well as the campus at which the students attend to measure the quality of the teachers.[22] The amount of time a teacher spends each day

[22]This method requires a teacher to teach either math or reading/english to be included in the sample. Thus, the number of teachers included using this method is much smaller than the number of teachers included in the sample when matching test scores at the campus level. In fact, matching test scores at the campus level allows the inclusion of 312,492 individuals on average per school year into the regressions,

on each task is used to weight the aggregated scores.[23] In addition, since all of the scores are on the same scale[24], I estimate a model using all of the teachers and all of the student scores simultaneously. The results of those estimations are presented in Table 15. There is evidence that lower quality teachers were more likely to enter the principal profession before the certification regime change, yet after the regime change the probability that a high quality teacher enters the principal profession increases. The conclusions are robust to the way in which the students' test scores are standardized.

F. A Robustness Check Using a Natural Experiment

One concern is that other unobserved factors that also changed at or near the time the certification costs changed is affecting the results. If so, the estimated effects from the previous section are falsely associated with changes in the certification costs. A natural experiment framework will help to eliminate these concerns.

Since the root of the reduced costs come from the introduction of new alternative training programs for principals, examination of where those programs opened and who was and was not affected by this treatment will aid in the understanding of this problem. One of the advantages of alternative training programs is the ability for a trainee to remain employed and attend classes at night. This is however not possible if the individual is too far from the training facility to commute on a daily basis. Therefore, I presume those individuals who are close enough to drive to a training

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whereas matching test scores to teachers at the campus, grade, and subject level results in 24,383 individuals included per school year.

[23]Teachers who taught 6th grade math half of the time and 7th grade math the other half are assigned a weighted average of the 6th and 7th grade math scores, for example.

[24]Scores are standardized in three ways: z-scores, percentiles, and rank based z-scores. See section IV.4 for more details.

Table 15. Principal Entry, Teachers-Students Matched by Campus, Grade & Subject

Variable	Estimate	St. Error
STANDARDIZED SCORE		
New Regime	-0.0001	0.0005
Δ Score	-0.0006**	0.0003
[Δ Score]*[New Regime]	0.0015***	0.0005
PERCENTILE		
New Regime	-0.0001	0.0005
Δ Score	-0.0019**	0.0010
[Δ Score]*[New Regime]	0.0040***	0.0015
RANK BASED Z-SCORE		
New Regime	-0.0001	0.0005
Δ Score	-0.0006**	0.0003
[Δ Score]*[New Regime]	0.0013***	0.0005

Notes: The table shows estimated marginal effects of probit regressions where the dependant variable is the probability of entering the principal profession. Regressions include controls for gender, education, experience, wage premium, the probability of promotion, and trends over time. Standard errors are shown in (·). An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Data covers school years 1995-1996 through 2001-2002 in Texas.

facility are 'treated' by the reduced costs and those too far to commute are considered the 'control' group. Individuals who were 100 miles away from an alternative training program are included in the control group. Those who were within 100 miles from an alternative training facility are assumed to be within a reasonable driving distance. Since the control group includes only individuals in non-urban[25] areas, the treatment group is also constrained to non-urban school districts.

The observations classified as treatment and control are not greatly different. Table 16 illustrates. In the treatment group, 2.9% are certified as a principal while 2.4% are certified in the control group. On average, those in the treatment group faced 0.6 open positions in any given year. Some observed no open principal positions while others observed as many as 6 open positions in their school district at any given time. The control group faced similar employment prospects. At any given time, an observation in the control group observed 0.5 open principal positions on average. The minimum number of open positions in a district at any given time in the control group is 0 while the maximum is 5 open principal jobs. In each group approximately 13% of the observations are male. The average experience in each group is nearly the same. Individuals in the treatment group have 12.4 years of experience while those in the control group have 13.4 years. Educational attainment between the two groups in nearly the same as well with the treatment group having a slightly more educated population. The only notable difference between the treatment and control groups is the number of observations. The treatment group has nearly 4 times as many observations as the control group with 20,357 instead of just 5,219.

Table 17 illustrates selected results of estimating equation (3.10) for the treat-

[25]An urban area is a core based statistical area defined by the U.S. Office of Management and Budget. This included both metropolitan areas consisting of a core of 50,000 people or more and micropolitan areas consisting of a core of 10,000 people ore more.

Table 16. Sample Statistics, Treatment and Control Groups

	Treatment	Control
Number of Observations	20,339	5,210
Certified as Principal	2.9%	2.4%
Number of Open Positions		
Average	.6	.5
Minimum	0	0
Maximum	6	5
Male	13.3%	13.1%
Experience	12.4	13.4
Bachelor's Degree	80.6%	84.5%
Master's Degree	18.6%	15.0%
Doctorate Degree	0.1%	0.0%

Notes: The table shows the sample statistics of treatment and control groups. Individuals in the Treatment group consist of those individuals who work at a non-urban school within 100 miles from an alternative training facility. The Control group consists of employees at non-urban schools located more than 100 miles from an alternative training program. Data covers school years 1995-1996 through 2001-2002 in Texas.

ment and control group separately. The results show that for the control group, those too far from an alternative training facility to commute, the change in the certification regime had no statistically significant effect. For those who were close enough to commute to an alternative training program, the lower entry costs increases the probability of entry by higher quality teachers, the same conclusion reached in the previous section. Again, conclusions are robust to the way in which the students' test scores are standardized.

Table 17. Principal Entry, Treatment and Control Groups

	Treatment		Control	
Variable	Estimate	St. Error	Estimate	St. Error
STANDARDIZED SCORE				
New Regime	-0.0002	0.0015	0.0000	0.0003
Δ Score	-0.0009	0.0006	-0.0000	0.0001
[Δ Score]*[New Regime]	0.0019**	0.0010	-0.0000	0.0001
PERCENTILE				
New Regime	-0.0011	0.0015	0.0000	0.0003
Δ Score	-0.0043**	0.0020	-0.0001	0.0005
[Δ Score]*[New Regime]	0.0057**	0.0032	-0.0000	0.0003
RANK BASED Z-SCORE				
New Regime	-0.0012	0.0015	0.0000	0.0003
Δ Score	-0.0010*	0.0006	-0.0000	0.0002
[Δ Score]*[New Regime]	0.0016*	0.0009	-0.0000	0.0000
Observations	20,339		5,210	

Notes: The table shows estimated marginal effects of probit regressions where the dependant variable is the probability of entering the principal profession. Teachers and students are matched on the campus, grade, and subject level. Regressions include controls for gender, education, experience, wage premium, the probability of promotion, and trends over time. Standard errors are shown in (·). An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Data covers school years 1995-1996 through 2001-2002 in Texas.

G. Conclusion

Certification and licensing requirements are emplaced in many service professions to ensure all professionals meet a minimum competency standard, thus, attempting to raise the quality of services. However, these requirements raise barriers to entry that may discourage potential entrants. Talented potential entrants may seek outside opportunities instead of incurring entry costs and therefore the effect of minimum standards on the quality of the professionals is unclear.

I use the public school principal profession in Texas to examine this problem. Results show evidence that the recent reduction in entry barriers to the principal profession in Texas has encouraged less educated potential entrants more than highly educated ones. Using student performance on TAAS exams as a proxy for teacher quality, I find that reducing the costs of entry encourages high quality entrants more than low quality ones. The talented teachers, no longer facing constraining entry barriers, find it optimal to enter school administration to increase earnings instead of seeking outside career advancement opportunities. These conclusions remain unchanged when geographically dividing the data into control and treated groups.

Policy implications for the education sector are less clear. Raising entry hurdles will decrease the quality of inputs into the principal profession, yet no evidence is presented that shows schools become more or less effective. I leave that to future research. In addition, providing incentives for high quality potential principals encourages the good teachers to leave the classroom. This may in fact have a negative impact on students.

To the extent that these results can be applied to other labor market professions, policy implications are more straightforward. Although a minimum quality standard for professionals in a market is sought, licensing and certification requirements set too high can have negative impacts on the average quality of the entrants into a profession. Care and consideration should be taken when designing the licensing and/or certification hurdles so that the bar is not set so high as to discourage the very highly talented individuals from entering the profession.

CHAPTER IV

SCHOOL CHOICE AND THE COMPENSATION OF SCHOOL ADMINISTRATORS

A. Introduction

One of the most important goals for society is to educate our youth and one of the most influential factors affecting the quality of education is the choice that parents have about where their child goes to school. If households (consumers of education) have more choice between schools, competition may increase school productivity. Many suggest that this choice comes from parents choosing a school district within a metropolitan area based on their household preferences for public education. Competition may have an effect on more than just student performance and per pupil spending. Our school districts also interact in the labor market for teachers and school administrators and the number and concentration of districts may play an important role in how educators are compensated.

When households have many choices about schooling, school districts face competitive pressure to increase efficiency and lower costs. The main expense of providing education is the salaries of the educators and thus competition may reduce schools' willingness and ability to pay educators well. However, schools are also concerned about educational productivity and a competitive environment will demand more adept leadership to manage our schools and install programs to aide teachers, help children learn, and ultimately increase test scores.

This chapter examines the effect of increased school choice on the earnings and abilities of school administrators. I use a rich dataset of personnel information for educators in the public schools in Texas and variation in the data across individuals and across time allows for a clear identification of the effect. I find an overall positive effect of competition on administrators' earnings suggesting that productivity gains from hiring talented managers outweigh the pressure to reduce costs by cutting salaries. However, the results are sensitive to the level of competition, the type of labor market, and the administrators' position. I control for possible endogeneity both mechanically and with outside instruments and my conclusions largely unchanged.

B. Basic Model

If a school district administrator's earnings are related to the amount of educational choice in the market, one must consider the driving mechanism behind this relationship the increase or decrease in earnings. The "Fat and Happy" theory is that in a market with low competitive pressure from other school districts, administrators are able to pay themselves well. Thus, administrators operating in a highly competitive educational market must use more of their available resources toward productivity. A high level of Tiebout choice would be observed alongside low earnings of school administrators. Hoxby (2000) finds that high levels of choice are associated with low school expenditures, which corroborates this theory.

Alternatively, in the "Talented Managers" theory school districts faced with high competitive pressure due to school choice must hire very productive administrators to avoid losing students to more productive school districts. These highly talented administrators demand a high market wage. Therefore, choice and administrators' earnings are positively correlated.

