Earnings Disparities: The Role of Internal Promotions and Job Performance Evaluations

Heather Krull*
University of North Carolina at Chapel Hill

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Abstract

This study utilizes a unique data set containing detailed labor market information for individuals employed by the state of North Carolina over ten years. The inclusion of the state's promotion and demotion decisions, as well as each worker's annual performance evaluation, allows for an empirical test of the presence of statistical discrimination that has not been possible in previous studies. Statistical discrimination is said to exist if, in the absence of perfect information about a worker's productivity, an employer uses characteristics of that worker's (race or gender) group to substitute for individual-specific information the firm cannot obtain in its receipt of a signal of the worker's productivity. If the signal is "noisier" for blacks or women than it is for white men, equally productive workers may potentially be paid differently. If, however, performance evaluation serves as a suitable proxy for individual productivity and if statistical discrimination exists at the point of hiring, then the significance of observable characteristics such as race and gender in explaining wage or promotion disparities should diminish as tenure with the firm increases.

The hypotheses that statistical discrimination is not present across both race and gender cannot necessarily be rejected. This result elicits further investigation into how statistical discrimination affects other oft-cited labor market outcomes which differ across groups, including wage disparities and the rate at which promotions (demotions) are realized. Equations explaining the dynamic employment process approximated by the wage and salary grade, performance evaluation, promotion and demotion, and quit probabilities of individuals working within the state of North Carolina over a ten-year period are estimated jointly to allow for correlation in unobserved permanent and time-varying heterogeneity factors affecting each outcome. Preliminary results suggest that younger, more educated workers are more likely to be promoted. Similarly, when controlling for measures unique to these data such as performance evaluation and promotion history, both black and white women are more likely than white men to experience a promotion, even as their tenure with the state increases.

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1 Introduction

To explain earnings disparities across gender or race, wage differential studies typically focus on a combination of explanatory variables including differences in the quantity or quality of education, labor force attachment, pre-market factors, geographic location, the returns to education, tenure, and experience, and affirmative action. The most obvious source of wage variation absent from this research is worker productivity. This information is seldom, if ever, available in nationally representative data sets and is often proxied by such variables as schooling, tenure, and experience. Also lacking from many wage differential studies, but highlighted by McCue (1996) and others, as a significant source of wage growth, is the incidence of internal mobility, including promotion. She finds that approximately 15% of the wage growth enjoyed by men throughout the lifecycle can be attributed to internal mobility, with a smaller contribution for women. Furthermore, better paid workers have a higher probability of being promoted and generally advance their positions early in their career.

It is important to distinguish between "statistical discrimination" and the more commonly referenced "taste discrimination" when evaluating reasons for earning disparities among groups (e.g., gender, race, or age).[1] Alternatively, an employer that statistically discriminates judges an individual on the basis of the average characteristics of the group to which she belongs rather than upon her own personal characteristics. Statistical discrimination may happen if a supervisor with particular characteristics has more reliable information at the onset of employment about a similar worker than about a worker belonging to a different group. The information disparity may be due to either differences in networking strategies across groups or a greater likelihood of miscommunication between members of different groups than between members of like groups. As more information becomes available about a worker's ability (i.e. productivity), statistical discrimination should diminish.

This research furthers the investigation of the earnings gap with a focus on possible differences due to statistical discrimination. The contributions are two-fold: 1) The analyses benefit from the

[1] One approach to examining racial or gender wage differentials involves a theory of discrimination, whereby differences in wages are decomposed into "explained" productivity attributes and "unexplained" differences, commonly cited as prejudice against women or racial minorities. This prejudice is of the "taste discrimination" form and assumes what cannot be explained with education, occupational choice, work experience, etc., is the result of disutility experienced by employers who hire women or minorities. See, for example, Becker (1971), Black (1995), Eckstein and Wolpin (1999), and Flabbi (2005).

availability of a uniform measure of a worker's productivity, and 2) The analyses seek evidence of disparities in wages even after controlling for endogenous tenure, promotion, and productivity. Support for the presence of statistical discrimination in the promotion process, for example, may be evidenced by changes in the size and statistical significance of coefficients measuring the influence of individual characteristics on the probability of promotion as a worker's tenure with a firm increases. Put differently, over the course of a worker's tenure with an employer, there may be significant differences across races in which characteristics are influential in the promotion process and when these attributes play an increasingly important role. That is, a firm may place more emphasis on the race and gender of a minority worker than on potentially less reliable observables such as education and labor market experience in the early stages of the worker's employment. Over time, however, the shift toward relying on worker performance may be much greater for minorities than for workers who are more prominently represented with the firm, which might suggest evidence of statistical discrimination. Hence, accurate measurement of the effects of these characteristics in explaining wages and promotion is necessary to verify their importance. The data used in this work allow for better measurement of these effects.

This work makes use of a rich and comprehensive data set from the North Carolina Office of State Personnel (hereafter referred to as the NC OSP) that is not publicly available. The data contain two features not available in nationally-representative data sets commonly used to study longitudinal employment behavior: a uniform measure of worker performance and an unambiguous definition of promotion (demotion). First, the state's system of annual evaluation provides a measure of performance comparable across workers and time. While worker effort is difficult to measure in general, a firm's evaluation of effort is more readily obtained. Such an evaluation, however, can only be used if comparable across individuals or when provided by a single firm. Usually this results in a small sample size. The state of NC, however, employs over 100,000 people each year. Secondly, previous studies have relied on a worker's self-reported promotion, change in tasks, or unusually large increase in wages (or a combination thereof) as an indication that a promotion has occurred. The state of NC, however, employs a salary grade system similar to the General Schedule (GS) pay scale utilized by the federal government. A promotion (demotion) is defined as an increase (decrease) in salary grade, accompanied by a change in the worker's position-specific

personnel number. The clarity of this definition leaves no room for arbitrary interpretation as deemed necessary by the data used in most other studies.

This paper proceeds as follows. Section 2 summarizes the literature. The data are described in Section 3. Section 4 provides a testable measure of statistical discrimination. The estimates of the empirical model are provided in section 5, and Section 6 concludes.

2 Related Empirical Literature

Black-white wage differential studies have unanimously documented a narrowing of the wage gap between roughly the 1940s and 1980, at which time progress began to slow. Smith and Welch (1987) find that in 1940, the average black man earned 43% of the wages the average white man earned, and black women earned 40% of the average white woman's earnings. That gap had closed to 73% and 99% for men and women, respectively, by 1980. Like many other studies, they attribute the gains to additional years of schooling coupled with improved quality of schooling, migration from the rural south to northern cities, and affirmative action (though Smith (1993) later cites that blacks are only a minority of the 75% of the population protected by affirmative action, with women benefitting the most in terms of improved economic status and higher wages). They suggest that the halted progress is the result of the accelerated break-up of the American family, rising rates of black unemployment, a weak attachment to the labor force among blacks, and a slow-down in American economic growth. This study explores whether there exists a potential difference in the rate at which whites and blacks are promoted, and if so, what role that difference contributes to the wage gap.

The focus of most previous studies of promotions has been gender differences. They are generally conducted in the form of static logit regressions, where the occurrence of a promotion is explained by personal observable characteristics and other variables specific to the employer or available data. Eberts and Stone (1985) estimate a multinomial logit regression using longitudinal data of public educators and determine that men are promoted at a faster rate than women initially (at the beginning of the 1970s) but that women enjoy significant gains throughout the decade as a result of the federal Title IX Equal Employment Opportunity legislation. They also find that more highly educated workers are more likely to be promoted and that promotion probabilities decline with experience for both men and women. Cannings (1988) analyzes managerial promotions within

four of the 400 largest Canadian corporations. She finds that women, on average, receive 0.56 fewer promotions per year than men even when holding constant "career-relevant" factors. Thus, she concludes, women are promoted less often as the result of being born women. Jones and Makepeace (1996) find that the proportion of women who reach managerial ranks falls short of the fraction of men who, in reality, are promoted to such positions, even when women are "treated" the same as men. However, unlike Cannings' evidence that women face a "glass ceiling," they find that the differential treatment is minimal when compared to labor market characteristics, particularly experience.

Hersch and Viscusi (1996) consider how a woman's promotions may be related to having recently terminated her current employment to follow her husband to a new job. Regressing the number of promotions on various demographic characteristics and two mobility variables (moved for a better job and moved because of spousal relocation), they find that women are promoted more frequently, most likely the result of accepting a lower level job than she is qualified for. Hersch and Viscusi also consider differences in promotion across races. They find that the negative impact of being white on the number of promotions is insignificant and likely the result of the extremely small number of blacks in the sample. The effect of the number of promotions on wages is half again as large for men as it is for women.

Killingsworth and Reimers (1983) estimate a logit regression of the probability that workers are assigned to a particular rank at a point in time. The results are then used to estimate the conditional (on the current period's rank) and unconditional likelihood of promotion. Using data on the civilian employees at a large U.S. Army base in the Southeast, they find that nonwhites tend to be employed in lower paid types of positions (blue collar "wage" versus white collar GS position) and lower paid levels within each type. Women are more likely to be in higher paid types of positions (white collar) but at lower paid levels. When these results are used to simulate promotion probabilities, they determine that more nonwhites would be employed in GS positions rather than "wage" (blue collar) jobs, whereas whites would be more likely to be in wage plans and lower GS positions. Furthermore, a larger percentage of nonwhites would be promoted out of GS 1-4 positions and into GS 7-9 or GS 11-16 if they were white, while a smaller percentage of whites would be promoted if they were nonwhite. Thus, Killingsworth and Reimers conclude that race is asscoiated with both different ranking probabilities and different probabilities of change in rank.

McCue (1996) deviates from traditional wage growth studies that examine workers not changing positions or those that change employers altogether. Instead, she considers internal mobility and uses a first differenced wage equation approach to estimate the contribution of promotions and other types of mobility to wage growth. She finds that excess wage growth from position changes contributes 9-18% of total wage growth during the first decade in the labor market. Wages grow most quickly for inexperienced workers. To examine the incidence of internal promotions (that she defines as categorization of a reported position change by respondents, ignoring measured wage changes), McCue estimates a hazard function where workers are at risk of leaving their current position. Black men and women are less likely to leave their current positions than are white men and women. Higher wages, more education, and less labor market experience and job tenure are associated with an increased likelihood of internal moves.

Empirical studies of statistical discrimination have considered a variety of environments including the labor market, traffic stops, mortgage lending, pension benefits, and automobile purchases, among others. Most relevant to this research is Oettinger's (1996) consideration of the effect of statistical discrimination on early career evolution and the racial wage gap. He develops a 2-period model of statistical discrimination in which a firm imperfectly observes worker productivity, where the signal for a black worker is "noisier" than that of a white worker ($\sigma^2_{\varepsilon,B} > \sigma^2_{\varepsilon,W}$) Both individuals and firms learn a worker's true productivity after the first period, and employees are faced with the decision to stay or leave. The model predicts the absence of a black-white wage gap at labor force entry followed by the emergence of an earnings differential as experience accumulates, mostly because blacks enjoy smaller benefits from job mobility. Whites are expected to experience larger wage gains for leaving, whereas blacks receive more substantial gains for staying, thus a distinction between experience and tenure is necessary. His empirical work with the NLSY data provides support for some of the model's predictions. Extensions to Oettinger's work are explored in section 4.

