I. Introduction

The effect of racial discrimination on wages depends on the source of discrimination. Becker (1957) identified three sources of discrimination: consumers, employers and coworkers. Competitive forces tend to eliminate wage differentials based on employer and coworker discrimination (Becker 1957; Arrow 1973). Kahn (1991) has shown, however, that consumer discrimination can cause long-run wage differentials in competitive equilibrium.

In order to test for the presence of consumer racial discrimination, empirical research must control for non-racial components of value, such as performance and ability. Given this necessity, a considerable amount of research has focused on the labor and memorabilia markets in the professional baseball industry. The primary advantage of studying these markets is that professional baseball compiles detailed statistics of player performance that provide relatively accurate measures of individual productivity. Controlling for differences in productivity allows estimation of the economic effect of discrimination. In contrast, labor market studies of non-sport industries face the difficulty of accounting for differences in worker productivity. Characteristics such as education, training, and experience serve as imperfect proxies for individual productivity.

Empirical tests for the presence of discrimination in the baseball labor and memorabilia markets have produced divergent results. Hill and Spellman (1984), Christiano (1988) and Kahn (1993) find no significant evidence of racial discrimination in professional baseball salaries.[1] Yet, Nardinelli and Simon (1990) and Andersen and LaCroix (1991) use data from the baseball card market to show that the value consumers derive from a player's card depends on his race.

These divergent results may be attributable to differences in the two markets. The study of baseball card prices permits the researcher to isolate the effect of consumer discrimination as distinct from employer or coworker discrimination. Discriminatory price differentials in the baseball card market reflect consumer discrimination alone since card prices directly measure the entertainment value that consumers derive from particular players.[2] In contrast, baseball salaries reflect the preferences and actions of employers and coworkers as well as those of consumers. Thus we have two possible explanations for the divergent discrimination results. First, the results are complementary and even though consumer racial discrimination exists in the baseball labor market, the actions of coworkers and employers negate its effect, thereby obscuring any evidence of salary discrimination.[3] Second, the results are contradictory and the finding of consumer racial discrimination in the baseball card market is unreliable.

In this paper, we reconsider the evidence of consumer racial discrimination in the baseball card market. Like the Nardinelli and Simon and Andersen and LaCroix studies, we model the prices of cards issued in a given year as a function of players' lifetime performance statistics. Our study differs, however, from these studies in two important ways. First, we use a data set in which card supply is constant and incentives for speculative demand are weaker. Second, we explore the robustness of our results across variable specifications and econometric techniques.

In contradiction to the aforementioned studies, our estimates yield little evidence of racial discrimination against black and Hispanic players.[4] The only consistent finding of discrimination occurs in the case of Hispanic pitchers. Our analysis indicates, however, that the Hispanic card price differential is limited to a range of performance that contains only three observations.

The next section describes the data and econometric models and discusses the differences between our analysis and those of previous studies. Sections III and IV present the results, and section V offers concluding remarks.

II. The Data and Empirical Models

Our data possess two desirable features: card supply is constant and the card set includes few active players. Constant supply permits the empirical model to attribute price variation to demand factors alone. Nardinelli and Simon use a card set containing substantial supply variation. Supply variation produces inconsistent tobit estimates if card supply is correlated with race, the effect of supply on price varies with player performance, or the conditional variance of price varies with supply.[5] Nardinelli and Simon dismiss the potential problems of supply variation by assuming that the elasticity of price with respect to performance is independent of supply. This assumption, however, is not sufficient to guarantee consistent estimates. To the extent that supply variation is independent of performance, the error term includes the effect of supply on price and the resulting heteroskedasticity produces inconsistent tobit estimates.

In order to examine a card set containing primarily retired players, we consider the 1994 prices of 1974 Topps cards. Consumers in 1994 could accurately evaluate the entire careers of players in the 1974 set since the players were, by that time, retired or near the end of their careers.[6] In contrast, Andersen and LaCroix study the 1985 prices of 1977 Topps cards, even though 122 of the 587 players in the 1977 set were still active in 1985. The 1985 prices of 1977 cards reflect speculation about the future performance of active players.[7] As Nardinelli and Simon note (p. 579), speculative demand can cause the card price of a young promising player to exceed that of an older, but statistically better, player. The speculative component of price, even if not correlated with race, can lead to inconsistent tobit estimates if the error variance changes with the amount of speculative demand.

Baseball card prices from any given year typically contain a large proportion of observations at the minimum price. For example, in our data set 370 (67%) of the 552 observations occur at the minimum price of fifty cents.[8] Collectors refer to cards that sell for the minimum price as common cards. Common cards sell for the same price despite significant differences in player performance. For example, the set of common cards includes players who hit over two hundred home runs, as well as those who hit only three home runs.