A third theory, "Increased Effort," also predicts positively correlated school choice and administrator earnings. Administrators faced with pressure from competition must put forth greater effort on the job. The increased effort must be rewarded with higher earnings otherwise administrators find outside opportunities more attractive.

Assume that a school district administrator's earnings, E_{idm}, are a function of the amount of choice in the educational market, C_m, other characteristics of the market, X_m, such as the price of housing or the cost of living, characteristics of the school district, X_{dm}, and individual characteristics, X_{idm},

$$E_{idm} = f(C_m, X_m, X_{dm}, X_{idm}) + \varepsilon_{idm}, \tag{4.1}$$

for administrator i working for school district d in educational market m, where ε_{idm} is an error term. The "Fat and Happy" theory predicts that $\frac{\partial f}{\partial C_m} < 0$, whereas the "Talented Manager" and "Increased Effort" theories predict the opposite.

C. Administrator Productivity

Assume that school district administrators are rewarded for higher school productivity and student achievement. School productivity and student achievement are both enhanced by competitive pressure in the market. [1] The observed positive relationship between the level of choice and administrators' earnings is biased due to the correlation between school choice and the error term (which contains any relationship between administrators' earnings and school output measures). Many studies have shown that agency costs are minimized by relating an executive's compensation to firm performance and to other variables that yield information regarding the actions taken by the executive. Murphy (1986) finds that firm performance is positively related to compensation changes for chief executive officers.

Suppose that an administrator's earnings are a function of the effort that she

[1] See Hoxby (2000).

exerts due to competitive pressure or school choice, C_m, the output in the school district she manages, Q_{dm}, and other characteristics about the administrator, the district, and the market, ν_{idm} so that

$$E_{idm} = g(C_m, Q_{dm}) + \nu_{idm}, \tag{4.2}$$

where E_{idm} is the salary that administrator i earns working for school district d in market m. Suppose also that the output the district produces, Q_{dm}, depends on the competitive structure of the market and other factors, or

$$Q_{dm} = h(C_m) + \xi_{dm}. \tag{4.3}$$

Then, the overall effect of increased choice in the market on the district administrator's salary is

$$\frac{\partial E_{idm}}{\partial C_m} = \frac{\partial g}{\partial C_m} + \frac{\partial g}{\partial Q_{dm}}\frac{\partial Q_{dm}}{\partial C_m}. \tag{4.4}$$

The term $\frac{\partial g}{\partial C_m}$ is the direct effect of increased competition on an administrator's earnings due to the increased effort when faced with stronger competitive pressures. If administrators are rewarded for their increased efforts, then $\frac{\partial g}{\partial C_m} > 0$. If the "Fat and Happy" theory applies, when faced with stiffer competition, administrators must take a cut in pay in order to focus more financial resources towards production, or $\frac{\partial g}{\partial C_m} < 0$.

The term $\frac{\partial g}{\partial Q_{dm}}\frac{\partial Q_{dm}}{\partial C_m}$ is the indirect effect of increased competition on the administrator's earnings due to changes in the performance of the district when faced with stronger competition. The first part of the the indirect effect, $\frac{\partial g}{\partial Q_{dm}}$, is the reward the district gives to the administrator for increased district productivity. For incentive compatibility assume that $\frac{\partial g}{\partial Q_{dm}} > 0$. The second part of the indirect effect is the change in district output due to an increase in competition. Hoxby (2000) shows that student achievement and productivity later in life increases with school choice, or $\frac{\partial Q_{dm}}{\partial C_m} > 0$.

The ambiguity in the sign of the net effect of increased choice on earnings warrants further inquiry. If $\frac{\partial g}{\partial C_m} < 0$ and the indirect effect is larger than the direct effect, then it is the increased output and student achievement that the administrators are rewarded for and finding a positive effect of higher choice on earnings misleads one to support the incorrect "Talented Managers" theory.

D. Endogeneity

There is reason to question the assumption of an exogenously determined level of Tiebout choice in a market. Suppose that school administrators are hired and compensated for their ability to enhance student achievement and overall school productivity. A district in an educational market hires a talented administrator and pays the individual a fair market wage for her talents. The talented manager increases student performance and efficiency in the district. Households in the market observe the new high student performance in that district and move into that community, changing relative sizes of all districts in the market. In the limit, all households move into the high performing district and as a result there is no choice left in that market. If the cost of moving is sufficiently large, enough households will not move. However, the same conclusion follows where districts are acquired by or merge with a more efficient one.

E. Data

In this study, I take advantage of a very rich set of data that is collected by the Texas Education Agency (TEA). The TEA is the statewide administrative unit that guides

Table 18. Summary Statistics by School Year and Educational Market Type

School Year	Number of Administrators	Earnings		Choice Index	
		Mean	St. Dev.	Mean	St. Dev.
1998-99	13,712	48,081	8,621	0.766	0.222
1999-00	14,282	50,598	9,259	0.771	0.222
2000-01	14,705	52,202	9,324	0.772	0.223
2001-02	15,188	53,755	9,846	0.777	0.224
2002-03	15,707	54,770	10,073	0.782	0.219
All Years	73,594	51,991	9,749	0.774	0.222
Metropolitan	67,253	52,480	9,838	0.815	0.175
Micropolitan	6,341	46,805	6,868	0.339	0.202

Notes: There are twenty-six Metropolitan Statistical Areas and forty-one Micropolitan Statistical Areas defined by the Bureau of Labor Statistics.

and oversees primary and secondary public education in Texas. Some of the duties of the TEA include managing textbook adoption, developing the statewide curriculum, rating school districts under the accountability system, monitoring for compliance with federal guidelines, serving as a fiscal agent for the distribution of state funds, and most importantly for this research, collecting data on public school students, staff, and finances. The TEA has collected data on public school system personnel salaries as well as demographics, years of experience, education, gender, and other individual characteristics. Also, enrollment at each campus and within each district is tracked. The data available covers all the school districts in the state (over 1000) for five school years, from the 1998-1999 school year through the 2002-2003 school year. These data are not publicly available.

Staff members who are not teachers or teachers' aids are considered administrators in the public school districts. These include principals and assistant principals, superintendents and assistant superintendents, human resource directors, tax assessors, business managers, athletic directors, and instructional officers. All of these positions operate on the school district level with the exception of principals and assistant principals, who operate on the campus level. Table 18 shows summary statistics for administrators' salaries. Salaries and the total number of school district administrators increase each year of the sample. These changes are not unexpected. The salary increases closely track inflation rates over the period and the changes in the number of employees is consistent with population growth in Texas.

F. Educational Markets

The 2000 labor market definitions provided by the Executive Office of the President - Office of Management and Budget (OMB) list twenty-six traditional metropolitan areas for the state of Texas. Also, forty-one newly defined micropolitan areas are now listed. These are rural areas that have at least one cluster of between 10,000 and 50,000 people, plus adjacent territory that has a high degree of social and economic activity. Micropolitan markets provide an added level of variation in the data. In locations not a part of a metropolitan and micropolitan statistical area, I use the county as the educational market.

Notice in Table 18 that the average salary for school administrators is $52,480 per year for those who work in metropolitan markets and $46,805 per year for those who work in smaller micropolitan areas, significantly less. This suggests that the type of market, urban or non-urban, as well as the cost of living in each market is a determining factor in an administrator's salary.

While Hoxby (2000) obtains variation in the level of school choice by using educational markets in different states and geographical areas of the country, I do it by including micropolitan markets as well as metropolitan markets.

G. Measuring Educational Choice

There are several ways in which one may define a measure of Tiebout choice in this framework. Hoxby (2000) suggests three measures for the level of choice present in the market. One may use the number of school districts in the educational market as the level of choice facing a household. This measure weights each district equally, regardless of the relative size (either in land area or population) of the school district. The other two measures offered by Hoxby (2000) are indices based on a Herfidahl-Hirshman index of the market shares of each district. They differ only in the way in which one calculates the market share for each school district. One could assume that the share of the market that a particular district captures is represented by its share of the total land are for that educational market. The measure is adequate if households locate randomly in space. However, commuting distances to employment centers and other attractions play a role in the location decision of the households. Therefore, Hoxby's third measure, in which the market share of a district is defined as the proportion of the students in that market who attend school in that district, is the best choice. As Hoxby (2000) explains, this measure has a nice interpretation. It is the probability that a student would find herself in a school district if she were to switch places with another student in the educational market at random. This is the measure that I use in the analysis to follow. Explicitly, the level of choice in market m, C_m, is defined as $C_m = 1 - H_m$, where H_m is the Herfindahl-Hirshman index for market m, or the sum of the squared market shares for all school districts in the market. A value of C_m close to zero indicates that households living in that market have little choice over which school district to locate. Likely, one large school district dominates nearly the entire market. A value of C_m close to one suggests that there are many small school districts in the market from which a household can choose.

I compute the choice index for each educational market in the sample. Subsequently each school district in the educational market is assigned the appropriate value of the choice index. And, administrators are assigned a value of the choice index based on the district in which they are employed. Table 18 reports summary statistics for the choice index. The average value of the index has been slowly increasing over time: in the last period it is only 1% higher than in the first period. A large difference in mean values of the index exists between the metropolitan and micropolitan areas. The metropolitan markets have on average much more choice than do the micropolitan areas. This finding is to be expected. In smaller markets, fewer choices in education, as well as in other factors that influence location decisions, exist.

H. Empirical Evidence

To test the predictions of the effect of Tiebout choice on school administrators' earnings I assume that $f(\cdot)$ takes a linear form and estimate the following empirical specification.

$$\begin{aligned} log(earnings)_{idmt} &= \alpha + \beta choice_{mt} + \gamma log(housing\ price)_{mt} \\ &\quad + \delta_1 X_{idmt} + \delta_2 X_{dmt} + \lambda_t + \varepsilon_{idmt}, \end{aligned} \tag{4.5}$$

for administrator i working in school district d in labor market m during school year t. *Earnings* are measured by a school administrator's annual salary, *choice* is measured by the choice index based on district enrollment, *housing price* is the average price of housing in the market and is included as a proxy for cost of living, X_{idmt} is a vector of individual characteristics commonly thought to be related to earnings, and X_{dmt} is a vector of school district demographics. λ_t allows for differences across time. I report ordinary least squares estimates in Tables 19 and 20.