3 Data Description

The data, provided by the NC OSP, contain basic demographic characteristics about each worker such as age, race, gender, and education level, as well as detailed job information each year the

individual is employed with the state.[2] Perhaps most importantly, the data include job performance and promotion indicators not typically found in standard individual-level data sets.

Specifically, the state of North Carolina annually evaluates the performance of each of its employees. The worker's performance is measured on a 1-5 scale, where "1" indicates "unsatisfactory" and "5" represents "outstanding." Typically, each worker's performance is evaluated on either March 31 or June 30. This Performance Management System date is described as the "Effective Date of Performance Management System Rating," indicating that the evaluation refers to the worker's perceived performance during the previous year, and the salary and salary grade take effect as of the date reported (and are thus valid for the next period). More commonly-used economic data sets (such as the CPS or NLSY) randomly sample individuals who do not work for the same employer, thus making a uniform comparison of worker performance an impossibility.

Additionally, previous studies of this nature rely on arbitrary definitions of a promotion (demotion), generally characterized as a self-reported change in tasks or an unusually large increase (decrease) in earnings. According to the state of North Carolina, a worker is promoted (demoted) if his salary grade increases (decreases) and position-specific personnel number changes. The NC OSP data set used in this study also contains a variable detailing the worker's most recent personnel action, including a promotion (demotion) code. This variable, supplemented with a researcher-constructed indicator of promotion/demotion based on salary grade and personnel number, should reasonably accurately capture the realized promotions (demotions).

Of the 1,081,533 employment positions offered by the state over a ten year period (1994-2003), 114,060 were vacant positions, leaving 967,473 valid filled positions (in some cases, a worker may hold multiple jobs in a single year). Of those, 190,784 were unique individuals. 857 workers

[2]The complete list of variables includes: Person-Specific Identification Number, Position-specific Personnel Number, Position-Career Status Code, Position Manager-Supervisor Code, Employee Position-Career Status Code, Employee Manager-Supervisor Code, Standard Occupational Category Code, Sex, Age, Race, Federal EEO Category Description, Employee Job Title Code, Employee Job Title Description, 5-digit Budget Code, Handicap Status, University Budget Source, Employment Status, Performance Management System (PMS) Code, Effective Date of Performance Management System Rating, Department/Division Description, Education Level Required, Veteran Status, Employee Aggregate Service in Months as of End of Last Complete Month, Employee Grade, T-Grade Designation, Employee Step in Salary Range, Employee Annual Salary or Hourly Wage, Federal EEO Category Code, Employee Education Level, Race Description of Employee, Position Type, Appointment Type, Position Months Per Year, Employee's Date of Birth, Employee's Entry on Duty (EOD) Date, County Code Representing Location of Position, Filler, Account Filler, Account Object, Budget Code of Position, Responsibility Cost Center of Position, Position Fund Code, Position Object Code, Budgeted Salary of Position, Position FLSA Code, Employee FLSA Code, Last Personnel Action on Employee, Date of Last Employee Action, Position Job Title Code, Position Job Title, Position County Name, Employee's Longevity Payment Due Date, Employee Part-Time Hours, Position (or budgeted) Grade Level, Position Part-Time Hours.

were dropped from the sample because they held multiple jobs with the state in at least one of the ten sample years. 90,203 individuals are dropped due to invalid tenure data (unavailable in all employment years or because tenure exceeds 12 months at the time the individual is first observed). 22,327 workers are dropped due to age restrictions, an additional 13 are missing age and birthdate data, and 24 have no report of gender. Three workers are eliminated because of conflicting promotion/demotion data (salary may increase, while salary grade decreases, for instance). 134 workers are excluded from the sample due to inconsistent reports of race, as well as the small sample (3,502 total) of the workers whose race is listed as "other" (American-Indian, Asian-American, Spanish-American, or "other."). Eight are dropped because they hold a position located somewhere other than the state of North Carolina (Atlanta, Washington, DC, or Chicago), and 69 have invalid or missing EEO categories in at least one employment year. Finally, 279 individuals were dropped with no report of education, and 50,322 were eliminated due to missing dependent variables[3]. The sample used in estimation contains 23,043 unique black or white individuals, each with a valid set of dependent variables and with the following summary statistics.

Each year, an employee's continuous years of service with the state of North Carolina can be categorized as a one-year spell, a multi-year spell, the longest spell, or the first spell. The descriptive statistics provided in the following tables make use of the worker's first spell with the state. Note that in the absence of demographic information, or if, during the longest multi-year spell the worker is paid both hourly and annually, an alternative spell could be used, if available. Hence, only one spell per worker is used.

Tables 1-5 provide descriptive statistics of the final sample.

3.1 Descriptive Statistics

The average worker in the sample is 37 years old at the time of hire. Nearly 60% of the sample is female, and three-quarters is white. The average performance evaluation is more than four, representing better than "very good." 85% of the reported employment-year education levels invole 12-16 years of schooling. The average annual salary is slighly less than $30,000. Finally, the average

[3]Of the 50,322 individuals dropped because of an incomplete set of dependent variables, 27,386 (54.42% of those dropped, and 37.33% of the remaining sample) are dropped because of missing performance evaluations. Of those, 18,959 had a performance evaluation of "not enough time in job to evaluate" during their first observation with the state. The remaining 8,427 had at least one performance evaluation outside the "unsatisfactory" to "outstanding" range.

experience with the state is roughly three years, and more than 50% of the sample is employed in professional or office and clerical positions.

White men enjoy the greatest earnings, followed by white women. Black men and women earn roughly the same annual salary, which is approximately $4,000 less than white women. White women receive the most favorable performance evaluations, on average. Finally, there is little variation across race or gender in the rate at which promotions and demotions occur.

As Table 3 depicts, the majority of all four demographic groups has earned a high school education, and whites (particularly white women) are most likely to bring to the labor market an advanced degree. The vast majority of the sample has never been promoted, and fewer still have experienced a demotion. Workers have been promoted, at most, every other year. White men and women are much more likely to be employed in professional positions, whereas blacks more frequently work in service and maintenance or as technicians. More men work in protective service and skilled craft, and women tend to occupy office and clerical positions.

While most of the individuals in the sample (94.42%) had one continuous employment spell between 1994 and 2003, consideration must be given to treatment of those who left the state and later returned during the ten-year period. As an alternative to using multiple spells for these individuals, either the first or longest spell seems most appropriate. Since the data are left-censored, the first observed employment spell is not necessarily the first spell with the state. Therefore, the longest spell (the first of the longest spells if multiple spells are of the same length) is used in estimation. Descriptive statistics of the sample's employment spells are detailed in Table 4.

When a worker is making her employment decision at the beginning of a period, economic measures that theoretically influence this decision include vacancies with the state, the unemployment rate, and outside wage offers. Table 9 describes these variables during the 1994-2003 period. There are 100 counties within the state of North Carolina, and more than one-third of the employment positions with the state are located in Orange and Wake counties. Buncombe, Burke, Granville, Guilford, Lenoir, Mecklenburg, Pitt, and Wayne counties account for an additional 25% of the positions, and the remaining 40% are spread throughout the other 90 counties. Of the 1,081,533 total positions offered by the state between 1994 and 2003, 114,060 were vacant. Because the data contain observations for every available position, not just those filled, this number accurately reflects the total number of employment openings offered by the state. The percentage of

Table 1: Descriptive Statistics

	Number of Observations	Mean/Percent	Std. Dev.	Min.	Max.
Non-Time-Varying Demographic Variables					
Age at EOD[1]	23,043	37.15	9.49	25	77
Sex (Female = 1)	23,043	0.57	0.5	0	1
Race (Black = 1)	23,043	0.31	0.46	0	1
Handicap Status (Yes = 1) at EOD	23,043	0.01	0.12	0	1
Veteran Status (Yes = 1) at EOD	23,043	0.11	0.32	0	1
Time-Varying Variables					
PMS Evaluation	84,588	4.13	0.70	1	5
1		0.06			
2		0.55			
3		17.33			
4		50.87			
5		31.18			
Education Level	84,588	3.11	1.09	1	5
Less than High School		3.44			
High School		32.92			
More than High School		24.38			
Four Year Degree		27.67			
Graduate Degree		11.58			
Annual Earnings	84,588	27,874.82	10,727.54	4,492.17	111,785.30
Tenure (in months)	84,588	34.69	26.36	0	120
Federal EEO Category	84,588				
Officials and Administrators		1.08			
Professionals		28.23			
Technicians		17.45			
Protective Service		6.76			
Paraprofessionals		1.18			
Office and Clerical		25.64			
Skilled Craft		9.64			
Service and Maintenance		10.02			

Note
1) This is the worker's age at the time of Entry on Duty.

Table 2: Time-Varying Descriptive Statistics by Race and Gender

	Number of Observations	Mean/Percent	Std. Dev.	Min	Max
Annual Earnings					
White Men	28,303	31,932.92	11,941.81	7,233.76	111,785.30
Black Men	9,340	24,260.06	8,631.26	6,396.31	78,431.18
White Women	30,864	27,734.33	10,149.58	5,634.23	96,069.32
Black Women	16,081	23,101.59	7,347.20	4,492.17	84,218.53
PMS Evaluation					
White Men	28,303	4.14	0.67	1	5
Black Men	9,340	3.82	0.69	1	5
White Women	30,864	4.29	0.68	1	5
Black Women	16,081	3.96	0.71	1	5
Ever Promoted (Yes = 1)					
White Men	7,269	0.21	0.41	0	1
Black Men	2,631	0.18	0.39	0	1
White Women	8,725	0.20	0.40	0	1
Black Women	4,418	0.19	0.39	0	1
Ever Demoted (Yes = 1)					
White Men	7,269	0.01	0.12	0	1
Black Men	2,631	0.02	0.13	0	1
White Women	8,725	0.02	0.14	0	1
Black Women	4,418	0.02	0.15	0	1

Table 3: Descriptive Statistics (Non-time Varying or at EOD) by Race and Gender

	White Men (7,269)	Black Men (2,631)	White Women (8,725)	Black Women (4,418)
Education at EOD				
Less than High School	3.23[1]	7.11	1.46	5.02
High School	28.50	45.04	24.79	38.84
More than High School	20.65	21.25	24.13	29.13
4-year Degree	32.87	21.51	33.59	21.16
Graduate Degree	14.75	5.09	16.03	5.84
Promotions (Number of)				
0	79.10	81.60	80.07	81.08
1	16.11	15.09	15.94	15.39
2	3.89	3.04	3.44	2.90
3	0.77	0.27	0.50	0.54
4	0.12	-	0.03	0.09
5	-	-	0.01	-
Demotions (Number of)				
0	98.61	98.18	98.09	97.67
1	1.36	1.79	1.87	2.29
2	0.03	0.04	0.05	0.05
Federal EEO Category at EOD				
Officials and Administrators	1.31	0.42	0.65	0.48
Professionals	32.10	16.12	31.05	15.57
Technicians	16.00	19.84	14.81	23.88
Protective Service	10.43	12.43	1.55	4.96
Paraprofessionals	0.84	0.84	0.92	0.68
Office and Clerical	11.06	10.07	43.31	36.76
Skilled Craft	21.75	13.65	1.63	0.54
Service and Maintenance	6.52	26.64	6.09	17.13

Note

1) This number represents the percentage of white men with less than a high school education, the percent with a high school diploma, etc.