Previous studies have attributed the preponderance of common players to censoring of the price distribution. As a consequence, these studies employ the tobit technique to estimate the relationship between card price and performance. In this paper, we use the sample selection model of Heckman (1976, 1979), as well as the tobit model, in order to explore the robustness of results. The sample selection model represents a less restrictive alternative to the tobit model.

The tobit and sample selection models suggest different interpretations of the process generating the data. An interpretation justifying tobit specifies two sources of consumer utility: intrinsic utility that collectors receive from using the card to complete a set, and performance utility that fans receive from a player's lifetime performance. Performance utility depends on a vector, x, of player performance and race, while intrinsic utility is the same for each card. Regardless of player performance, a card is at least as valuable as its intrinsic utility for completing a set, and intrinsic utility is equivalent across cards as long as supply is constant. Common players generate different levels of performance utility, but censoring precludes observation of these differences so that card price reflects only the intrinsic value. Censoring occurs due to a discontinuity in consumer utility as a function of player performance (and possibly race).

Formally, the log of card price can be expressed as,

(1) $$P = P_c + \max\left[0,\ \beta' x + \varepsilon\right],$$

where P_c is the log of the minimum (common) price, β is a vector of unknown parameters, and ε is a normally distributed error with zero mean. The performance component of price, $\beta' x$, is censored since it is only included in total price if it is positive. The tobit technique estimates β from equation (1). If the error term exhibits heteroskedasticity, however, tobit produces inconsistent estimates (Maddala 1983, pp. 178-82). Therefore, we correct our reported results for heteroskedasticity of the form,

(2) $$E\left[\varepsilon^2\right] = \left(\exp[\delta' w]\right)^2,$$

where vector w includes a constant and performance variables, δ is a vector of parameters.

The tobit model assumes that the same stochastic process determines the price of non-common cards and whether or not a card is non-common. In contrast, the sample selection model allows the mean and selection processes to differ. The sample selection model is particularly appropriate when explanatory variables have relatively different effects on the probability of a card being non-common and on the price of a non-common card. For example, world series appearances might increase a player's visibility and thereby strongly affect his probability of achieving non-common status. But given non-common status, world series appearances might only weakly affect mean card price relative to offensive performance measures such as lifetime home runs.

Like the tobit model, the sample selection model is consistent with the theoretical argument that card price depends on intrinsic and performance utility and the latter determines whether a card is non-common. The sample selection model, however, is also consistent with the theoretical argument that there are different price regimes for common and non-common cards and visibility, as a function of player performance, determines which regime holds. According to this perspective, only the performance statistics of non-common (star) players stimulate consumer interest enough to noticeably affect card price. For common cards, a relationship may exist between card price and performance utility, but the effect is small and unobserved in the reported card prices. In this context, censoring is a consequence of a discontinuity in the relationship between card price and utility. This contrasts with the previous argument that censoring arises from a discontinuity in utility as a function of performance.

The sample selection model involves two equations. In the selection equation,

(3) $$Y = \beta_1' x + \varepsilon_1 ,$$

where β_1 is a vector of unknown parameters and ε_1 is a normally distributed error with zero mean. The latent index variable, *Y*, denotes the star quality of the player, perhaps in terms of performance utility or public visibility. We observe the dichotomous selection, *S*, rather than *Y*. Let *S* indicate star status, so that $S = 1$ if and only if $Y > 0$. Thus, the probability that a player achieves star status is the probability that $\varepsilon_1 > -\beta_1' x$.

In the log price equation for star players,

(4) $$P^* = \beta_2' x + \varepsilon_2 ,$$

where P^* is the difference between the natural logarithms of a non-common player's card price and the minimum card price (i.e., $P - P_c$), β_2 is a vector of unknown parameters and ε_2

is a disturbance term. The sample selection model reduces to the tobit model when the selection and mean equations are identical.

We assume that ε_1 and ε_2 follow a bivariate normal distribution with correlation ρ and zero mean. The expected log price given that a player has star status is

(5) $$E\left[P^* \mid \varepsilon_1 > -\beta_1' x\right] = \beta_2' x + E\left[\varepsilon_2 \mid \varepsilon_1 > -\beta_1' x\right] .$$

In this expression, $E\left[\varepsilon_2 \mid \varepsilon_1 > -\beta_1' x\right] = \rho\sigma_2\lambda(\alpha_1)$ where $\alpha_1 = -\beta_1' x / \sigma_1$ and σ_1 and σ_2 are the standard deviations of ε_1 and ε_2 (see Greene 1993, p. 707). Here $\lambda(\alpha) = \phi(\alpha)/(1 - \Phi(\alpha))$ is the inverse Mills ratio (IMR) defined by the ratio of the normal density to the cumulative normal density. Intuitively, the IMR captures the impact of the probability that a card is non-common on the expected price of the card. Substitution for ε_2 in equation (4) yields,

(6) $$P^* = \beta_2' x + \gamma_\lambda \lambda(\alpha_1) + \nu ,$$

where $\gamma_\lambda = \rho\sigma_2$ and ν is a normally distributed error with zero mean. We hypothesize that γ_λ is positive since both the likelihood that a player's card is non-common and the expected price of that card are positively related to performance.