The first column of Tables 19 and 20 reports the results for the fully-specified model.[2] Holding fixed labor market characteristics, cost of living, variations across time, individual level characteristics, and district level student characteristics, a marginal increase in the choice index leads to 6.2% higher earnings for school administrators. Individual characteristics measured include the administrator's age and experience in the Texas public school system. I include indicators for administrators's race and/or ethnicity as well as indicators for sex and educational attainment. The base group for comparison is a white female with a bachelor's degree. Results are expected. Earnings increase with age and experience. African Americans earn slightly less than whites (0.9%), Hispanics earn more than whites (2.1%), and there is no significant difference between the earnings of Asian and white administrators. Men earn 3.4% more than women. Returns to higher education are prevalent; administrators with a Master's degree earn 5.6% more than those with a Bachelor's degree, holding other factors fixed. Administrator's holding a Ph.D. earn 15% more than someone with only a Bachelor's degree. I include district level student characteristics to proxy for variations in non-monetary rewards. If the students in a district are difficult to work with or the district is crowded, the efforts of the administrator is higher and the administrator must be justly compensated. Failing to control for these factors affecting an administrator's earnings could bias the estimate of the effect of choice on earnings.

Under the "Talented Manager" theory, controlling for individual characteristics that might be related to personal productivity may not reveal the true effect of choice

[2]Tables 19 and 20 report robust standard errors clustering on individuals. Appendix D compares those standard errors to robust standard errors by labor market. Although the standard errors by labor market are generally larger, inference about the effect of school choice on administrators' earnings is not affected.

Table 19. Estimates of the Log-Earnings Equation; Market and Individual Characteristics

	OLS(1)	OLS(2)	Fixed	Random
Market Characteristics				
Index of Choice	0.062***	0.061***	0.038***	0.051***
	0.006	0.007	0.008	0.006
Urban District	0.029***	0.038***	-0.028***	0.009***
	0.004	0.005	0.006	0.004
Log(Avg. Housing Price)	0.047***	0.027***	0.081***	0.053***
	0.004	0.005	0.004	0.003
Individual Characteristics				
Age	0.005***	—	—	—
	0.000	—	—	—
Experience	0.005***	—	—	—
	0.000	—	—	—
Black	-0.009***	—	—	—
	0.003	—	—	—
Hispanic	0.021***	—	—	—
	0.003	—	—	—
Asian	-0.015	—	—	—
	0.020	—	—	—
Male	0.034***	—	—	—
	0.002	—	—	—
High School Diploma	0.002	—	—	—
	0.007	—	—	—
Master's Degree	0.056***	—	—	—
	0.003	—	—	—
Doctorate	0.150***	—	—	—
	0.006	—	—	—

Notes: Results of the above models are continued in the next table. The dependent variable is the log of annual salary for public school administrators in Texas. All regressions include a constant. Each regression contains 72,493 observations and robust standard errors are reported for the OLS regressions assuming an individual level cluster effect. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level.

Table 20. Estimates of the Log-Earnings Equation; District Characteristics

	OLS(1)	OLS(2)	Fixed	Random
District Characteristics				
TAAS Performance	0.001***	0.002***	0.000***	0.000***
	0.000	0.000	0.000	0.000
District Enrollment(1,000's)	0.000***	0.000***	0.000***	0.000***
	0.000	0.000	0.000	0.000
Special Education	0.305***	0.197***	-0.014	0.041
	0.078	0.095	0.057	0.051
Immigrants	0.568***	0.499***	0.142***	0.215***
	0.046	0.051	0.025	0.023
Economically Disadvantaged	-0.025***	-0.005***	-0.021***	-0.011***
	0.007	0.008	0.006	0.005
School Year Dummies				
1999-00	0.047***	0.047***	0.064***	0.064***
	0.001	0.001	0.001	0.001
2000-01	0.076***	0.073***	0.110***	0.109***
	0.001	0.002	0.001	0.001
2001-02	0.095***	0.093***	0.152***	0.150***
	0.002	0.002	0.001	0.001
2002-03	0.104***	0.102***	0.189***	0.186***
	0.002	0.003	0.002	0.001

Notes: Results of the above models are continued from the previous table. The dependent variable is the log of annual salary for public school administrators in Texas. All regressions include a constant. Each regression contains 72,493 observations and robust standard errors are reported for the OLS regressions assuming an individual level cluster effect. The variable $TAASPerformance$ measures the fraction of students in the school district that passed all the required TAAS examinations. $SpecialEducation$ measures the percentage of students in the district who require special needs. $Immigrants$ measures the percentage of students in the district that have immigrated from a foreign country. $EconomicallyDisadvantaged$ is a variable that measures the percentage of students who are poor. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level.

on earnings. Column 2 reports the results of a parsimonious model controlling only for market characteristics. This specification allows for administrators operating in urban markets to earn higher salaries, after controlling for differences in the cost of living, time, district level student characteristics, and the amount of educational choice. Given the type of labor market, the cost of housing, student characteristics and the school year, a marginal increase in the choice index leads to 6.1% higher earnings for school administrators.

The signs and magnitudes of the choice effect on administrator earnings in each OLS specification are similar. Either individual ability is not correlated with the amount of choice in the market or the metrics used poorly proxy ability.

1. Individual Ability

I assume the included individual characteristics proxy ability. However, given the structure of the data, I propose the following two-way error component model to account for ability.

$$\begin{aligned} log(earnings)_{idmt} &= \alpha + \beta choice_{mt} + \gamma log(housing\ price)_{mt} \\ &\quad + \delta_2 X_{dmt} + \mu_i + \lambda_t + \nu_{idmt}, \end{aligned} \tag{4.6}$$

where μ_i captures the individual administrator's ability, λ_t allows for differences across time, and ν_{idmt} is a classical exogenous error term.

I estimate the above specification in two different ways and report the results in Table 19 and 20. First, I estimate a fixed effects model. Choice has a positive effect, yet the magnitude of the effect is approximately half as large as in the OLS specifications. The inability of the individual characteristics to perfectly proxy administrator's ability and the important effect of ability on earnings are possible explanations for the difference in magnitudes. In this model the ability level of the administrators is fixed and thus variation due to a district hiring talented administrators is not observed. Therefore, if the overall positive effect of more school choice on earnings originates both from the "Talented Managers" theory and the "Increased Efforts" theory, then the fixed effects model, having controlled for administrator talent, finds only the effect of more choice on earnings due to increased administrator efforts. The second OLS specification, allowing for differences in administrator talent, illustrates the overall impact of school choice on school earnings.

The fixed effects model yields consistent but inefficient estimates. Making some simple assumptions about the μ_i, the random effects model provides consistent and efficient estimates, if the assumptions are met. First, it is assumed that the the μ_i are random, that is $\mu_i \sim IID(0, \sigma_\mu^2)$, and the μ_i are independent of the ν_{idmt}. Also the random effects model assumes that *choice*, $log(housing\ price)$, and X_{dmt} are independent of the the μ_i. This may or may not be true. If school districts under competitive pressure hire more talented administrators the level of choice may be correlated with the average ability levels of administrators in that market. District level student characteristics such as the percent of the student population requiring special education may also be correlated with the ability levels of the administrators. It is not difficult to argue that a large number of students with special needs is more challenging to manage and requires a more talented manager.

The random effects model results in a conclusion not unlike the previous models. I find if the assumptions described above are true, the effect of a marginal increase in school choice on the earnings of school administrators is a 5.1% increase in salary. The positive effect is consistent with the "Talented Managers" theory. However, if this theory is true the assumptions of the model are violated, rendering results neither efficient nor consistent. To this extent, evidence provided by the fixed effects model are preferred over the random effects model despite its inefficiency.

2. The Hausman-Taylor Model

Assuming the endogeneity described above occurs only through the individual ability component of the error term in the two-way error component specification, Hausman and Taylor (1981) suggest taking advantage of exogenous components of the covariates to instrument for the endogenous regressors. Explicitly, assume the following empirical specification,

$$ln(earnings)_{it} = \beta X_{it} + \gamma Z_i + \mu_i + \nu_{it}, \tag{4.7}$$

where X_{it}= [X_{it}^1, C_{it}] and Z_i=[Z_i^1, $NoDegree_i$, $Master'sDegree_i$, $Doctorate_i$]. X_{it} is a matrix of regressors that vary over time and across individuals. X_{it} is comprised of both exogenous covariates, X_{it}^1, and choice, C_{it}, assumed to be endogenous. Z_i is a matrix of time invariant regressors. Some of which are exogenous, Z_i^1, while others are assumed to be endogenous. I assume an administrator's education is endogenous as it is highly correlated with the ability component of the error term. $NoDegree_i$, $Master'sDegree_i$, and $Doctorate_i$ are indicators for the highest college degree obtained by the individual and the default degree is a bachelor's degree.

The first column of Table 21 shows that controlling for possible endogeneity of educational choice does not change the coefficient estimates, in either sign or magnitude. The estimated effects are consistent with the prediction of the "Talented Manager" theory. This conclusion may lead one to believe that the concern about endogeneity is unwarranted or that the Hausman-Taylor specification does a poor job of correcting for it.

Table 21. Estimates of the Log-Earnings Equation, Controlling for Endogeneity

	Hausman Taylor	Instrumental Variables Models Fixed	G2SLS	EC2SLS
Market Characteristics				
Index of Choice	0.043***	0.034***	0.055***	0.098***
	0.010	0.009	0.006	0.014
Urban District	-0.026***	-0.037***	0.021***	-0.008
	0.006	0.006	0.007	0.006
Log(Avg. Housing Price)	0.070***	0.084***	0.063***	0.042***
	0.005	0.005	0.006	0.005
Hausman Tests				
X^2	—	1,252.7	1,945.8	1,878.7
p-value	—	0.000	0.000	0.000

Notes: The dependent variable is the log of annual salary for public school administrators in Texas. All regressions include a constant as well as individual characteristics, district characteristics, and school year indicator variables found in the model specifications shown in Tables 19 and 20. Each regression contains 72,493 observations. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level.

3. Outside Instruments

For those readers not swayed by the evidence provided using the Hausman-Taylor model, I use an outside instrument for school choice. I propose a market performance index that aims to measure the pressure for a household to "switch" to another school district. Let

$$mpi_{m,t} = \sum_d (P_{d,m,t-1} - P_{.,m,t-1})^2, \tag{4.8}$$

where $mpi_{m,t}$ is the market performance index of market m at time t, $P_{d,m,t-1}$ is the mean performance of the students on standardized tests in district d, in market m, at time $t-1$, and $P_{.,m,t-1}$ is the mean performance of all students in market m at time $t-1$.