Table 4: Employment Spells in Sample

	n	Percent
Number of Employment Spells		
One	22,146	96.11
Two	863	3.75
Three	33	0.14
Four	1	0.00
Length of Longest Spell		
One Year	5,909	25.64
Two Years	4,037	17.52
Three Years	3,205	13.91
Four Years	2,385	10.35
Five Years	2,155	9.35
Six Years	1,526	6.62
Seven Years	1,247	5.41
Eight Years	1,108	4.81
Nine Years	784	3.40
Ten Years	687	2.98

Table 5: Entry into Employment

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Cumulative
New	2,275	2,200	2,654	2,493	2,548	2,734	2,401	2,290	1,725	1,723	23,043
Entrants	9.87%	9.55%	11.52%	10.82%	11.06%	11.86%	10.42%	9.94%	7.49%	7.48%	100%
Number of	2,275	3,954	5,818	7,258	8,593	9,968	10,828	11,506	11,938	12,450	23,043
Employees	2.69%	4.69%	6.88%	8.58%	10.16%	11.78%	12.80%	13.60%	14.11%	14.72%	100%

vacant positions by year is presented in Table 9. Generally, a larger percentage of total positions that were vacant increased as the sample progressed, with more than 10% vacant by 1999. A worker deciding whether to work for the state in the next period would base that decision, in part, on the unemployment rate in the state. It serves as an indicator of the likelihood of finding alternative employment. Unemployment rates are available annually by county, but only statewide unemployment rates are presented.[4] Workers in the state of North Carolina faced a spike in unemployment in 2001, and that pattern persisted through 2003.

Appendix Table 10 contains information on outside employment options for a worker as he considers whether to continue working for the state or terminate his employment. In addition to accepting another job, workers may quit working for the state to enter retirement, return to school, or raise a family. However, for the purposes of quantifying the value of lifetime utility if a worker quits, outside earnings will be used.[5]

While the NC OSP data contain variables not found in standard economic data sets, the econometrician nonetheless faces empirical issues that must be dealt with. These include issues related to outside employment alternatives, the reported incidence of involuntary termination, candidate pool for potential hires, the worker's wage and outside earnings potential, the potential lack of supervisor information, and the specific nature of the data. Information regarding each of these, and efforts to deal with them, are presented in Appendix B.

4 Model

4.1 Static Statistical Discrimination Model

A formal model of statistical discrimination, first developed by Phelps (1972) and Aigner and Cain (1977), and subsequently expanded and tested in a variety of contexts[6], is used as the starting point here. The basic static model assumes that firms do not observe a worker's true productivity,

[4] See Table 9

[5] Reported earnings are from the Bureau of Labor Statistics Occupational Employment and Wage Estimates for the State of North Carolina. Earnings are archived according to 2000 SOC equivalent code numbers. Using documentation on the translation between 2000 SOC codes and the eight-category SOC classification system used by states, average hourly and annual earnings are created for each of the eight SOC occupations. Note that the BLS collects earnings data on all employees, including state workers. However, in 2003, for instance, BLS wage estimates are calculated based on the earnings of 3.7 million employees, only 100,000 of whom are included in the data used in this study. The BLS data should sufficiently represent a worker's outside earnings potential.

[6] Knowles, Perisco, and Todd (2001)

μ. Instead, a noisy signal, s, is observed, where

$$s = \mu + u. \tag{1}$$

True productivity, μ, is assumed to be normally distributed with mean m and variance σ_μ^2, i.e., $\mu \sim N(m, \sigma_\mu^2)$. Suppose initially that different groups of workers are equally productive, on average. Independent of μ, u is normally distributed, $u \sim N(0, \sigma_u^2)$. A signal of the worker's productivity may consist of a single observable measure such as a test score, but more realistically may be multi-dimensional and include information conveyed on a resumè (education level, job market experience), as well as worker characteristics observed by a firm during an interview (gender, race, age).

The model of statistical discrimination rests on the assumption that a black worker may send an employer a noisier signal than a white worker, i.e. $\sigma_{u,b}^2 > \sigma_{u,w}^2$. Arguments justifying this claim include the sociological observation that workers belonging to different groups are more likely to miscommunicate than workers in the same group. If a firm employs predominantly white managers, a black job applicant may have a more difficult time communicating his ability to a potential supervisor than would a white worker. Second, white workers more frequently network for jobs using personal contacts, a method which allows for the acquisition of additional information about the quality of a candidate by the firm.

A firm making a hiring, wage, or promotion decision, observing only a worker's signal, uses that information to predict the employee's unobserved productivity.[7] The expected value of a worker's ability, given his signal, is

$$\hat{\mu} = E(\mu|s) = (1 - \theta^2)m + \theta^2 s, \tag{2}$$

where

$$\theta^2 = \frac{\sigma_\mu^2}{\sigma_\mu^2 + \sigma_u^2} \tag{3}$$

is the square of the correlation coefficient between the signal and the true productivity and measures the reliability of the signal. The assumption that $\sigma_{u,b}^2 > \sigma_{u,w}^2$ implies that firms will place less weight on the individual signal and more emphasis on average group productivity for blacks than for whites. This conditional expectation reveals itself in the wage determination process, assuming firms pay

[7] The terms 'skill,' 'ability,' and 'productivity' will be used synonymously here.

workers according to their expected marginal productivity (i.e., $w = \hat{\mu} = E(\mu|s)$)[8]. If average productivity, m, is identical across groups, all workers will receive the same earnings. If m differs across groups, a wage differential will necessarily exist.

Aigner and Cain describe an empirical test of statistical discrimination, whereby performance evaluation is regressed on individual and group characteristics. This procedure is possible using data from the state of North Carolina because of the inclusion of annual performance evaluation. The test and results of it are described in detail in section 5.

In this basic static framework, the presence of statistical discrimination suggests that the state will place more emphasis on average group performance than the individual-specific signal for a black worker than white. However, as the state observes a worker's productivity, it is able to update its beliefs about the worker's ability using both his signal and previous performance evaluations. As the next section shows, the conditional variance of ability decreases as the state learns about a worker.

4.2 Dynamic Model

4.2.1 Statistical Discrimination

Consider now a dynamic framework. As in the static model, at the beginning of the first period, neither the worker nor the firm knows the worker's productivity. The firm, however, receives a noisy signal about the worker's skill, where

$$s_t = \mu + u_t. \tag{4}$$

Consistent with the static model, $\mu \sim N(m, \sigma_\mu^2)$, and independent of μ, $u \sim N(0, \sigma_u^2)$. The worker's (unconditional and conditional (on μ)) signal is distributed normally, where

$$s \sim N(m, \sigma_\mu^2 + \sigma_u^2) \tag{5}$$

$$s|\mu \sim N(\mu, \sigma_u^2) \tag{6}$$

At the beginning of the first period, the state's beliefs about a worker's ability can only be conditioned on the first observed signal. That is,

$$\mu|s \sim N\left((1-\theta^2)m + \theta^2 s, \sigma_\mu^2(1-\theta^2)\right), \tag{7}$$

[8] Oettinger assumes workers are paid a weighted average of expected marginal productivity and piece rate wages. This specification produces the same average wage (m) but is not used here because of the nature of the data used in estimation, whereby workers are almost certainly not paid piece rate wages.

where θ is defined as in Equation 3.

At the end of the first period (and at the end of every subsequent employment year), the state evaluates the worker's performance in his current position. Like a worker's signal, observed performance, p_t, is also a noisy measure of the worker's true ability. Thus,

$$p_t = \mu + \epsilon_t. \tag{8}$$

Similar to a worker's signal, performance evaluation is distributed normally, both conditionally and unconditionally.

$$p \sim N(m, \sigma_\mu^2 + \sigma_\epsilon^2) \tag{9}$$

$$p|\mu \sim N(\mu, \sigma_\epsilon^2) \tag{10}$$

Additionally, given that μ and u are uncorrelated, as are μ and ϵ, it must be the case that s and p are orthogonal, conditional on μ.

At the beginning of the next period, after evaluating a worker's performance, the state updates its beliefs about a worker's ability by conditioning on both the current signal and last period's performance evaluation. Using Bayes' Rule[9], it can be shown that, conditional on both the signal and previous evaluation, the variance of worker ability is[10]

$$\text{var}(\mu|s,p) = \frac{1}{\frac{1}{\sigma_u^2} + \frac{1}{\sigma_\mu^2} + \frac{1}{\sigma_\epsilon^2}} \tag{11}$$

Comparing the period two prior (period one posterior) belief about the variance of ability to the period one prior information, it is clear that the additional information about a worker's

[9] For examples of Bayesian updating, see Crawford and Shum (2005), and Hamilton and Chan (2005), and Mira (2005).

[10] $f(\mu|s,p) = \frac{f(\mu)f(s,p|\mu)}{f(s,p)}$

performance decreases the conditional variance of ability. Specifically, $\text{var}(\mu|s,p) < \text{var}(\mu|s)$ if

$$\begin{aligned} \frac{1}{\frac{1}{\sigma_u^2}+\frac{1}{\sigma_\mu^2}+\frac{1}{\sigma_\epsilon^2}} &< \sigma_\mu^2(1-\theta^2), \\ \text{or } \frac{1}{\frac{1}{\sigma_u^2}+\frac{1}{\sigma_\mu^2}+\frac{1}{\sigma_\epsilon^2}} &< \frac{\sigma_\mu^2\sigma_u^2}{\sigma_\mu^2+\sigma_u^2} \\ \sigma_\mu^2+\sigma_u^2 &< \frac{\sigma_\mu^2\sigma_u^2}{\sigma_u^2}+\frac{\sigma_\mu^2\sigma_u^2}{\sigma_\mu^2}+\frac{\sigma_\mu^2\sigma_u^2}{\sigma_\epsilon^2} \\ \frac{\sigma_u^2\sigma_\mu^2}{\sigma_\epsilon^2} &> 0 \end{aligned} \tag{12}$$

Since $\frac{\sigma_u^2\sigma_\mu^2}{\sigma_\epsilon^2}$ is always positive, the conditional variance of ability will shrink with the addition of new information (the worker's performance evaluation) each period. The posterior information at the end of period t will be become the prior belief of the state at the beginning of period $t+1$. As a worker's tenure with the state increases, beliefs about ability will evolve in this manner according to Bayes' Rule.

This shrinking of the variance is particularly important as the state makes decisions about a worker's salary and salary grade, as well as whether or not to promote a particular worker. Since these decisions are all made after a worker is evaluated, the posterior information is used rather than the prior, and over time, the state will become more informed about a worker's true ability by using all available information.