A two-step procedure due to Heckman (1976, 1979) consistently estimates the parameters in the sample selection model. The procedure involves the use of probit to estimate (3) and obtain an estimate of β_1. An estimate of $\lambda(\alpha_1)$ follows from the estimate of β_1. With $\lambda(\alpha_1)$ in hand, OLS estimation of equation (6) can proceed.[9] Through the IMR, the estimation of equation (6) incorporates information from the estimated sample selection process.

A specification test due to Lin and Schmidt (1984) suggests that sample selection, rather than tobit, is the appropriate econometric model of baseball card prices. Lin and Schmidt derive a Lagrange multiplier statistic to test the restrictions imposed by the tobit model against an alternative model proposed by Cragg (1971). Like the sample selection model, the Cragg model specifies different stochastic processes for the probability of a limit observation and for the mean of nonlimit observations. Specifically, the Cragg model constitutes a special case of the sample selection model in which the selection and mean processes are independent. As discussed further below, the Lin and Schmidt test consistently rejects at better than the one percent level the restrictions implied by the tobit model. Hence, the Lin and Schmidt test supports the validity of the sample selection model. In order to demonstrate robustness and to contrast our results with those of previous studies, the next section presents both tobit and sample selection results, distinguishing between hitters and pitchers in each case.

III. Tobit Results

Hitters

The two aforementioned studies employ alternative approaches to measuring hitting performance. Nardinelli and Simon measure lifetime performance with disaggregated data such as hits and home runs. This approach avoids imposing *a priori* restrictions on the estimated relationships. Andersen and LaCroix measure hitting performance with an index known as offensive average: total bases reached from hits, stolen bases and bases on balls, divided by total plate appearances (at-bats plus bases on balls). The single-index approach saves degrees of freedom and facilitates construction of interactive dummy variables between race and performance.[10] To evaluate the robustness of our results, we present models implementing both approaches, but with one qualification: we use a different performance index, total bases reached, to make our interaction and fixed effects models directly comparable. By replacing disaggregated performance variables with total bases reached, we impose linear restrictions on a subset of the coefficients in the fixed effects model. In contrast, Andersen and LaCroix's specification is not directly comparable to that of Nardinelli and Simon since offensive average assumes a non-linear relationship between performance and card price. In Andersen and LaCroix's specification, the marginal effect of total bases reached on card price varies inversely with total plate appearances. The fixed effects model, however, assumes constant marginal effects of the performance variables that compose total bases reached.[11]

In the fixed effects model for hitters, the independent variables include lifetime hits, doubles, triples, home runs, stolen bases, at bats, seasons, and world series games.[12] Dummy variables indicate whether a player played most of his career at first base, second base, shortstop, third base or catcher. The dummy variables *Black* and *Hispanic* measure the fixed effect of race on card price. Following Andersen and LaCroix, we include a dummy variable to indicate rookie cards (those featuring first-year players) and a variable representing the number of seasons served as a team manager.[13] Rookie cards represent players' most desirable cards and frequently sell for a premium. Players who become managers might have higher priced cards due to the extra exposure offered by the managerial position.

As stated above, the interaction model measures batting performance with total bases reached. This index replaces the performance variables from which it is constructed: hits, doubles, triples, home runs, bases on balls and stolen bases. To determine whether the effect of discrimination varies with performance, the specification includes variables interacting race with performance. Like Andersen and LaCroix, we also allow the effect of rookie status to vary with performance.

Since heteroskedasticity can lead to inconsistent estimates in the tobit model, we correct our reported results for heteroskedasticity of the form defined in equation (2). To specify the variables in the error variance function, we estimate equation (2) with all the non-binary performance variables, then pare down the specification by sequentially removing the variable with the lowest t-statistic and reestimating the model until all the remaining heteroskedasticity terms have t-statistics exceeding one in magnitude.[14] The heteroskedasticity terms are presented in the appendix.

Table 1 presents the fixed effects and interaction specifications of the tobit model for hitters. The coefficients on *Black* and *Hispanic* in the fixed effects model garner asymptotic t-statistics of only -.99 and -.30. In the interaction specification, none of the race coefficients are individually significant at the .10 level and both pairs of coefficients have opposite signs.[15] Several of the performance and position variables, however, significantly affect card price at the .05 level: hits, triples, home runs, stolen bases, at bats, seasons as manager, shortstop, catcher and rookie card in the fixed effects model, and seasons as manager, catcher and the performance index in the interaction model.