To illustrate what this index is measuring consider the example in Table 22.

Table 22. Market Performance Index Example

	TAAS Passing Rate	Market Avg.	Distance to Mean	*Distance*^{2}
Market Situation 1				
District 1	78	72	6	39
District 2	67	72	-5	23
District 3	70	72	-2	3
District 4	72	72	0	0
		Market Performance Index:		65
Market Situation 2				
District 1	98	77	21	452
District 2	67	77	-10	95
District 3	70	77	-7	46
District 4	72	77	-5	23
		Market Performance Index:		615

Table 22 shows two possible situations in which an educational market can find itself. In the first situation, the students in all the districts perform about the same on standardized tests. Therefore if households choose a school district based on observed outcomes such as average test scores, the pressure for a household to switch districts in a market in this situation is low. Accordingly, the market performance index is low here. In contrast, consider situation 2. In this situation, one school district is greatly outperforming all the others in the market. The pressure for a household to move to that district is high because the reward from moving, in terms of better schools, is great. It is more likely that households will move to the winning district in situation 2, and therefore the market performance index in that situation is higher.

Since it is the movement of households to the successful district that renders the level of choice endogenous, the pressure for households to move is negatively correlated with the level of choice in the educational market. The market performance index relies on the relative performance of all the students in the market, not just those supervised by an administrator working in a particular district. As such, the performance index is uncorrelated with an individual administrator's earnings. Therefore, the market performance index is a valid instrument and can be used to control for endogeneity.

I base the market performance index on the passing rate on the standardized state-wide TAAS test. I use the results of three tests, math, science, and writing, to compute three indices to measure the pressure on a household to move across districts. I therefore have three outside instruments, mpi^{math}, $mpi^{reading}$, and $mpi^{writing}$, to control for endogeneity.

The last three columns of Table 21 summarize the results of an instrumental variables two-way error-component model estimation. The fixed effects model controlling for choice endogeneity yields results not unlike those found in the standard fixed effects model. However, the efficiency of the fixed effects model is not the best. The random effects instrumental variables model or generalized two stage least squares, G2SLS, shows again a positive effect of Tiebout choice on the earnings of school administrators. Not surprisingly, an error component two stage least squares, EC2SLS, approach shows results similar to G2SLS. Controlling for ability of the administrators and possible endogeneity in the level of choice available to households I again find evidence in support of the "Talented Managers" theory on the relationship between administrators' earnings and school competition.

To test for endogeneity and illustrate the validity of the instruments, the results of Hausman tests are included. I compare the instrumental variables model with fixed effects to the original fixed effects model that does not control for endogeneity.

I reject the null hypothesis that the coefficients estimates in the two models are the same, suggesting that the instrumental variables model is appropriate. Similar conclusions result when comparing G2SLS and EC2SLS to the random effects model not controlling for endogeneity. Also, partial F-statistic from the first stage regression is 5,479.6. An F-statistic greater than 10 suggests valid instruments, a commonly accepted rule-of-thumb. The partial R^2 from the first stage regression is 0.204.

4. Split Sample Results

An interesting continuity gap in the relationship between choice and earnings is present. As Figure 6 makes clear, there is a gap in the data around a value of 0.8 for the index of level of choice. For values of the index below this mark, low choice, it appears that no relationship exists between choice and earnings. After the break, the high index value, there is a positive relationship with possibly a larger variance in earnings.

I examine this further by splitting the data into two groups. One sample for administrators in markets with high competition (index > 0.8), and one sample for administrators in low index markets. The results of these regressions are shown in Table 23. Results of the split-sample regressions show that indeed there exists a large positive effect of choice on administrators' salary for markets that are highly competitive. In markets that are either moderately competitive or uncompetitive, the positive effect is absent. In fact, in some specifications there is a very small negative effect of school competition on earnings.

The relationship between administrators' earnings and school choice also breaks down when estimating separate regressions for administrators in urban and rural areas. I find a positive effect for those administrators who work in urban markets and no effect or a negative effect for non-urban administrators. This suggests that both

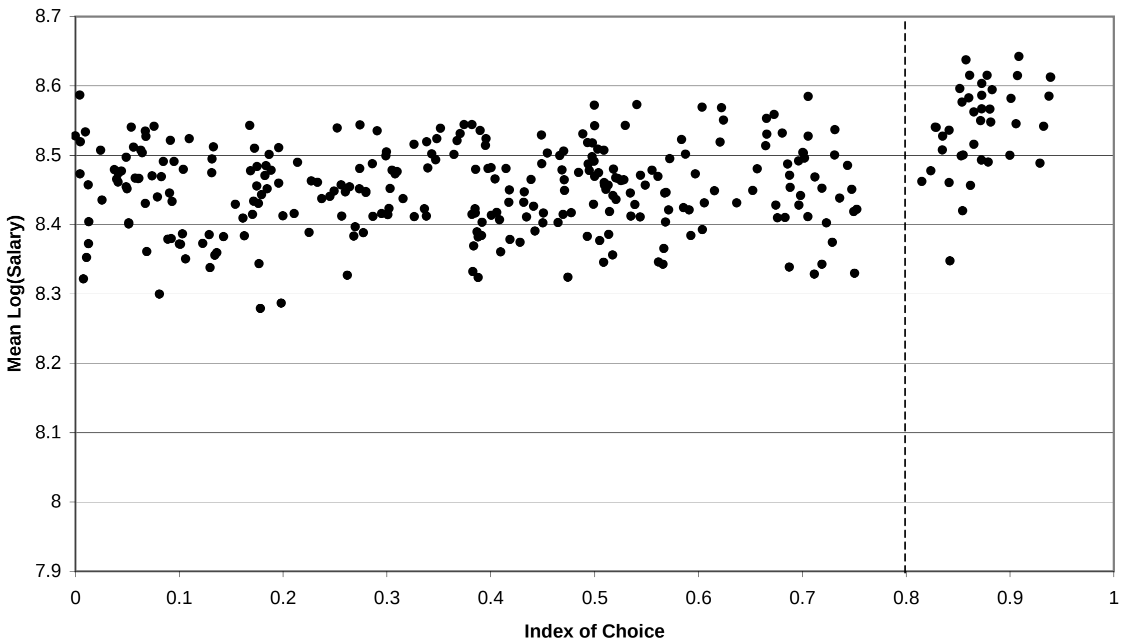

Fig. 6. Plot of Mean Log(Salary) Versus Index of School Choice

theories, "Fat & Happy" and "Talented Managers," may be plausible.

5. Sub-Sample Results

It is reasonable to assume that the behavior of a district-level administrator is different from the behavior of a campus-level administrator. On-campus administrators work more closely with the students, are more accessible to parents, and can be held accountable for outcomes more directly. Off-campus administrators may have a more business oriented job description while on-campus administrators tend more toward education responsibilities. Therefore, as a robustness check, I divide the sample by on-campus or off-campus status.

Table 24 summarizes the results of each model estimated for on-campus and off-campus administrators and them to the results from the full sample. In most of the models the effect of choice on earnings is no longer present for off-campus

Table 23. Split Sample Regression Results, Estimated Coefficient on Index of Choice in Log-Earnings Model, By Method of Estimation

School Choice	Choice > 0.8	Choice < 0.8	Urban	Rural
OLS	0.111***	-0.043***	0.078***	-0.039***
	0.021	0.005	0.004	0.008
Between	0.048	-0.038***	0.075***	-0.024*
	0.038	0.008	0.007	0.014
Fixed Effects	0.270***	-0.002	0.050***	-0.087***
	0.052	0.014	0.011	0.020
Random Effects	0.186***	-0.023***	0.070***	-0.063***
	0.034	0.008	0.007	0.013
Hausman-Taylor	0.402***	0.002	0.065***	-0.070***
	0.059	0.013	0.013	0.017
IV Regressions				
Fixed Effects	0.231***	0.002	0.043***	-0.070***
	0.057	0.014	0.012	0.020
G2SLS	0.215***	-0.034***	0.077***	-0.065***
	0.035	0.008	0.007	0.013
EC2SLS	0.242***	-0.036***	0.077***	-0.068***
	0.035	0.008	0.007	0.013

Notes: Specifications are similar to those in Tables 19 and 20. Standard Errors are reported below coefficient estimates. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level.

administrators. For on-campus administrators, however, the positive effect remains and is often larger than the estimated effect for the full sample.

I. Conclusion

I find evidence that Tiebout choice is positively related to school district administrators' earnings, a conclusion consistent with two theories. The first theory, "Talented Managers," suggests schools under competitive pressure pay more to hire talented individuals as administrators. In the second theory, "Increased Efforts," administrators faced with pressure from competition must put forth greater effort on the job. The increased effort must be rewarded with higher earnings otherwise administrators find

Table 24. Sub-Sample Regression Results, Estimated Coefficient on Index of Choice in Log-Earnings Model, By Method of Estimation

School Choice	All School Administrators	Off Campus Administrators	On Campus Administrators
OLS	0.064***	0.037***	0.066***
	0.006	0.011	0.003
Fixed Effects	0.037***	0.007	0.046***
	0.008	0.025	0.009
Random Effects	0.050***	0.008	0.059***
	0.006	0.016	0.006
Hausman-Taylor	0.043***	-0.008	0.054***
	0.010	0.018	0.007
IV Regressions			
Fixed Effects	0.034***	0.000	0.047***
	0.009	0.027	0.010
G2SLS	0.055***	0.017	0.063***
	0.006	0.015	0.006
EC2SLS	0.054***	0.015	0.063***
	0.006	0.016	0.006

Notes: Specifications are similar to those in Tables 19 and 20. Standard Errors are reported below coefficient estimates. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level.

outside opportunities more attractive.

This finding is robust to model specification. I estimate OLS, fixed effects, and random effects models and the conclusion remains the same. Concerned that the level of school choice is endogenous, I estimate a Hausman-Taylor model assuming that the degree held by an administrator is correlated with individual ability and therefore also endogenous. I construct an outside instrument, the market performance index, that is negatively correlated with the level of school choice yet uncorrelated with an individual administrator's ability. The results of estimating model controlling for endogeneity agree with my previous conclusion.