4.2.2 Promotion Model

At the end of a period, after observing a worker's performance evaluation, the state updates its beliefs about a worker's ability according to Bayes' Rule, as described in the previous section. If, at the end of a period, the state has decided to promote exactly one worker to a new position in period $t+1$, its decision will be based upon the relative period $t+1$ expected productivities of each applicant in the new position, μ_{t+1}, given their current signals, s_t, and previous performance evaluations, p_t.

First, the firm will only promote a worker whose conditional expectation of period $t+1$ output exceeds realized period t productivity. In other words, worker i will only be promoted from

position j to j' in period t if

$$E\left(\mu_{ij't+1}|s_{ij't+1}, p_{ijt}\right) \;>\; p_{ijt}. \tag{13}$$

Additionally, when considering which of two (or more) workers to promote, individual i will be promoted from position j to $j^{'}$ if the net gain of promoting worker i exceeds that of worker $i^{'}$. That is, if

$$E\Big[\left(\mu_{ij't+1}|s_{ij't+1}, p_{ijt}\right) - w_{ij't+1}\Big] \;>\; E\Big[\left(\mu_{i'j't+1}|s_{i'j't+1}, p_{i'jt}\right) - w_{i'j't+1}\Big]. \tag{14}$$

If workers are paid according to their expected productivity, this simplifies to

$$\begin{aligned} E\Big[\left(\mu_{ij't+1}|s_{ij't+1}, p_{ijt}\right) \;-\; E\left(\mu_{ij't+1}|s_{ij't+1}, p_{ijt}\right)\Big] > \\ E\Big[\left(\mu_{i'j't+1}|s_{i'j't+1}, p_{i'jt}\right) \;-\; E\left(\mu_{i'j't+1}|s_{i'j't+1}, p_{i'jt}\right)\Big]. \end{aligned} \tag{15}$$

Finally, using the law of iterated expectations,

$$\begin{aligned} E\left(\mu_{ij't+1}|s_{ij't+1}, p_{ijt}\right) - E\left(\mu_{ij't+1}\right) \;>\; E\left(\mu_{i'j't+1}|s_{i'j't+1}, p_{i'jt}\right) - E\left(\mu_{i'j't+1}\right), \\ \text{or}\;\; E\left(\mu_{ij't+1}|s_{ij't+1}, p_{ijt}\right) - m_i \;>\; E\left(\mu_{i'j't+1}|s_{i'j't+1}, p_{i'jt}\right) - m_{i'}. \end{aligned} \tag{16}$$

Therefore, the two conditions which must hold in order for a firm to decide to promote worker i from position j to $j^{'}$, instead of individual $i^{'}$, are

$$E\left(\mu_{ij't+1}|s_{ij't+1}, p_{ijt}\right) \;>\; p_{ijt}, \tag{17a}$$

$$\text{and}\;\; E\left(\mu_{ij't+1}|s_{ij't+1}, p_{ijt}\right) - m_i \;>\; E\left(\mu_{i'j't+1}|s_{i'j't+1}, p_{i'jt}\right) - m_{i'}. \tag{17b}$$

Note that if different groups of workers are equally productive, i.e. $m_i = m_{i'}$, the second condition simply requires that worker i's conditional expected productivity in position $j^{'}$ exceeds that of worker $i^{'}$.

By allowing the state's expectation of a worker's productivity in a potentially new position to be conditioned on his current signal *and* known (perceived) performance in previous periods, Bayesian updating describes how the state's productivity beliefs evolve. If the state is observed to statistically discriminate, one might expect more favorable outcomes for a discriminated-against worker as his tenure with the state increases. In other words, when the state updates its information, conditional signal variance decreases (potentially to zero if productivity is perfectly observed), and

the reduction happens more quickly for minority workers. As this new information is used in future promotion decisions, a black worker or woman should be observed to be more likely to experience a promotion as tenure increases, relative to an otherwise observationally-equivalent white male.

4.3 Empirical Model

The estimated empirical model allows for a test of statistical discrimination because of the data's inclusion of a worker's performance evaluation. Specifically, as Aigner and Cain observe, the state's estimate of worker ability, $\hat{\mu}$ can be thought of as a least squares prediction, where the worker's productivity is expressed in terms of a group effect, $(1-\theta^2)m$, an individual effect, $\theta^2 s$, and an error term, $u^{'}$. That is,

$$\mu = (1-\theta^2)m + \theta^2 s + u^{'} \tag{18}$$

This equation is estimable if a worker's end-of-period performance evaluation, for example, is treated as a measure of ability and is regressed upon group (race or gender) and individual characteristics[11]. That is,

$$p_t = (1-\theta_{pt}^2)m + \theta_{pt}^2 s_{pt} + u_{pt}^{'}, \tag{19}$$

Different signal error variances across groups support there being evidence of statistical discrimination. Since σ_u^2 is imbedded in θ^2 (equation 3), if equation 19 is estimated separately for two groups, different θ^2s imply differences in either the variance of the signal error (σ_u^2) or the variance of the group's productivity (σ_μ^2). Specifically, consider estimating equation 19 separately for blacks and whites (or men and women) such that

$$p_w = (1-\theta_w^2)m_w + \theta_w^2 s_w + u_w^{'} \tag{20a}$$

$$p_b = (1-\theta_b^2)m_b + \theta_b^2 s_b + u_b^{'} \tag{20b}$$

Here, the "group effect," $(1-\theta^2)m$, is simply the constant term. From that parameter estimate, θ^2 can be extracted, and conclusions can be drawn regarding σ_u^2 and σ_μ^2. The individual component, s, consists of the employee's age (h_t), education level (ed_t), months of tenure at the time of evaluation (x_t), and current salary grade (g_t) when estimated in the first period of employment to determine

[11]Note that here the performance evaluation equation is specified as an OLS regression, but may also be estimated using multinomial logit. For the purposes of testing for statistical discrimination, OLS is used.

whether the state statistically discriminates before beginning to learn about a worker's performance. In subsequent periods, performance evaluation is regressed on these variables, as well as current salary (w_t), promotion and demotion history (a_{t-1}), lagged performance evaluations (p_{t-1}), and various interactions of these variables.

Since workers are paid according to their expected marginal productivity, earnings can similarly be estimated using individual and group factors:

$$w_t = (1 - \theta_{wt}^2)m_w + \theta_{wt}^2 s_{wt} + u_{wt}^{'}.$$

In this specification, the individual effect contains the same explanatory variables as the performance evaluation equation in the first period. Future wage observations, however, are estimated using lagged earnings rather than current salary.

Estimating these regressions in reduced form will result in biased coefficients if any of the explanatory variables are endogenous. One would assume measures such as salary grade, tenure, and the probability of being promoted (demoted) are determined within the model and need to be estimated rather than taken as exogenously given. To that end, equations explaining these endogenous variables are estimated in addition to performance evaluation and earnings.

While salary grade and earnings are highly correlated, each salary grade is associated with a range of earnings levels. Thus, a worker's race (r), gender (f), age, education level (ed_t), occupational category (o_t), tenure with the state (x_t), promotion/demotion history (a_t), current performance evaluation (which is a function of previous evaluations), previous salary (w_{t-1}), and previous salary grade (g_{t-1}), as well as interactions of these variables, are assumed to determine which salary grade a worker is assigned.

$$g_t = X_{gt}^{'}\beta_g + u_{gt}^{'}, \tag{21}$$

where $X_{gt} = (r, f, h_t, ed_t, o_t, x_t, a_t, p_t, g_{t-1}, w_t)$.

At the end of a period, the firm decides if a worker should be promoted, demoted, or remain in his current position. Many of the same variables that influence the other observed outcomes will affect which action the firm takes. One contribution this study makes to the empirical promotion literature is the inclusion of the worker's performance evaluation in the firm's promotion decision. Therefore, assuming a logistic error, u_{at}, the probability that the firm chooses action a_t at the end

of period t, is

$$P(a_t = k) = \frac{exp\left\{X'_{at}\beta_{ak}\right\}}{\sum_{k'=0}^{2} exp\left\{X'_{at}\beta_{ak'}\right\}}, k = 0, 1, 2, \tag{22}$$

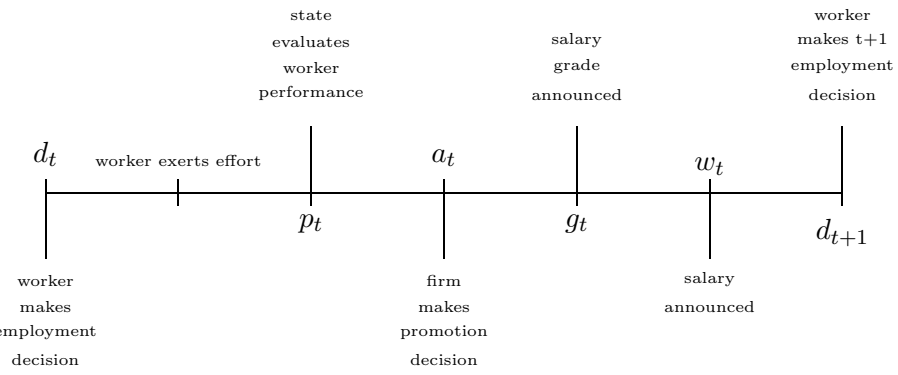
where $X_{at} = (r, f, h_t, ed_t, o_t, x_t, a_{t-1}, p_t, g_t, w_t)$.

Finally, a worker's tenure is accumulated as he makes employment decisions each period. With his current wage offer, salary grade, and promotion decision in hand, he chooses to stay with the firm for one more year or quit in favor of a different alternative. Specifically, the probability of continuing to work for the state, $d_{t+1} = 1$, is given by (assuming a logistic error, u_{dt})

$$P(d_{t+1} = 1) = \frac{exp\left\{X'_{dt}\beta_{d}\right\}}{1 + exp\left\{X'_{dt}\beta_{d}\right\}}, \tag{23}$$

where $X_{dt} = (r, f, h_{t+1}, ed_{t+1}, x_t, a_t, p_t, g_{t+1}, w_{t+1})$.

The independent variables in each equation have been selected with the nature of employment with the state of North Carolina and timing of the model in mind. Timing is as follows.



Conditional on having been hired, a worker makes the decision to continue working for the state or leaving based on demographic characteristics and lagged variables, including whether or not he was promoted at the end of the previous period, how he was evaluated, and his new wage and salary grade offer. If he is observed to continue working for the state, he exerts some effort level. At the end of the period, the state assesses the worker's effort level in the form of a performance evaluation. With an evaluation of the individual's ability, the state decides to promote or demote the worker, or make no change in position status. Since a promotion (demotion) is defined as a simultaneous change in personnel number and increase (decrease) in salary grade, once a promotion

decision has been made, salary grade and salary (within that salary grade) are announced. The worker uses all of this information to make his employment decision at the start of the next period.