The data is split into two groups, low to moderate school choice and high school choice. I find that there is no relationship between school choice and administrators' earnings in the low to moderate choice education markets. In the highly competitive markets, there is a statistically significant positive relationship between the level of school choice and administrators' earnings.

Further robustness checks compare urban areas to rural areas. Evidence is consistent with the "Talented Manager" theory in urban areas. However, no evidence exist to suggest there is a relationship between the level of school choice in rural areas and administrators' earnings. Also, on-campus administrators earn a premium in more competitive education markets but off-campus administrators do not.

CHAPTER V

CONCLUSION

This dissertation studies public school administrators, some of the choices they make, and some of the factors that influence those choices. Many people have studied teacher labor markets, interested in factors that may increase the quality of education within a state or country. Few, however, have considered issues facing school administrators.

Over a ten year period from 1994 until 2004 the gender composition of teachers and principals in Texas public schools suggests that men are over-represented in the administrative ranks comprising 48% of the principals and only 22% of the teachers. The number of principals, however, declines over this period. Since specific training and certification is required to serve as a principal in Texas, I identify those individuals who desire advancement and are qualified for the job. I show there is no statistically significant difference in the probability of promotion between men and women over this time period. I further show using duration analysis that women in fact face a higher hazard of promotion to principal than men in Texas public schools. Men face their highest hazard of promotion four years after becoming certified. Women's hazard rates peak at six or seven years after certification. This result is consistent with Affirmative Action for women as well as the theory that men face more opportunities outside of education and are less committed to the education sector. Further analysis shows however that men do not leave Texas public schools more frequently than women. In fact, women are more likely to leave if they are not promoted.

Certification and licensing requirements raise barriers to entry that may discourage potential entrants. I use the public school principal profession in Texas to show evidence that the recent reduction in entry barriers to the principal profession in Texas has encouraged less educated potential entrants more than highly educated ones. Using student performance on TAAS exams as a proxy for teacher quality, I find that reducing the costs of entry encourages high quality entrants more than low quality ones. The talented teachers, no longer facing constraining entry barriers, find it optimal to enter school administration to increase earnings instead of seeking outside career advancement opportunities. These conclusions remain unchanged when geographically dividing the data into control and treated groups.

Policy implications for the education sector are not clear. Raising entry hurdles will decrease the quality of inputs into the principal profession, yet no evidence is presented that shows schools become more or less effective. I leave that to future research. In addition, providing incentives for high quality potential principals encourages the good teachers to leave the classroom. This may in fact have a negative impact on students.

I find evidence that Tiebout choice is positively related to school district administrators' earnings, a conclusion consistent with two theories. This finding is robust to model specification. I estimate OLS, fixed effects, and random effects models and the conclusion remains the same. Concerned that the level of school choice is endogenous, I estimate a Hausman-Taylor model assuming that the degree held by an administrator is correlated with individual ability and therefore also endogenous. I construct an outside instrument, the market performance index, that is negatively correlated with the level of school choice yet uncorrelated with an individual administrator's ability. The results of estimating a model controlling for endogeneity agree with my previous conclusion.

The data is split into two groups, low to moderate school choice and high school choice. I find that there is no relationship between school choice and administrators' earnings in the low to moderate choice education markets. In the highly competitive markets, there is a statistically significant positive relationship between the level of school choice and administrators' earnings. Further robustness checks compare urban areas to rural areas and on-campus to off-campus administrators.

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APPENDIX A

SUPPLEMENTARY TABLES FOR CHAPTER II

Table 25. Principal Attrition Rates

School Year	No Longer Principal	Back to Classroom
1995-96	16.5%	1.5%
1996-97	18.4%	1.4%
1997-98	16.0%	1.4%
1998-99	22.0%	1.4%
1999-00	22.4%	1.6%
2000-01	18.9%	1.2%
2001-02	19.0%	1.5%
2002-03	17.9%	1.5%
2003-04	16.3%	1.4%

Table 26. Advanced Degrees and Principal Certification

Years Since Certification	Master's Degree	Doctorate
1	75.7%	1.5%
2	83.1%	1.8%
3	87.1%	2%
4	88.8%	2.3%
5	90.1%	2.6%
6	91.1%	3.2%
7	91.5%	3.8%
8	91.7%	4.4%
9	91.8%	4.7%
10	92.2%	5.1%
11	91.9%	5.5%
12	91.7%	6%
13	91.3%	6.5%
14	90.8%	7%
15	90.4%	7.5%
16	89.9%	8%
17	90%	8%
18	89.5%	8.6%

Table 27. Probability of Being a Principal, Probit Regressions, Metropolitan and Micropolitan Labor Market Statistics

Variable	Full Sample		Certified as a Principal	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Male	0.152***	0.002***	0.009	0.002
	0.005	0.000	0.006	0.002
Teaching Experience	-0.002***	0.000***	0.005***	0.001***
	0.000	0.000	0.000	0.000
Master's Degree	1.022***	0.022***	0.243***	0.064***
	0.007	0.000	0.012	0.003
Doctorate Degree	0.882***	0.029***	0.086***	0.025***
	0.014	0.001	0.017	0.005
Black	-0.118***	0.000***	-0.149***	-0.040***
	0.008	0.000	0.010	0.003
Hispanic	0.090***	0.001***	0.012***	0.003
	0.006	0.000	0.008	0.002
Asian	-0.336***	-0.002***	-0.210**	-0.054**
	0.046	0.000	0.065	0.016
Native American	0.041	0.000	-0.063	-0.017
	0.040	0.000	0.051	0.014
Open Positions	0.019***	0.000***	0.024***	0.007***
	0.000	0.000	0.001	0.000
Number Certified	-0.008***	0.000***	-0.011***	-0.003***
	0.000	0.000	0.000	0.000
Age of Certification				
1 to 5 years old	1.872***	0.100***	0.973***	0.301***
	0.009	0.001	0.024	0.008
6 to 10 years old	2.317***	0.203***	1.512***	0.506***
	0.009	0.002	0.024	0.008
11 to 15 years old	2.333***	0.210***	1.591***	0.544***
	0.010	0.003	0.025	0.008
16 to 20 years old	2.228***	0.183***	1.538***	0.537***
	0.011	0.003	0.026	0.009
21 to 25 years old	2.092***	0.152***	1.455***	0.521***
	0.014	0.003	0.027	0.009
More than 25 years	1.818***	0.097***	1.261***	0.455***
	0.019	0.003	0.030	0.011

Notes: This table shows estimated probit models for the probability of promotion to school principal. The Full Sample consists of 3,222,624 observations and the restricted sample consists of 252,321 observations. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level.

Table 28. Time to Promotion to Principal, Metropolitan and Micropolitan Labor Market Statistics

Variable	Separate Models	
	Men	Women
Teaching Experience	0.982	1.046***
	0.010	0.011
Experience Squared	0.998***	0.997***
	0.000	0.000
Master's Degree	0.654***	0.593***
	0.042	0.037
Doctorate Degree	0.295***	0.358***
	0.041	0.039
Black	1.015***	0.780
	0.072	0.043
Hispanic	0.949	1.184***
	0.472	0.051
Asian	0.967	0.919
	0.433	0.326
Native American	1.683**	0.870
	0.452	0.308
Open Positions	1.049***	1.066***
	0.002	0.002
Number Certified	0.987***	0.987***
	0.002	0.002
Observations	70,383	101,983

Notes: The regressions fit a Cox proportional hazards model in which the dependant variable is time until promotion to school principal measured in years after certification. Standard errors appear under the estimated hazard ratios for each covariate. $OpenPositions$ and $NumberCertified$ are measured as the number of individuals per 1,000 labor market employees. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level.

APPENDIX B

SUPPLEMENTARY FIGURES FOR CHAPTER II

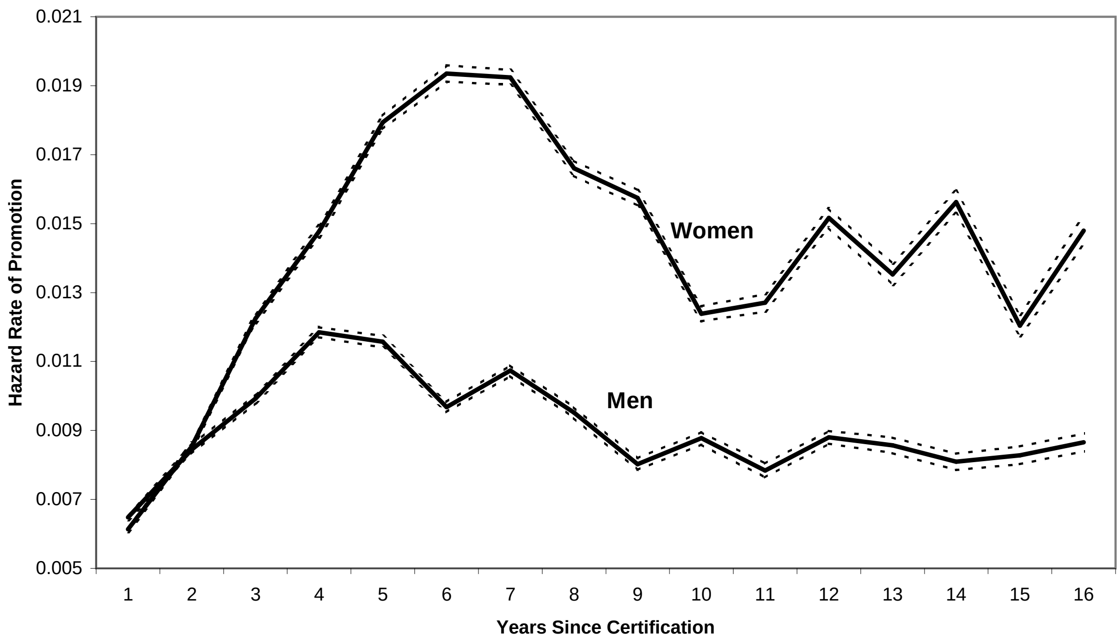

Fig. 7. Estimated Hazard Rate of Promotion to Principal, Evaluated for a White Individual with a Master's Degree, Including 95% Confidence Bands

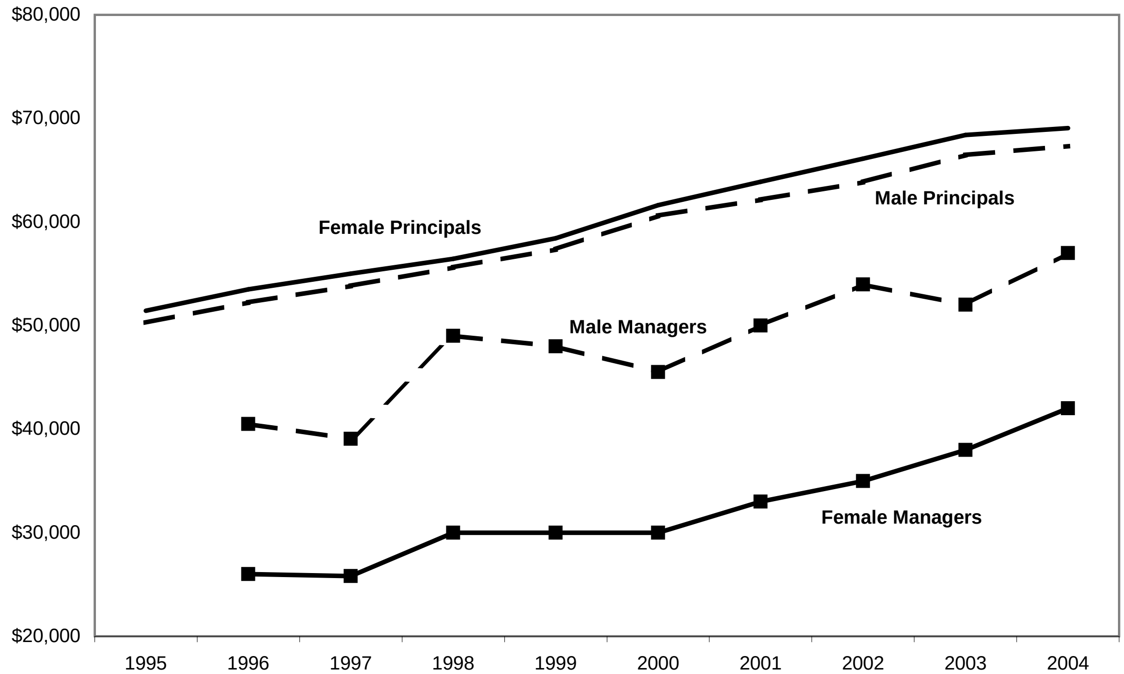

Fig. 8. Median Annual Earnings, Principals in Texas vs. Full-Time Managers in Texas Age 25-65 from CPS

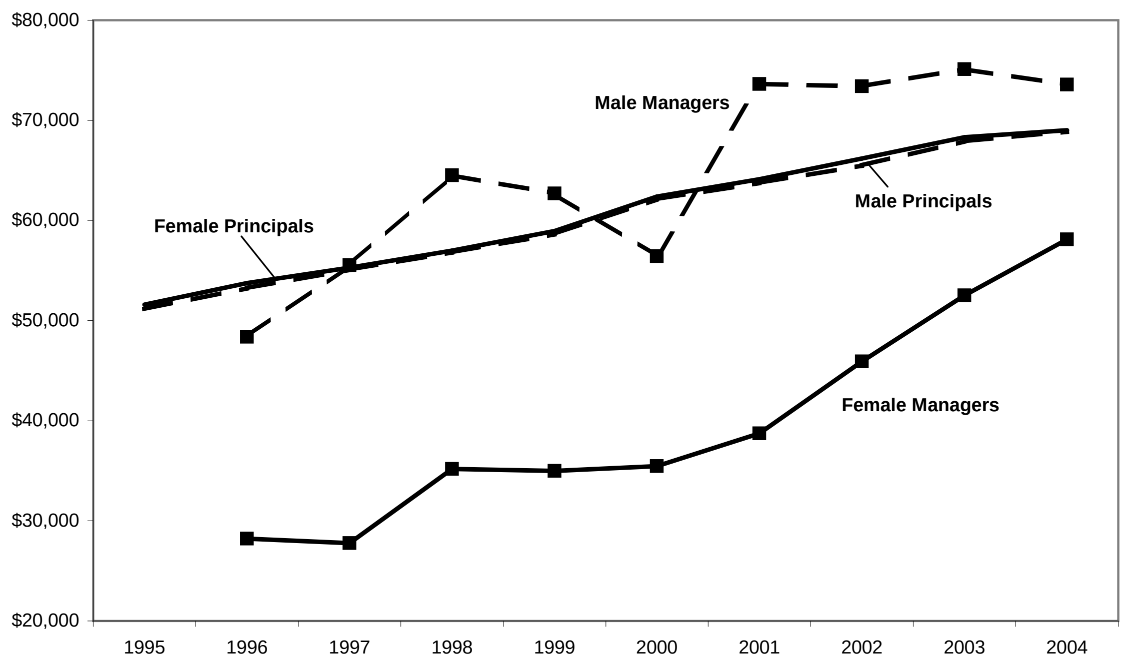

Fig. 9. Mean Annual Earnings, Principals in Texas vs. Full-Time Managers in Texas Age 25-65 from CPS

APPENDIX C

SUPPLEMENTARY TABLES FOR CHAPTER III

Table 29. Teacher-Principal Mobility Rates

Year Certified	Number Certified	Same District
1996	1,319	83.7%
1997	1,228	85.4%
1998	1,117	80.4%
1999	1,820	83.7%
2000	874	81.6%
2001	1,304	81.3%
2002	1,536	79.0%
2003	1,865	83.7%
All Years	11,063	82.5%

Notes: The table shows the percentage of certified principals who stay in the same school district in which they were employed before becoming certified. This includes individuals who were employed by the same district the year before certification and the year after certification.

Table 30. The Wage Premium Model

Variable	Estimate	St. Error
A	0.417***	0.002
Bachelors Degree	0.154***	0.000
Masters Degree	0.222***	0.000
Doctorate	0.376***	0.001
Experience	0.018***	0.000
Age	0.000***	0.000
Male	0.054***	0.000
Hispanic	0.023***	0.000
African American	0.022***	0.000
Asian	0.039***	0.001
Native American	0.008***	0.002
A*[Bach. - $\overline{Bach.}$]	-0.017**	0.007
A*[Mast. - $\overline{Mast.}$]	-0.147***	0.007
A*[Doc. - $\overline{Doc.}$]	-0.241***	0.007
A*[Exp. - $\overline{Exp.}$]	-0.009***	0.000
A*[Age - $\overline{Age}$]	-0.001***	0.000
A*[Male - $\overline{Male}$]	-0.066***	0.001
A*[Hisp. - $\overline{Hisp.}$]	-0.009***	0.002
A*[Afr. - $\overline{Afr.}$]	-0.016***	0.003
A*[Asian - $\overline{Asian}$]	-0.207***	0.017
A*[Native - $\overline{Native}$]	-0.008	0.012
R^2	0.6494	

Notes: This table shows the estimated wage premium model where the dependant variable is the log of annual earnings. A is an indicator variable equal to 1 if the individual is employed as a principal and zero otherwise. Data covers school years 1994-1995 through 2003-2004 in Texas. Education measures are indicator variables for the highest degree attained. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. The estimated wage premium is $log(w^a/w^c) = 0.417$, or $w^a/w^c = 1.517$. That is, principals earn 51.7% more than teachers in Texas.

Table 31. The Probability of Promotion Model

Variable	Estimate	St. Error
Experience	0.007***	0.000
Male	-0.001	0.006
Hispanic	0.005	0.007
African American	-0.047***	0.010
Asian	-0.157**	0.065
Native	-0.066	0.051
Open Positions	0.006***	0.001
Number Certified	-0.001***	0.000
Age of Cert.	0.024***	0.009
LR statistic	7,738	
p-value	0.001	
Pseudo R^2	0.298	

Notes: This table shows the estimated probability of promotion model. Data covers school years 1994-1995 through 2003-2004 in Texas. $OpenPositions$ is the number of open administration positions in the school district that year. $NumberCertified$ is the number of other individuals in the district that hold a principal certificate. $AgeofCert.$ is the number of years since an individual's certification was first issued. The number of observations for this model is 249,889. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level.

Table 32. Entry and Education, Models 1 & 2 with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
Model 1			
New Regime	0.693	0.0270***	0.0270***
Bachelor's Degree	0.601	0.0243***	0.0245***
[Bach.]*[New Regime]	-0.585	0.0269***	0.0270***
Master's Degree	1.972	0.0257***	0.0280***
[Mast.]*[New Regime]	-0.633	0.0265***	0.0266***
Doctorate	2.488	0.0323***	0.0370***
[Doc.]*[New Regime]	-0.789	0.0342***	0.0343***
Male	0.316	0.0054***	0.0088***
Experience	-0.044	0.0006***	0.0010***
Wage Premium	0.182	0.0643***	0.1022*
Prob. Of Promotion	28.758	0.0671***	0.1298***
Model 2			
New Regime	0.718	0.0277***	0.0278***
Bachelor's Degree	0.857	0.0250***	0.0252***
[Bach.]*[New Regime]	-0.609	0.0276***	0.0277***
Master's Degree	2.658	0.0269***	0.0273***
[Mast.]*[New Regime]	-0.66	0.0272***	0.0273***
Doctorate	3.492	0.0342***	0.0348***
[Doc.]*[New Regime]	-0.837	0.0355***	0.0356***
Male	0.550	0.0059***	0.0081***
Experience	-0.025	0.0006***	0.0009***
Wage Premium	3.717	0.0722***	0.0751***
Prob. Of Promotion	34.529	0.0788***	0.1594***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2003-2004 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for year and/or race.