Unobserved permanent or time-varying individual heterogeneity that influences one or more of the outcomes reveals itself as correlation among the error components of each equation, u'_{et}, for $e = p, w, g, a, d$. Failure to model this correlation results in biased estimates of the marginal effects of these variables when they are used as explanatory variables in the dynamic employment process. To capture these unobservables, the error term, u'_{et}, is decomposed into a permanent individual heterogeneity component, γ, a time-varying individual heterogeneity component, ν_t, and an i.i.d. error, u''_{et}, where

$$u'_{et} = \rho_e \gamma + \omega_e \nu_t + \xi_{et} \tag{24}$$

The set of dynamic equations is estimated jointly to allow for this correlation across equations. No distributional assumption is imposed on the permanent and time-varying individual components. Rather, their distribution is estimated using the discrete factor random effects estimation method.[12]

5 Results

5.1 OLS Results of Testing for Statistical Discrimination

If equation 19 is estimated separately for blacks and whites (or men and women),

$$\begin{aligned} p_w &= (1-\theta_w^2)m_w + \theta_w^2 s_w + u'_w \\ p_b &= (1-\theta_b^2)m_b + \theta_b^2 s_b + u'_b \end{aligned}$$

and results indicate that $\text{var}(\theta_w^2) \neq \text{var}(\theta_b^2)$, theory predicts that signal quality does indeed vary across groups, implying $\text{var}(\mu^b) \neq \text{var}(\mu^w)$ or $\text{var}(u^b) \neq \text{var}(u^w)$, though it may not be possible to identify the source of the variation in signal quality.

The inclusion of a worker's performance evaluation in this data set allows for estimation that was only previously a theoretical possibility. Additionally, as described above, if workers are paid according to their expected marginal productivity, earnings can also be regressed on a group effect and an individual effect, where the same interpretation of the group effect is possible.

[12] See Heckman and Singer (1984), Mroz and Guilkey (1992), and Mroz (1999).

If a multiplicative transformation of the constant vector is used in the two equations, the slope on the constant (in this case, the group mean of the dependent variable in question) is (1-θ^2). Results of the constants in separate OLS regressions of both performance evaluation and earnings by race and gender are reported below:

Table 6: Test of Equal Signal Quality Across Groups in the First Period of Employment

	Performance Evaluation				Annual Earnings			
	Avg. Eval. (1-4) (SD)	Constant (SE)	θ^2	z	ln(Avg. Salary)	Constant	θ^2	z
Whites	3.008 (0.728)	0.523 (0.179)	1.523	0.555	10.136 (0.362)	0.722 (0.012)	1.722	0.036
Blacks	2.752 (0.703)	0.313 (0.333)	1.313		9.936 (0.300)	0.721 (0.019)	1.721	
Men	2.872 (0.705)	0.457 (0.204)	1.457	1.639	10.094 (0.356)	0.728 (0.013)	1.728	0.902
Women	2.988 (0.749)	0.955 (0.225)	1.955		10.060 (0.356)	0.709 (0.017)	1.709	

For both race and gender and in both equations, z-tests fail to reject the null hypothesis of equal signal qualities across groups in the first period of employment[13]. While signal quality does not statistically significantly differ across groups, the true test of statistical discrimination is imbedded in θ^2.

Recall that $\theta^2 = \frac{\sigma_\mu^2}{\sigma_\mu^2+\sigma_u^2}$, where statistical discrimination is defined as $\sigma_{u,b}^2 > \sigma_{u,w}^2$. If the variance of worker productivity differs across groups, different signal variances may still produce θs that do not differ, as these results suggest. Therefore, while the test for equal signal qualities in the first period suggests an insignificant difference by both race and gender, the possibility of statistical discrimination cannot necessarily be ignored.

[13]When all periods of employment are included in these regressions, the null hypothesis is rejected for both gender and race in both evaluation and earnings equations. See appendix Table 11 for these results

It is especially worth noting that the performance evaluation and wage equations contain endogenous variables (namely current salary grade, and in later periods, current or lagged salary, promotion history, tenure with the state, and lagged performance evaluations), which suggests the estimated coefficients from these reduced form equations will be biased. As such, in order to accurately test for the existence of statistical discrimination, the five equations must be estimated simultaneously.

5.2 Results of Other Outcomes

As described above, the full empirical model estimates five equations: performance evaluation, earnings, salary grade, the decision to stay with the state or leave, and the probability of being promoted/demoted.

Consideration is given to the way in which tenure and age enter the specifications. Specifically, quadratic and cubic age polynomials are estimated, with linear age often only becoming significant with the exclusion of the cubic term. Cubic and quadratic tenure, in addition to linear, cubic, and quadratic tenure interacted with both race and gender are considered. Two-year tenure dummies (in addition to interaction terms) and spline tenure functions (with three, four, and five knots) are also estimated to capture the way in which tenure influences the various dependent variables. The "best" specifications are detailed in the appendix and summarized below.[14]

5.3 Results Controlling for Unobserved Heterogeneity

OLS estimates that do not control for heterogeneity can be found in Appendix Table 12. The results that follow are from a model that allows for both permanent individual and time-varying unobserved heterogeneity. The "best" specification is a two factor model containing one permanent 4-mass point and one time-varying 2-mass point factor[15].

[14] All contain tenure dummies, but the best tenure spline estimates and the best tenure dummy estimates are nearly indistinguishable.

[15] Results with and without heterogeneity also contain year dummies, occupational categories, and a constant term.

Table 7: Results with Heterogeneity

	Stay/Leave n = 95,497 (Stay Excl.)	Action n = 61,894 (No Promo/Demo Excl.)		Evaluation n = 85,103 (Eval = 5 Excl.)			Earnings n = 85,103	Grade n = 85,103
	Leave	Promoted	Demoted	Eval = 1-2	Eval = 3	Eval = 4		
Grade		-0.410	1.122	0.002	-0.083	-0.016	0.049	
		(0.016)	(0.088)	(0.026)	(0.013)	(0.009)	(0.0001)	
ln(Earnings)		3.807	-19.196	-0.835	2.428	0.647		1.652
		(0.273)	(1.646)	(0.466)	(0.231)	(0.169)		(0.004)
Current Eval = 3		0.488	-1.690					
		(0.421)	(1.495)					
Current Eval = 4		0.804	-2.024					
		(0.419)	(1.473)					
Current Eval = 5		0.934	-2.214					
	(0.108)	(0.419)	(1.478)	(0.389)	(0.285)	(0.287)	(0.004)	(0.008)
Female	0.161	0.111	2.317	-0.514	0.372	0.259	0.019	-0.014
	(0.050)	(0.104)	(0.623)	(0.176)	(0.045)	(0.035)	(0.004)	(0.002)
Black	0.331	-0.315	-0.747	1.296	-1.051	-0.448	0.011	-0.022
	(0.59)	(0.131)	(0.695)	(0.186)	(0.060)	(0.053)	(0.004)	(0.003)
Female*Black	-0.430	0.286	-1.065	-0.072	-0.017	-0.063	0.002	0.006
	(0.050)	(0.104)	(0.449)	(0.190)	(0.060)	(0.049)	(0.001)	(0.002)
Age	-0.146	-0.027	-0.051	-0.001	0.017	0.015	0.006	-0.019
	(0.010)	(0.021)	(0.115)	(0.026)	(0.011)	(0.008)	(0.0002)	(0.002)
Age^2	0.136	0.022	0.080	0.006	-0.028	-0.019	-0.005	0.031
	(0.011)	(0.025)	(0.132)	(0.031)	(0.013)	(0.010)	(0.0003)	(0.004)
Age^3								-0.018
								(0.003)
High School	-0.071	0.370	-1.435	-0.204	0.062	0.035	-0.003	0.017
	(0.064)	(0.168)	(0.991)	(0.232)	(0.076)	(0.065)	(0.002)	(0.003)
> High School	0.126	0.708	-2.083	-0.118	0.175	0.103	-0.013	0.047
	(0.067)	(0.173)	(1.001)	(0.250)	(0.081)	(0.069)	(0.002)	(0.003)
College	0.346	0.910	-2.590	-0.155	0.441	0.288	-0.021	0.070
	(0.070)	(0.177)	(1.023)	(0.262)	(0.084)	(0.071)	(0.002)	(0.003)
Graduate Degree	0.616	1.401	-2.358	-0.317	0.827	0.442	-0.022	0.085
	(0.076)	(0.190)	(1.063)	(0.302)	(0.094)	(0.076)	(0.002)	(0.004)
Tenure (in months)							0.001	
							(0.0002)	
$Tenure^2$							-0.001	
							(.00003)	
$Tenure^3$							0.0003	
							(0.0002)	
Female*Tenure	0.002	-0.013	-0.023	0.001	-0.003	-0.001	-0.0005	-0.0003
	(0.001)	(0.002)	(0.009)	(0.004)	(0.001)	(0.001)	(0.0002)	(0.000)
Female*$Tenure^2$							0.001	
							(0.0004)	
Female*$Tenure^3$							-0.0003	
							(0.0002)	
Black*Tenure	-0.002	-0.003	0.026	-0.007	0.007	0.002	0.00003	0.0003
	(0.001)	(0.002)	(0.009)	(0.004)	(0.001)	(0.001)	(0.0002)	(0.000)
Black*$Tenure^2$							-0.001	
							(0.0004)	
Black*$Tenure^3$							0.0005	
							(0.0002)	

Continued on the next page

Table 7: Results with Heterogeneity, cont.

	Stay/Leave	Action		Evaluation			Earnings	Grade
	Leave	Promoted	Demoted	Eval = 1-2	Eval = 3	Eval = 4		
3-4 Yrs Tenure	-0.151	-0.529	-2.288	0.475	-0.406	-0.229		-0.019
	(0.030)	(0.066)	(1.058)	(0.150)	(0.046)	(0.033)		(0.001)
5-6 Yrs Tenure	-0.320	-2.680	-3.551	0.619	-0.387	-0.242		-0.052
	(0.048)	(0.097)	(1.068)	(0.212)	(0.063)	(0.043)		(0.002)
7-8 Yrs Tenure	-0.596	-5.317	-4.842	0.459	-0.321	-0.180		-0.075
	(0.072)	(0.148)	(1.122)	(0.297)	(0.085)	(0.057)		(0.003)
9-10 Yrs Tenure	-0.907	-6.955	-4.871	1.025	-0.286	-0.123		-0.100
	(0.117)	(0.211)	(1.205)	(0.389)	(0.125)	(0.081)		(0.004)
New Job				-3.930	1.227	0.275	0.777	0.517
				(0.331)	(0.282)	(0.288)	(0.014)	(0.011)
New Job*Female							-0.009	-0.022
							(0.002)	(0.002)
New Job*Black							-0.016	-0.031
							(0.002)	(0.002)
Ever Promoted	-1.422	5.207	0.481	-0.097	-0.207	-0.156	-0.016	0.050
	(0.054)	(0.056)	(0.198)	(0.162)	(0.044)	(0.028)	(0.0007)	(0.001)
Time Since Promo	0.402			-0.068	0.061	0.064	-0.001	-0.004
	(0.020)			(0.080)	(0.023)	(0.014)	(0.0003)	(0.001)
Promoted in t-1	0.948	-5.040	-0.917	0.347	0.191	0.156	-0.006	-0.008
	(0.067)	(0.105)	(0.332)	(0.267)	(0.081)	(0.051)	(0.001)	(0.002)
Ever Demoted	-1.669	0.257	27.053	0.787	0.668	-0.007	0.065	-0.142
	(0.209)	(0.198)	(2.481)	(0.411)	(0.161)	(0.126)	(0.003)	(0.005)
Time Since Demo	0.435			-0.591	0.254	0.011	-0.002	0.009
	(0.062)			(0.394)	(0.075)	(0.045)	(0.001)	(0.002)
Demoted in t-1	1.302	-1.357	-26.159	-0.279	0.781	0.136	0.00007	0.018
	(0.228)	(0.354)	(2.902)	(0.741)	(0.272)	(0.192)	(.0004)	(0.008)
Lagged Grade	-0.076							0.008
	(0.003)							(0.0001)
Lagged Salary	1.206						0.075	
	(0.034)						(0.001)	
Lagged Eval = 3	-1.122			-1.882	-0.221	-0.793	0.005	-0.002
	(0.107)			(0.314)	(0.284)	(0.291)	(0.004)	(0.008)
Lagged Eval = 4	-1.525	0.804	-2.024	-4.912	2.622	0.088	0.010	-0.011
	(0.107)	(0.419)	(1.473)	(0.320)	(0.280)	(0.287)	(0.004)	(0.008)
Lagged Eval = 5	-1.675	0.934	-2.214	-7.581	5.522	2.714	0.010	-0.015
	(0.108)	(0.419)	(1.478)	(0.389)	(0.285)	(0.287)	(0.004)	(0.008)
ρ	1.000	5.192	-20.176	-0.322	0.413	-0.148	-0.941	1.681
	(1.000)	(0.359)	(1.948)	(0.666)	(0.278)	(0.207)	(0.003)	(0.007)
ω	1.000	1.176	-2.148	0.107	1.500	0.556	-0.573	0.976
	(1.000)	(0.243)	(0.897)	(0.364)	(0.164)	(0.118)	(0.002)	(0.004)

5.4 Analysis of Estimates

The results of many previous empirical studies are mirrored in this analysis. Younger and more highly-educated workers are more likely to be promoted (relative to no change in status). As

tenure with the state increases, individuals are less likely to experience a promotion or a demotion. This supports the notion that workers are most likely to experience internal mobility early in their careers. Individuals who have experienced either a promotion or demotion in the past are more likely to experience another, but are less likely to change position status during two consecutive periods than if a lapse has occurred since the last promotion or demotion. Workers whose performance in the current period has been evaluated more favorably (i.e. as a 3, 4, or 5 rather than 1 or 2) are more likely to be promoted and less likely to be demoted.

One feature of this study not present in other analyses of promotion is the ability to control for a worker's productivity using performance evaluation as a proxy for ability. Moreover, if the state of North Carolina uses this perception of ability to update expectations about how a worker would perform in a new position following a promotion, the coefficients on race and gender variables yield information about the rate at which blacks and women are promoted, as well as how that rate changes as a worker's performance is observed. Both white and black women are more likely than white men to be promoted. Black men, however are less likely to be promoted. The coefficients on race and gender interacted with tenure are both negative but the smallest in magnitude of all the race and gender effects. Therefore, despite the negative coefficient, even as tenure increases and the state's beliefs about a worker's ability are updated, black and women are more likely to be promoted than men.

Finally, goodness of fit tests can be performed on the model by using different simulation techniques. When the five outcomes are simulated using the actual data and the coefficient estimates, the model predicts employment decisions, earnings, salary grade, and promotion/demotion decisions quite well. However, performance evaluation is underestimated. Unlike the data which show very few evaluations of 1 and 2 and a majority of 4s and 5s, simulated performance evaluation is much more evenly distributed across the four possible outcomes.

6 Conclusions

This study makes use of a rich data set provided by the state of North Carolina that has never been released for external empirical research. Included in the data are two variables that do not typically exist in standard nationally-representative economic data sets. Specifically, the state of

Table 8: Goodness of Fit Test with Actual Data

Outcome	Number of Observations	Mean/Percent	Std. Dev.	Min	Max
Actual Stay/Leave	95,181	0.11129	0.315	0	1
Stay	84,588	88.87%			
Leave	2,631	11.13%			
Simulated Stay/Leave	95,181	0.11078	0.314	0	1
Stay	84,637	88.92%			
Leave	10,544	11.08%			
Actual ln(Annual Earnings)	84,588	10.17289	0.345	8.410	11.624
Simulated ln(Annual Earnings)	84,588	10.15704	4.088	-7.048	28.579
Actual Salary Grade	84,588	62.71024	0.695	50	91
Simulated Salary Grade	84,588	62.8547	5.551	-170.123	310.280
Actual Performance Evaluation	84,588	1.87367	0.703	1	4
1-2	514	0.61%			
3	14,663	17.33%			
4	43,034	50.87%			
5	26,377	31.18%			
Simulated Performance Evaluation	84,588	2.50082	1.119	1	4
1-2	21,093	24.94%			
3	21,448	25.36%			
4	20,776	24.56%			
5	21,271	25.15%			
Actual Promotion/Demotion	61,545	0.10430	0.327	0	2
No Change (0)	55,546	90.25%			
Promotion (1)	5,579	9.06%			
Demotion (2)	420	0.68%			
Simulated Promotion/Demotion	61,545	0.10386	0.326	0	2
No Change (0)	55,559	90.27%			
Promotion (1)	5,580	9.07%			
Demotion (2)	406	0.66%			

North Carolina defines a promotion as a change in position (personnel number) accompanied by an increase in salary grade. Both of these measures exist in the data, which makes identifying a promotion unambiguous and does not require reliance on an arbitrary characterization such as a change in tasks or unusually large wage increase. Additionally, the state of North Carolina annually evaluates the performance of all of its workers on a standard 1-5 scale. Because all employees in the data are employed by the same firm and evaluated using the same rubric, comparison of ability on the job of different workers is permissible.

These unique features create the opportunity to perform empirical tests and develop theoretical models that are either not possible or lack important components when estimated with other data. The existence of performance evaluation allows for a simple test of statistical discrimination. Specifically, the expected value of a worker's performance on the job, conditional on the receipt of an imperfect signal of ability, yields an equation that is estimable by OLS, whereby performance evaluation is regressed on individual and group characteristics. While an exact test of statistical discrimination cannot be performed due to the relevant measures being imbedded in a ratio containing two parameters, the equality of signal reliability across groups can be tested. In the first period, there does not appear to be a difference in signal qualities between men and women or blacks and whites. However, when performance evaluation for all employment years is estimated, a difference emerges for both race and gender. In either cases, the existence of statistical discrimination, imbedded in, but not defined by differences in, signal quality, cannot necessarily be rejected.

One important determinant of wage differentials is the rate at which workers enjoy internal mobility within a firm via promotions. Since these data contain an unambiguous definition of when a promotion occurs, another obvious use of the data is estimation of the probability that a particular worker is promoted. Both the promotion equation and the performance evaluation equation contain endogenous variables, so in the end, a five-equation model of performance evaluation, promotion, earnings, salary grade, and employment decisions, is estimated simultaneously, allowing for permanent and time-varying heterogeneity. The model predicts that more highly-educated, younger workers enjoy promotions at a higher rate, and more often at the beginning of their tenure with the state. Similarly, both black and women are more likely to be promoted than are white men.

The existence of these two unique variables, promotion and performance evaluation, also elicits a model explaining the way a firm learns about a worker's productivity and uses that information to make the most efficient promotion decisions. A dynamic promotion model has been described and will be extended to incorporate learning and the updating of beliefs.

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Appendix A: Variable Construction

A.1 Promotion/Demotion

According to the NC OSP, a promotion (demotion) is defined as an increase (decrease) in salary grade, accompanied by a change in the worker's position-specific personnel number. The "last action taken" variable also contains a code for "promotion (demotion) from." Since salary grade is not available for every employment-year observation, and some salary grades are recoded as missing (detailed below), a promotion (demotion) is also said to have occurred if "last action taken" is coded as such. In cases where it appears a promotion and demotion occurred simultaneously (possible if "last action taken" indicates a promotion (demotion) occurred at the same time personnel number changes and salary grade decreases (increases)), if salary and salary grade change in the same direction, it is assumed "last action take" is miscoded. If salary and salary grade movement conflict, those individuals are dropped from the sample.

A.2 Age

The data include a measure of age, as well as the individual's birth date. A second measure of age is calculated as the number of years between June 30 of a particular year and the worker's birth date. If reported age and calculated age differ in any of the ten years, the calculated measure of age is used as long as the two are the same in at least one year (in these cases, the years in which they differ typically report the worker as being between 80 and 100 years old). If reported age and calculated age are never equal, age is reported as missing. Similarly, if a worker's birth date is never available, coded invalidly (such as 236305 or 64610), or coded 10101, age is reported as missing.

A.3 Race

Race is coded as "White," "Black," "Hispanic," "Asian-American," "American-Indian or Alaskan Native," and "other." If no information on race is available, or if race appears to change during the employee's years of employment, it is coded as missing, and those individuals are dropped from the sample. In the end, only workers who are consistently reported as "White" or "Black" are used in the final sample.

It is worth nothing that according to the NC OSP, "The state employs only United States citizens or aliens who can provide proof of identity and work authorization with three working days of employment."

A.4 Gender

A study of this nature necessitates that no worker have gender coded as missing. Therefore, if reported gender varies during the worker's tenure with the state, the most commonly-occurring report of gender is used all years during which the individual is employed. If gender is never reported, the individual is dropped from the sample.

A.5 Tenure

The data include a measure of aggregate service months each year, as well as the original date the employee began working for the state of North Carolina. If neither is ever reported, or if the worker's entry date changes throughout the sample, experience is coded as missing. Note that when hire date changes, this does not necessarily reflect that the worker left the state and returned. Workers who left and returned most often have a constant entry date, and most individuals with changing entry dates had only one employment spell. Experience is also coded as missing if there exists no valid entry date and reported aggregate service never changes during the worker's employment.

Based on entry date, tenure is manually calculated each year. If calculated tenure exceeds reported aggregate service, it is assumed the individual left the state and returned at some point. Therefore, aggregate service is used as the tenure measure. If the worker's hire date is unavailable and reported aggregate service changes during the sample period, reported service is used. If aggregate service is unavailable or reported service is constant during the sample period (always missing, zero, or some unchanging positive value), and hire data is available and unchanging, calculated tenure is used.

Of the workers who have constant hire dates and varying reports of aggregate service, but whose reported aggregate service exceeds calculated tenure by more than six months in every employment year, there appears to have been a coding error. Though the reported service values appear too large, they are used as the measure of tenure.

After coding tenure as detailed above, if an individual has zero months of tenure in multiple years (reported aggregate service months are constant during a portion of the sample period, though not in every period), the first nonzero observation is used to calculate tenure for all previous periods. If calculated tenure is positive in each employment year, tenure is recoded in this manner. However, for workers with tenure less than zero in at least one of the previous employment years, tenure is considered missing.

For all workers whose tenure is still missing, a random draw is taken from the uniform distribution for the first employment year and observed tenure is assigned according to this draw within the actual observed tenure distribution. The final sample contains only workers who have 0-12 months of reported service at the start of the first observation.