Table 33. Entry and Education, Models 3 & 4 with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
Model 3			
New Regime	0.722	0.0277***	0.0278***
Bachelor's Degree	0.541	0.0250***	0.0252***
[Bach.]*[New Regime]	-0.610	0.0277***	0.0277***
Master's Degree	2.260	0.0257***	0.0269***
[Mast.]*[New Regime]	-0.637	0.0273***	0.0274***
Doctorate	3.094	0.0313***	0.0333***
[Doc.]*[New Regime]	-0.798	0.0349***	0.0349***
Male	0.540	0.0045***	0.0072***
Wage Premium	3.352	0.0462***	0.0682***
Prob. Of Promotion	28.626	0.0665***	0.1278***
Model 4			
New Regime	0.742	0.0284***	0.0285***
Bachelor's Degree	0.772	0.0256***	0.0259***
[Bach.]*[New Regime]	-0.622	0.0283***	0.0284***
Master's Degree	2.817	0.0266***	0.0271***
[Mast.]*[New Regime]	-0.652	0.0279***	0.0280***
Doctorate	3.901	0.0327***	0.0332***
[Doc.]*[New Regime]	-0.833	0.0362***	0.0362***
Male	0.723	0.0048***	0.0073***
Wage Premium	6.063	0.0504***	0.0534***
Prob. Of Promotion	34.661	0.0785***	0.1584***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2003-2004 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for school year, experience, and/or race.

Table 34. Entry and 4th Grade Test Scores with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
4th Grade Math			
New Regime	0.059	0.0002***	0.0002***
Δ Score	-0.028	0.0001***	0.0001***
[Δ Score]*[New Regime]	0.065	0.0001***	0.0001***
Bachelor's Degree	0.347	0.0044***	0.0044***
Master's Degree	1.891	0.0047***	0.0047***
Doctorate	2.712	0.0069***	0.0070***
Male	0.631	0.0002***	0.0002***
Wage Premium	2.276	0.0159***	0.0171***
Prob. Of Promotion	20.877	0.0290***	0.0348***
4th Grade Reading			
New Regime	0.095	0.0148***	0.0149***
Δ Score	-0.026	0.0082***	0.0082***
[Δ Score]*[New Regime]	0.069	0.0125***	0.0125***
Bachelor's Degree	0.349	0.0660***	0.0660***
Master's Degree	1.892	0.0686***	0.0689***
Doctorate	2.714	0.0833***	0.0837***
Male	0.630	0.0138***	0.0143***
Wage Premium	2.279	0.1260***	0.1306***
Prob. Of Promotion	20.880	0.1702***	0.1864***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2001-2002 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for school year and experience.

Table 35. Entry and 5th Grade Test Scores with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
5th Grade Math			
New Regime	0.092	0.0151***	0.0151***
Δ Score	-0.016	0.0079**	0.0079**
[Δ Score]*[New Regime]	0.051	0.0123***	0.0123***
Bachelor's Degree	0.321	0.0666***	0.0666***
Master's Degree	1.864	0.0692***	0.0694***
Doctorate	2.693	0.0841***	0.0844***
Male	0.574	0.0138***	0.0143***
Wage Premium	2.252	0.1278***	0.1324***
Prob. Of Promotion	20.892	0.1712***	0.1869***
5th Grade Reading			
New Regime	0.091	0.0151***	0.0151***
Δ Score	-0.023	0.0084***	0.0084***
[Δ Score]*[New Regime]	0.052	0.0130***	0.0130***
Bachelor's Degree	0.322	0.0666***	0.0666***
Master's Degree	1.865	0.0692***	0.0694***
Doctorate	2.694	0.0841***	0.0844***
Male	0.574	0.0138***	0.0143***
Wage Premium	2.252	0.1278***	0.1324***
Prob. Of Promotion	20.883	0.1712***	0.1868***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2001-2002 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for school year and experience.

Table 36. Entry and 6th Grade Test Scores with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
6th Grade Math			
New Regime	0.009	0.0169	0.0169
Δ Score	-0.023	0.0100**	0.0100**
[Δ Score]*[New Regime]	0.083	0.0165***	0.0165***
Bachelor's Degree	0.201	0.0719***	0.0719***
Master's Degree	1.747	0.0751***	0.0754***
Doctorate	2.411	0.0904***	0.0908***
Male	0.491	0.0139***	0.0145***
Wage Premium	2.406	0.1442***	0.1495***
Prob. Of Promotion	23.082	0.1987***	0.2155***
6th Grade Reading			
New Regime	0.010	0.0169	0.0169
Δ Score	-0.016	0.0105	0.0105
[Δ Score]*[New Regime]	0.048	0.0168***	0.0168***
Bachelor's Degree	0.202	0.0720***	0.0720***
Master's Degree	1.749	0.0752***	0.0754***
Doctorate	2.414	0.0904***	0.0909***
Male	0.492	0.0139***	0.0145***
Wage Premium	2.412	0.1443***	0.1495***
Prob. Of Promotion	23.076	0.1987***	0.2156***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2001-2002 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for school year and experience.

Table 37. Entry and 7th Grade Test Scores with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
7th Grade Math			
New Regime	0.064	0.0186***	0.0187***
Δ Score	0.008	0.0122	0.0122
[Δ Score]*[New Regime]	0.000	0.0198	0.0198
Bachelor's Degree	0.279	0.0872***	0.0872***
Master's Degree	1.789	0.0902***	0.0906***
Doctorate	2.360	0.1050***	0.1057***
Male	0.428	0.0147***	0.0157***
Wage Premium	2.335	0.1549***	0.1645***
Prob. Of Promotion	28.366	0.2456***	0.2679***
7th Grade Reading			
New Regime	0.016	0.0185	0.0185
Δ Score	-0.009	0.0119	0.0119
[Δ Score]*[New Regime]	0.019	0.0194	0.0194
Bachelor's Degree	0.279	0.0872***	0.0872***
Master's Degree	1.788	0.0902***	0.0906***
Doctorate	2.358	0.1050***	0.1057***
Male	0.428	0.0147***	0.0157***
Wage Premium	2.330	0.1549***	0.1645***
Prob. Of Promotion	28.360	0.2456***	0.2679***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2001-2002 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for school year and experience.

Table 38. Entry and 8th Grade Test Scores with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
8th Grade Math			
New Regime	0.063	0.0186***	0.0186***
Δ Score	-0.003	0.0126	0.0126
[Δ Score]*[New Regime]	0.036	0.0199**	0.0199**
Bachelor's Degree	0.289	0.0871***	0.0871***
Master's Degree	1.796	0.0900***	0.0904***
Doctorate	2.363	0.1048***	0.1054***
Male	0.426	0.0146***	0.0156***
Wage Premium	2.359	0.1542***	0.1634***
Prob. Of Promotion	28.349	0.2445***	0.2669***
8th Grade Reading			
New Regime	0.015	0.0184	0.0184
Δ Score	-0.003	0.0124	0.0124
[Δ Score]*[New Regime]	0.004	0.0190	0.0190
Bachelor's Degree	0.288	0.0869***	0.0869***
Master's Degree	1.796	0.0899***	0.0903***
Doctorate	2.363	0.1046***	0.1052***
Male	0.426	0.0146***	0.0156***
Wage Premium	2.360	0.1541***	0.1634***
Prob. Of Promotion	28.341	0.2444***	0.2668***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2001-2002 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for school year and experience.

Table 39. Entry and 10th Grade Test Scores with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
10th Grade Math			
New Regime	0.003	0.0160	0.0160
Δ Score	0.032	0.0121***	0.0121***
[Δ Score]*[New Regime]	-0.039	0.0178**	0.0178**
Bachelor's Degree	0.381	0.0664***	0.0665***
Master's Degree	2.042	0.0699***	0.0702***
Doctorate	2.695	0.0823***	0.0829***
Male	0.486	0.0138***	0.0147***
Wage Premium	4.520	0.1479***	0.1528***
Prob. Of Promotion	31.661	0.2407***	0.2668***
10th Grade Reading			
New Regime	0.091	0.0165***	0.0165***
Δ Score	0.014	0.0122	0.0122
[Δ Score]*[New Regime]	-0.002	0.0178	0.0178
Bachelor's Degree	0.380	0.0664***	0.0665***
Master's Degree	2.039	0.0699***	0.0702***
Doctorate	2.691	0.0823***	0.0829***
Male	0.484	0.0138***	0.0147***
Wage Premium	4.507	0.1478***	0.1527***
Prob. Of Promotion	31.654	0.2406***	0.2668***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2001-2002 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for school year and experience.

Table 40. Principal Entry and Standardized Test Scores, Teachers and Students Matched by Campus, Grade, and Subject, with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
Standardized Test Scores			
New Regime	-0.003	0.0269	0.0269
Δ Score	-0.032	0.0163**	0.0163**
[Δ Score]*[New Regime]	0.081	0.0242***	0.0242***
Bachelor's Degree	0.358	0.1558**	0.1558**
Master's Degree	2.303	0.1597***	0.1597***
Doctorate	3.061	0.1788***	0.1789***
Male	0.666	0.0218***	0.0223***
Wage Premium	5.143	0.2236***	0.2240***
Exp. 6-10	0.410	0.0225***	0.0225***
Exp. 11-15	0.234	0.0296***	0.0298***
Exp. 16-20	0.055	0.0373	0.0377
Exp. 20+	-0.245	0.0498***	0.0505***
Native American	0.927	0.1022***	0.1075***
Asian American	1.844	0.1144***	0.1190***
African American	1.131	0.0202***	0.0214***
Hispanic	0.344	0.0192***	0.0200***
Prob. Of Promotion	31.066	0.3619***	0.3774***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2001-2002 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for school year.

Table 41. Principal Entry and Test Scores Percentiles, Teachers and Students Matched by Campus, Grade, and Subject, with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
Test Scores Percentiles			
New Regime	-0.003	0.0269	0.0269
Δ Score	-0.105	0.0545**	0.0545**
[Δ Score]*[New Regime]	0.215	0.0797***	0.0798***
Bachelor's Degree	0.359	0.1559**	0.1559**
Master's Degree	2.304	0.1598***	0.1598***
Doctorate	3.061	0.1789***	0.1790***
Male	0.666	0.0218***	0.0223***
Wage Premium	5.139	0.2236***	0.2240***
Exp. 6-10	0.410	0.0225***	0.0225***
Exp. 11-15	0.233	0.0296***	0.0298***
Exp. 16-20	0.055	0.0373	0.0377
Exp. 20+	-0.246	0.0498***	0.0505***
Native American	0.927	0.1022***	0.1075***
Asian American	1.843	0.1145***	0.1191***
African American	1.131	0.0202***	0.0214***
Hispanic	0.343	0.0192***	0.0200***
Prob. Of Promotion	31.062	0.3619***	0.3774***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2001-2002 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for school year.