A.6 Education

Both "employee education level" and "education level required" are reported in the data and are supposed to be equal to one another. In some cases (73 occurrences in the 967,473 total observations), "employee education level" is missing or listed as "other" or "miscellaneous." When that occurs, "education level required" is used as the employee's education level. Categorical education levels include less than high school (workers with education reported as "less than 9th grade" or "high school, not graduated"), high school, more than high school but no degree (workers with education reported as "high school + 1 year," "high school + 2 years," or "high school + 3 years"), college graduate, and graduate degree (workers with education reported as "masters," "phd.," "assoc. degree," "dentist," "attorney," or "physician").

Education is considered missing if reported as "miscell.," "other," or "miscellaneous, doctors, lawyers, medical profession." Excluding one-year spells, reported education does not change while employed with the state for most workers. If education is missing during any of their years with the state, it is imputed as the level reported in other years.

If education is missing during any of the years employed with the state, it is assumed to be the previous reported level (or next, in the case of a worker whose education is not reported in the first year he or she is employed with the state). For instance, a worker whose education is first reported to increase from "high school" to "more than high school, no degree" in 1997 is assumed

to be a high school graduate in all years prior to 1997 and a high school graduate with additional years of schooling in all years after and including 1997.

The remaining workers report a decrease and/or multi-level categorical increase (for instance, directly from "high school graduate" to "graduate degree") in their education level during their employment with the state. Like the workers with no report of education, education is coded as missing for these individuals. The final sample contains only individuals whose education is not considered missing throughout the sample period and whose missing education levels could be imputed from other years of data for that worker.

A.7 Salary/Wage

A record of salary is present for all workers for each year they worked with the state. There exist no missing observations. However, an annual salary is indistinguishable from hourly and monthly earnings as reported. The only way to identify how earnings are reported is to examine the integer of earnings. If the integer of earnings ("wage") differs from reported earnings, it appears that the worker earns an hourly wage.

Earnings are considered hourly if salary and its integer do not differ and annual otherwise. There exist 1020 observations where salary and its integer do not differ, but salary is less than or equal to \$85. In these cases, it appears as if the individual's hourly wage is an even dollar amount (e.g., \$14.00), so earnings are coded as hourly. For one worker who is employed in each of the ten sample years, he reportedly earns \$195.00 in every period. This individual's record indicates that his hours per year vary from 3 months to 12 months. As these data do not seem reliable, this salary of \$195 is also coded as hourly, and thus, not used in estimation. The next smallest salary is \$750 (followed by \$855, \$1000, \$1350, \$1500, \$2000, \$2500, \$3000, \$3500, \$3510, etc.), which seems less likely to be a (pattern of) hourly wages, particularly if these individuals began working with the state near the end of a sample period and earned only a partial annual salary.

A.8 Salary Grade

The North Carolina salary schedule includes grades 50-96. However, in addition to 50-96, the data contain salary grades 0, 00, 03, 04, 07, 32, 33, 37, A1, A2, A3, A4, A5, B, B1, B2, B3, B4, C, C1, C2, C3, C4, D, D2, D3, D4, E, G, FR (flat rate), and NG (no grade, used for trainees). In estimation,

salary grade will be used a measure of ranking, and as such, FR and NG have no meaning and will be coded as missing. According to the NC OSP, 0, 03, 04, and 07 should be considered NG, and 00 is treated as bad data on temporary workers. 32, 33, and 37 are likely teachers (in hospitals, for instance, whose salary grades were later consolidated to FR) whose salary grades are invalid and should be considered NG. Finally, there appears to be a hierarchical structure to grades A1 through G, though it is not clear how they compare to grades 50-96. Therefore, all grades that do not fall within the 50-96 will be treated as missing.

Appendix B: Data Limitations

B.1 Employment Alternatives

When a worker's employment at the state is terminated (either voluntarily or involuntary), neither the reason for leaving nor the new destination is clear. The data contain the date and description of the "Last Personnel Action on Employee," which in theory, should allow the researcher to determine the exact reason for departure. However, if the employee notifies the state that he is quitting in favor of alternative employment, but a subsequent personnel action is taken during the same time period, the new destination will be replaced with the most recent action taken. Furthermore, while there exist 157 detailed action codes, only 69 actually appear in the data.[16] If an employee works for the state in one time period but not the next, all that is clear is that his tenure was terminated.

B.2 Involuntary Termination

Related to the lack of information about the worker's destination after leaving the state, none of the action codes appearing in the data suggest that a worker was fired. In much the same way a future destination may be masked by a subsequent personnel code, if an action is taken after the worker is fired, the econometrician is unable to detect an involuntary termination. It is not clear why such separations do not appear in the data, but there does not seem to be a way to identify when a worker has been fired by the state. As such, if a promotion (demotion) is conditional on

[16]The action codes which appear include: Fill by Temporary, Position Transferred To, Position Title Change, Range Revision on Position, Remarks Only, EOD (Entry on Duty) - New Hire, Salary Adjustment, Performance Increase, Range Revision, Reallocation - Employee, Promotion From, Demotion From, Re-Statement, Appointment Change From, Increment Cancelation, Reassignment From, Performance Bonus, Did Not Report, Temporary Assignment Terminated, Other Employment, Separation - Other, Legislative Increase (Automated Update), Accelerated Pay Plan Salary Adjustment, Initial Employee Entry, Broad Banded Area Change, Broad Banded Level Change, Grade-Band Transfer, Broad Banded Job Change, Broad Banded Salary Adjustment, Cancel COLA and/or CGRA, Cancel Legislative Increase, Judicial Automatic Salary Adjustment, Promotional Increase Granted After Effective Date, Reallocation Increase Granted After Effective Date, Range Revision Increase Granted After Effective Date, Special Entry Rate Increase, Geographic Differential, Geographic Differential Increase After Effective Date, Special Salary Adjustment - Retention, Special Salary Adjustment - Equity, Accelerated Pay Plan Salary Adjustment, Salary Adjustment - Trainee, Acting Capacity Promotion, Return From Acting Capacity, Salary Adjustment - Lead Worker, Cancel Salary Adjustment - Lead Worker, Reallocation - Trainee, In-Range - Higher Level, In-Range - Increased Variety and Scope, In-Range - Equity, In-Range - Retention, In-Range Turnover, In-Range - Other Labor Market, In-Range - Skill Based, Cancel In-Range, Demotion (Personal Conduct), Demotion (Unsatisfactory Performance), Demotion (Grossly Ineffective Job Performance), Reallocation Down (Personal Conduct), Reallocation Down (Unsatisfactory Job Performance), Reallocation Down (Grossly Ineffective Job Performance), Legislative Increase - CGRA Bonus, Legislative Increase - Performance Bonus, Legislative Increase - Comp Bonus, as well as five additional codes without descriptions.

having not been fired in the previous period, there does not exist a way to identify employees for whom the condition is not met.

B.3 Potential Hires

Like most employment data sets, only applicants to a particular position who receive and accept a job offer from the state are included in the data. Nothing is known about the state's decision to hire the individuals for whom data are available relative to other applicants. Therefore, only workers who begin their tenure with the state during the sample period will be used in estimation and analysis. In other words, all individuals have 0-12 months of tenure when first observed, and in the case of multiple employments spells between 1994 and 2003, only the first is used.

B.4 Outside Wages

The empirical concern with wages in this study is not unique to the NC OSP data. An employee's wage is not observed after he leaves the state. Therefore, it is not possible for the econometrician to compare the monetary benefits of an outside employment option with the employee's current salary offered by the state. One alternative is to use the average earnings within the state of North Carolina for the occupational category in which the employee was last observed. This approach is used, as it seems reasonable for the individual to consider the option of joining the private sector when making his next-period employment decision.

B.5 Supervisor Demographic Information

One explanatory variable that might prove important in many of the outcomes is information about a particular worker's supervisor. Specifically, if one argument supporting the theory of statistical discrimination is that workers belonging to particular groups communicate differently than workers in the same group, it would be useful to know information about the supervisor making performance evaluation, promotion, etc. decisions. If the majority of managerial positions are filled by white employees, black workers may have difficulty demonstrating their true producity to a white supervisor. Therefore, of particular use to this study is the supervisor's race and gender. Codes in the data that would contain this information are no longer maintained, so the best attempt at obtaining these demographic characteristics would be to identify the worker with

the highest salary grade in a particular department. A series of approximately eight budget codes exist which might allow for disaggregation of all positions into smaller departmental units, from which a supervisor could be isolated.

B.6 Nature of the Data

Finally, the nature of the data may preclude generalization of the results of this study to other industries or the private sector. All individuals in the sample are employed by the (public sector) state of North Carolina. Furthermore, only employees of the state who are covered by the State Personnel Act (SPA) are included in the data.[17]

Appendix C: Additional Data Tables

This section contains information which may be useful in an employee's decision to stay with the state in the following period or leave in favor of some other alternative.

[17]Those employees exempt from the SPA and who are excluded from the data fall into one of the following four categories: Exempt from the Personnel Act (EPA) Professional, Faculty, Senior Academic Administrative Officer Tier-I (SAAO Tier-I), or Senior Academic Administrative Officer Tier-II.

Table 9: County, Vacancy, and Unemployment Descriptive Statistics

	Number of Observations	Mean/Percent
County - Location of Position	84,588	
Orange County	11,040	13.05
Wake County	25,199	29.79
Other	47,349	55.98
Vacancies	114,060	10.55[1]
1994	8,774	8.78[2]
1995	9,553	9.28
1996	9,671	9.24
1997	9,790	9.29
1998	10,746	9.97
1999	11,781	10.67
2000	12,817	11.51
2001	13,391	11.89
2002	13,943	12.39
2003	13,594	11.93
State Unemployment Rate[3]		
1994		4.3
1995		4.3
1996		4.3
1997		3.6
1998		3.5
1999		3.2
2000		3.6
2001		5.5
2002		6.7
2003		6.5

Note

1) The state had 1,081,533 total positions available between 1994 and 2003, and 10.55% of those were vacant.

2) This number represents the percentage of positions in 1994 that were vacant, not the percentage of vacant positions in 1994 relative to the total 114,060 vacancies. Specifically, there were 99,910 positions in 1994, of which 8.78% (8,774) were vacant.

3) Due to the large number of North Carolina counties, only the statewide unemployment rate is presented here.

Table 10: Outside (Private Sector) Earnings

Annual Earnings

	Officials and Admin.	Professional	Technicians	Protective Service	Para-professional	Office and Clerical	Skilled Craft	Service and Maint.
1998	43,228.89	44,355.69	31,473.13	31,016.00	15,925.00	24,138.66	26,381.38	21,963.58
	66,651.79	37,120.08	24,305.14	24,372.31	26,772.55	22,381.95	23,934.11	17,998.84
1999	47,012.69	47,621.18	32,947.95	30,228.33	18,465.00	25,586.20	27,580.42	21,932.86
	66,995.25	37,849.64	25,123.70	24,897.03	28,024.47	23,126.15	24,904.38	18,398.19
2000	49,304.00	49,838.60	34,290.00	32,489.17	20,765.00	27,943.47	28,211.57	23,031.26
	67,867.98	39,770.47	26,056.01	25,658.58	27,518.46	23,787.69	25,594.87	18,959.53
2001	52,202.18	52,259.49	35,461.40	32,706.15	21,165.00	28,801.53	29,614.79	24,004.74
	73,551.02	41,432.55	26,644.61	26,683.15	28,408.01	24,930.54	27,014.14	19,692.95
2002	56,422.96	54,686.85	36,440.93	33,636.15	21,455.00	29,927.61	29,966.24	24,788.95
	72,613.46	41,994.64	27,355.06	27,027.31	30,130.48	25,573.84	27,124.69	20,086.25
2003	59,844.21	57,324.59	37,454.42	35,205.38	22,950.00	30,386.39	30,940.34	25,062.65
	72,144.77	44906.21	29,572.86	30,164.96	31,759.98	27,478.90	30,188.21	21,374.02

Hourly Earnings

	Officials and Admin.	Professional	Technicians	Protective Service	Para-professional	Office and Clerical	Skilled Craft	Service and Maint.
1998	20.78	21.74	15.13	14.91	7.66	11.61	12.68	10.56
	22.23	13.44	11.87	3.87	10.98	8.68	11.40	8.34
1999	22.50	23.93	15.88	14.53	8.88	12.37	13.26	10.54
	19.16	14.30	12.73	5.37	8.89	8.89	11.21	8.74
2000	23.62	24.70	16.54	15.62	9.98	13.51	13.56	11.03
	20.34	15.26	12.79	10.12	4.57	9.18	10.39	9.25
2001	25.02	25.62	17.04	15.72	10.18	13.92	14.24	11.54
	29.56	15.74	12.63	10.82	12.64	9.82	10.58	9.19
2002	27.07	27.24	17.51	16.17	10.32	14.47	14.41	11.92
	23.59	18.00	13.54	5.66	12.86	9.98	10.61	9.24
2003	49.76	28.17	17.99	16.93	11.04	14.70	14.88	12.05
	24.31	18.32	13.82	11.52	12.99	10.12	11.39	9.47

Note

Prior to 1998, the OES program only collected employment statistics on a 3-year cycle. Wage information prior to 1998 has not yet been located. The top row for each year contains private sector average earnings, and the bottom row is the average earnings within the data for NC state employees.

Appendix D: Additional Results

Table 6 contains tests of statistical discrimination for both the earnings and performance evaluation equations in the first period. All results indicate that the null hypothesis of equal signal quality across groups cannot be rejected. When employment observations are used, however, the null hypothesis is rejected for men and women, as well as blacks and whites, for both equations. Results follow.

Table 11: Test of Equal Signal Quality Across Groups Using All Employment Years

	Performance Evaluation				Annual Earnings			
	Avg. Eval. (1-4) (SD)	Constant (SE)	θ^2	z	ln(Avg. Salary)	Constant	θ^2	z
Whites	3.220 (0.681)	0.241 (0.054)	1.241	2.880	10.238 (0.348)	0.389 (0.006)	1.389	5.264
Blacks	2.907 (0.702)	-0.099 (0.105)	0.901		10.022 (0.284)	0.458 (0.011)	1.458	
Men	3.061 (0.691)	0.060 (0.076)	1.060	2.124	10.245 (0.351)	0.444 (0.006)	1.444	7.589
Women	3.178 (0.707)	0.267 (0.061)	1.267		10.115 (0.329)	0.371 (0.008)	1.371	

Here, statistical evidence suggests that $\theta_b^2 \neq \theta_w^2$ and $\theta_m^2 \neq \theta_f^2$. It is unclear whether $\text{var}(\mu^b) \neq \text{var}(\mu^w)$ or $\text{var}(\epsilon^b) \neq \text{var}(\epsilon^w)$ (or both), but the assumption of statistical discrimination ($\text{var}(\epsilon^b) \neq \text{var}(\epsilon^w)$) cannot be dismissed.

The following table contains results from the 5-equation model without correction for endogeneity and unobserved heterogeneity. It corresponds to Table 7 in the results section.

Table 12: OLS Estimates

	Stay/Leave n = 95,497 (Stay Excl.)	Action n = 61,894 (No Promo/Demo Excl.)		Evaluation n = 85,103 (Eval = 5 Excl.)			Earnings n = 85,103	Grade n = 85,103
	Leave	Promoted	Demoted	Eval = 1-2	Eval = 3	Eval = 4		
Grade		-0.247	0.527	0.0013	0.026	0.006	0.035	
		(0.010)	(0.050)	(0.0001)	(0.001)	(0.005)	(0.0001)	
ln(Earnings)		0.861	-7.852	-1.021	-1.187	-0.385		0.965
		(0.146)	(0.897)	(0.337)	(0.096)	(0.077)		(0.004)
Current Eval = 3		0.453	-0.979					
		(0.400)	(1.232)					
Current Eval = 4		0.782	-1.466					
		(0.400)	(1.244)					
Current Eval = 5		0.894	-1.769					
		(0.398)	(1.292)					
Female	0.198	0.132	2.698	-0.514	-0.397	-0.267	-0.021	-0.005
	(0.048)	(0.104)	(0.535)	(0.172)	(0.045)	(0.034)	(0.007)	(0.004)
Black	0.346	-0.263	-0.666	1.305	1.060	0.457	0.008	-0.036
	(0.057)	(0.137)	(0.619)	(0.180)	(0.060)	(0.052)	(0.009)	(0.005)
Female*Black	-0.440	0.304	-1.494	-0.074	0.027	0.068	0.005	0.030
	(0.048)	(0.109)	(0.384)	(0.190)	(0.064)	(0.052)	(0.002)	(0.003)
Age	-0.148	-0.010	-0.227	-0.003	-0.027	-0.020	0.006	0.012
	(0.009)	(0.020)	(0.092)	(0.038)	(0.012)	(0.009)	(0.0003)	(0.002)
Age^2	0.139	0.007	0.258	0.009	0.036	0.023	-0.006	-0.033
	(0.011)	(0.024)	(0.129)	(0.044)	(0.014)	(0.010)	(0.0004)	(0.005)
Age^3								0.027
								(0.004)
High School	-0.060	0.410	-1.872	-0.206	-0.066	-0.039	-0.020	0.071
	(0.064)	(0.163)	(0.845)	(0.242)	(0.083)	(0.071)	(0.003)	(0.004)
> High School	0.117	0.665	-2.033	-0.130	-0.192	-0.118	-0.011	0.100
	(0.066)	(0.168)	(0.836)	(0.253)	(0.087)	(0.014)	(0.003)	(0.005)
College	0.315	0.830	-2.555	-0.174	-0.465	-0.309	-0.017	0.141
	(0.069)	(0.172)	(0.844)	(0.272)	(0.091)	(0.075)	(0.003)	(0.005)
Graduate Degree	0.560	1.269	-2.418	-0.337	-0.864	-0.471	-0.013	0.176
	(0.075)	(0.186)	(1.133)	(0.306)	(0.102)	(0.079)	(0.003)	(0.005)
Tenure (in months)							-0.0006	
							(0.003)	
Tenure^2							0.001	
							(0.001)	
Tenure^3							-0.0008	
							(0.0003)	
Female*Tenure	0.002	-0.012	-0.023	0.002	0.003	0.001	0.001	0.0004
	(0.001)	(0.002)	(0.008)	(0.004)	(0.001)	(0.001)	(0.0004)	(0.0001)
Female*Tenure^2							-0.002	
							(0.001)	
Female*Tenure^3							0.001	
							(0.0004)	
Black*Tenure	-0.002	-0.004	0.027	-0.007	-0.006	-0.002	0.001	0.00006
	(0.001)	(0.002)	(0.008)	(0.004)	(0.001)	(0.001)	(0.001)	(0.0001)
Black*Tenure^2							-0.002	
							(0.001)	
Black*Tenure^3							0.001	
							(0.001)	

Continued on the next page

Table 12: OLS Estimates, cont.

	Stay/Leave	Action		Evaluation			Earnings	Grade
	Leave	Promoted	Demoted	Eval = 1-2	Eval = 3	Eval = 4		
3-4 Yrs Tenure	-0.148	-0.468	-2.936	0.481	0.399	0.231		-0.007
	(0.029)	(0.063)	(1.014)	(0.147)	(0.047)	(0.032)		(0.002)
5-6 Yrs Tenure	-0.322	-2.555	-4.213	0.629	0.356	0.242		-0.030
	(0.045)	(0.098)	(1.021)	(0.210)	(0.062)	(0.041)		(0.003)
7-8 Yrs Tenure	-0.601	-5.170	-5.618	0.472	0.270	0.175		-0.039
	(0.069)	(0.146)	(1.065)	(0.299)	(0.085)	(0.054)		(0.004)
9-10 Yrs Tenure	-0.913	-6.735	-5.643	1.041	0.222	0.118		-0.046
	(0.124)	(0.209)	(1.135)	(0.339)	(0.121)	(0.075)		(0.006)
New Job				-3.932	-1.228	-0.278	3.762	2.048
				(0.331)	(0.288)	(0.291)	(0.020)	(0.018)
New Job*Female							-0.023	-0.052
							(0.005)	(0.004)
New Job*Black							-0.067	-0.126
							(0.005)	(0.005)
Ever Promoted	-1.435	5.139	0.763	-0.100	0.223	0.157	0.010	0.071
	(0.050)	(0.055)	(0.168)	(0.156)	(0.045)	(0.028)	(0.001)	(0.002)
Time Since Promo	0.402			-0.067	-0.060	-0.063	-0.007	-0.015
	(0.018)			(0.078)	(0.023)	(0.014)	(0.001)	(0.001)
Promoted in t-1	0.935	-5.066	-0.868	0.345	-0.189	-0.155	-0.020	-0.047
	(0.065)	(0.096)	(0.297)	(0.268)	(0.083)	(0.056)	(0.002)	(0.004)
Ever Demoted	-1.641	0.582	17.798	0.817	0.607	0.006	0.018	-0.127
	(0.159)	(0.198)	(1.693)	(0.449)	(0.184)	(0.138)	(0.005)	(0.008)
Time Since Demo	0.436			-0.590	-0.248	-0.010	0.002	0.023
	(0.053)			(0.384)	(0.103)	(0.047)	(0.002)	(0.003)
Demoted in t-1	1.321	-1.381	-17.632	-0.283	-0.782	-0.139	0.008	0.063
	(0.214)	(0.349)	(2.020)	(0.838)	(0.319)	(0.213)	(0.008)	(0.012)
Lagged Grade	-0.062							0.032
	(0.003)							(0.0002)
Lagged Salary	1.042						0.369	
	(0.024)						(0.002)	
Lagged Eval = 3	-0.983	0.453	-0.979	-1.878	0.224	0.798	0.016	0.002
	(0.110)	(0.400)	(1.232)	(0.322)	(0.289)	(0.293)	(0.008)	(0.013)
Lagged Eval = 4	-1.391	0.782	-1.466	-4.910	-2.632	-0.089	0.023	-0.012
	(0.109)	(0.400)	(1.244)	(0.339)	(0.286)	(0.290)	(0.008)	(0.013)
Lagged Eval = 5	-1.545	0.894	-1.769	-7.581	-5.540	-2.720	0.027	-0.026
	(0.111)	(0.398)	(1.292)	(0.435)	(0.291)	(0.290)	(0.008)	(0.013)