Table 42. Principal Entry and Rank-Based Z-Scores, Teachers and Students Matched by Campus, Grade, and Subject, with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
Rank-Based Z-Scores			
New Regime	-0.003	0.0269	0.0269
Δ Score	-0.033	0.0165**	0.0165**
[Δ Score]*[New Regime]	0.070	0.0241***	0.0241***
Bachelor's Degree	0.359	0.1558**	0.1558**
Master's Degree	2.303	0.1597***	0.1597***
Doctorate	3.061	0.1789***	0.1789***
Male	0.666	0.0218***	0.0223***
Wage Premium	5.141	0.2236***	0.2240***
Exp. 6-10	0.410	0.0225***	0.0225***
Exp. 11-15	0.233	0.0296***	0.0298***
Exp. 16-20	0.055	0.0373	0.0377
Exp. 20+	-0.245	0.0498***	0.0505***
Native American	0.927	0.1022***	0.1075***
Asian American	1.843	0.1145***	0.1191***
African American	1.130	0.0202***	0.0214***
Hispanic	0.344	0.0192***	0.0200***
Prob. Of Promotion	31.057	0.3619***	0.3774***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2001-2002 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for school year.

Table 43. Principal Entry and Standardized Test Scores, Natural Experiment Design with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
Treatment Group			
New Regime	-0.010	0.1350	0.1351
Δ Score	-0.088	0.0553	0.0554
[Δ Score]*[New Regime]	0.172	0.0892**	0.0893**
Bachelor's Degree	4.671	3.0084	3.0084
Master's Degree	6.977	3.0020**	3.0020**
Male	1.271	0.1029***	0.1053***
Wage Premium	10.645	1.0980***	1.1023***
Prob. Of Promotion	138.325	6.3768***	6.3991***
Control Group			
New Regime	0.174	0.2969	0.3302
Δ Score	-0.078	0.1378	0.1395
[Δ Score]*[New Regime]	-0.049	0.1835	0.1875
Master's Degree	6.139	0.3934***	0.6256***
Male	1.315	0.2729***	0.4553***
Wage Premium	19.184	2.8375***	5.0457***
Prob. Of Promotion	157.338	15.3532***	44.1988***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2001-2002 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for school year, experience, and race.

Table 44. Principal Entry and Test Score Percentiles, Natural Experiment Design with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
Treatment Group			
New Regime	-0.093	0.1327	0.1328
Δ Score	-0.404	0.1816**	0.1819**
[Δ Score]*[New Regime]	0.520	0.2936*	0.2938*
Bachelor's Degree	4.666	3.1421	3.1422
Master's Degree	6.973	3.1360**	3.1361**
Male	1.271	0.1030***	0.1053***
Wage Premium	10.634	1.0985***	1.1029***
Prob. Of Promotion	138.370	6.3855***	6.4083***
Control Group			
New Regime	0.168	0.2962	0.3252
Δ Score	-0.243	0.4328	0.4369
[Δ Score]*[New Regime]	-0.167	0.5762	0.5963
Bachelor's Degree	3.455	0.3935***	0.6224***
Male	1.314	0.2734***	0.4284***
Wage Premium	19.217	2.8379***	5.2778***
Prob. Of Promotion	157.356	15.3817***	38.9286***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2001-2002 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for school year, experience, and race.

Table 45. Principal Entry and Rank-Based Z-Scores, Natural Experiment Design with Murphy-Topel Errors

Variable	Estimate	St. Error	Murphy-Topel
Treatment Group			
New Regime	-0.103	0.1330	0.1332
Δ Score	-0.095	0.0542*	0.0543*
[Δ Score]*[New Regime]	0.151	0.0862*	0.0863*
Bachelor's Degree	4.671	3.0156	3.0156
Master's Degree	6.974	3.0092**	3.0093**
Male	1.268	0.1031***	0.1055***
Wage Premium	10.621	1.0987***	1.103***
Prob. Of Promotion	138.144	6.3752***	6.3976***
Control Group			
New Regime	0.188	0.2984	0.3326
Δ Score	-0.112	0.1191	0.1202
[Δ Score]*[New Regime]	-0.004	0.1593	0.1631
Bachelor's Degree	3.282	0.3929***	0.6209***
Male	1.311	0.2735***	0.4276***
Wage Premium	19.158	2.8339***	5.2698***
Prob. Of Promotion	157.244	15.3007***	38.7948***

Notes: This table shows the estimated coefficients, the naive standard errors, and the Murphy & Topel (1985) corrected standard errors for the probability of entry model. Data covers school years 1994-1995 through 2001-2002 in Texas. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level. Regressions also include controls for school year, experience, and race.

Table 46. Teacher Exit Rates

		Leaving Education	
Experience	All Employees	Teachers	Certified
Less than 5 years	0.332	0.428	0.060
5 to 10 years	0.174	0.181	0.115
10 to 15 years	0.141	0.114	0.121
15 to 20 years	0.129	0.090	0.149
More than 20 years	0.224	0.187	0.554

Notes: The first column shows characteristics of all employees in Texas public schools. The second column shows statistics on teachers upon exit from Texas public schools. The third column shows statistics on certified individuals upon exit. Data covers school years 1994-1995 through 2003-2004 in Texas.

APPENDIX D

SUPPLEMENTARY FIGURE FOR CHAPTER III

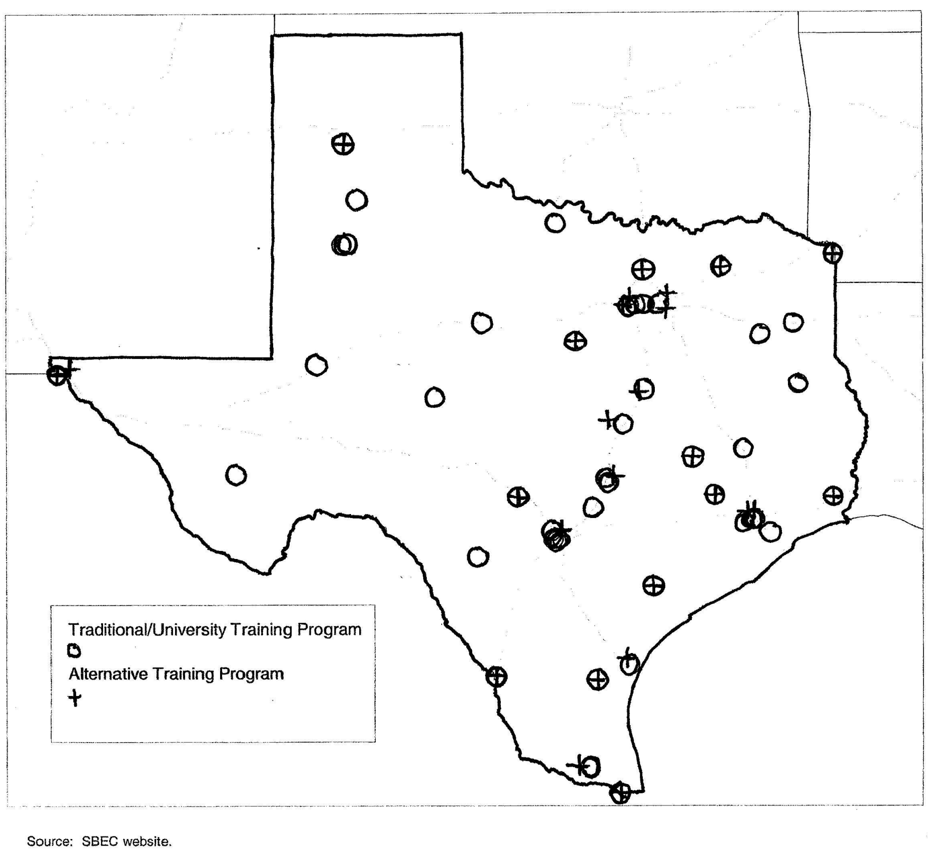

Fig. 10. Locations of Traditional and Alternative Training Facilities

APPENDIX E

SUPPLEMENTARY TABLES FOR CHAPTER IV

Table 47. Estimates of the Log-Earnings Equation, Robust Standard Errors; Market and Individual Characteristics

Clustering on:	Individual	Labor Market
Market Characteristics		
Index of Choice	0.062***	0.062**
	0.006	0.026
Urban District	0.029***	0.029***
	0.004	0.013
Log(Avg. Housing Price)	0.047***	0.047***
	0.004	0.021
Individual Characteristics		
Age	0.005***	0.005***
	0.000	0.001
Experience	0.005***	0.005***
	0.000	0.001
Black	-0.009***	-0.009***
	0.003	0.006
Hispanic	0.021***	0.021***
	0.003	0.004
Asian	-0.015	-0.015
	0.020	0.011
Male	0.034***	0.034***
	0.002	0.004
High School Diploma	0.002	0.002
	0.007	0.020
Master's Degree	0.056***	0.056***
	0.003	0.006
Doctorate	0.150***	0.150***
	0.006	0.006

Notes: Results of the above models are continued in the next table. The column labeled *Individual* reports robust standard errors where clustering is on an individual in the data. The column labeled *LaborMarket* reports robust standard error where clustering is on a labor market. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level.

Table 48. Estimates of the Log-Earnings Equation, Robust Standard Errors; District Characteristics

Clustering on:	Individual	Labor Market
District Characteristics		
TAAS Performance	0.001***	0.001***
	0.000	0.001
District Enrollment(1,000's)	0.000***	0.000***
	0.000	0.000
Special Education	0.305***	0.305
	0.078	0.435
Immigrants	0.568***	0.568**
	0.046	0.281
Economically Disadvantaged	-0.025***	-0.025
	0.007	0.039
School Year Dummies		
1999-00	0.047***	0.047***
	0.001	0.003
2000-01	0.076***	0.076***
	0.001	0.006
2001-02	0.095***	0.095***
	0.002	0.006
2002-03	0.104***	0.104***
	0.002	0.006

Notes: Results of the above models are continued from the previous table. The variable $TAASPerformance$ measures the fraction of students in the school district that passed all the required TAAS examinations. $SpecialEducation$ measures the percentage of students in the district who require special needs. $Immigrants$ measures the percentage of students in the district that have immigrated from a foreign country. $EconomicallyDisadvantaged$ is a variable that measures the percentage of students who are poor. An '*' indicates estimates significant at a 90% level; '**' indicates a 95% significance level; and '***' indicates a 99% significance level.

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