[Table 1 on page 14]

Table 3 reports Wald test results for the joint significance of the race coefficients. The marginal joint significance level (p-value) for the race coefficients in the fixed effects model is .60. Similarly, in the interaction specification, the marginal joint significance level for the black coefficients is .27, while the Hispanic coefficients do not prove significant at less than the .95 level. Given the t-statistics and Wald statistics presented in tables 1 and 3, we cannot reject, at any conventional significance level, the null hypothesis that race has no effect on the card prices of hitters.

Pitchers

The tobit models for pitchers feature six independent variables that capture positive aspects of pitching performance: wins, saves, strikeouts, complete games, innings pitched and world series innings pitched. We expect these variables to positively affect card price. Two additional variables, earned runs allowed and losses, measure negative aspects of pitching performance and should negatively affect card price.[16] We also include a variable to indicate rookie status. As in the hitters case, we estimate tobit models that incorporate fixed and variable effects of race. We permit the effect of race to vary with an index of pitching performance: the sum of wins, saves and complete games minus losses.[17]

Table 2 presents the fixed effects and interaction specifications of the tobit model for pitchers. The results are corrected for heteroskedasticity of the form defined in equation (2).[18] As shown in table 2, estimation of the fixed effects model yields asymptotic t-statistics of -0.08 and -2.75 for *Black* and *Hispanic.* The Hispanic fixed effect is statistically significant at the .01 level. Thus, the tobit results indicate that consumers undervalue the cards of Hispanic pitchers. When we allow the effect of race to vary with performance, however, the evidence of discrimination against Hispanic pitchers essentially evaporates. None of the race coefficients in the interaction model have a t-statistic greater than .40 in magnitude. Similarly, table 3 reports that the marginal joint significance level for the Hispanic coefficients is .33, while the black coefficients do not prove significant at less than the .90 level. The weak evidence of racial discrimination cannot be attributed to poor model fit since the coefficients for several of the performance variables prove significant at the .05 level: wins, losses and saves in the fixed effects model, and World Series innings, rookie card and the performance index in the interaction model.

[Tables 2 and 3 on pages 15 and 16]

IV. Sample Selection Results

The Lin and Schmidt test rejects the tobit restrictions at better than the one percent level for each of the four tobit specifications (hitters and pitchers with fixed and variable effects of race).[19] This finding suggests that Heckman's sample selection model more accurately represents the process generating baseball card prices. Hence, in this section we examine the relationship between race and card price by employing the sample selection model and the two-step Heckman estimation technique. The results generally concur with those of the tobit model that race does not significantly affect card price, except perhaps for Hispanic pitchers, and that performance variables prove to be significant determinants of card price. The sample selection model, however, provides a more detailed characterization of the discrimination result for Hispanic pitchers.

Hitters

The independent variables in both the selection and mean equations correspond to those used in the tobit analysis described above, except that the mean equation now includes the IMR. In the selection equation, the dependent variable is a dichotomous variable equal to one for player cards with a price above fifty cents and zero otherwise. To avoid potential inconsistency in the probit estimates of the selection equation, we apply a heteroskedasticity-corrected probit model with the error variance defined as in equation (2) except that the vector no longer includes a constant.[20]

Table 4a presents the fixed effects specification of the sample selection model for hitters. The probit estimates indicate that race does not significantly affect the probability that a card sells for the common price. In the OLS estimation of the mean price of non-common hitters, the estimated fixed effects of race do not differ significantly from zero. The coefficients on *Black* and *Hispanic* each garner t-statistics of -1.30 and -1.38. As table 6 indicates, the joint marginal significance of the race coefficients is only .28. As in the tobit model, the significant determinants of card price are performance and position variables. Hits, home runs, stolen bases, at bats, world series games, first base, shortstop, catcher and rookie card have estimated effects that are significant at the .05 level.[21]

[Table 4a on page 17]

Table 4b presents the interaction specification of the sample selection model for hitters. Again, the probit estimates indicate that race does not significantly affect the probability that a card sells for the common price. In the OLS estimation of the mean price of non-common hitters, the Hispanic coefficients prove individually and jointly insignificant (see tables 4b and 6). The black coefficients, though, are individually significant at the .10 level and, as table 6 indicates, their joint marginal significance is .13. Despite the evidence of statistical significance, no direct inferences can be drawn since the coefficients on *Black* and *Black*Performance* have opposite signs. For this reason, we calculate Wald test statistics across the entire performance range to determine whether the black coefficients produce statistically significant price differentials. We discovered that a negative price differential is significant at the .10 level only for non-common black players with fewer than 2699 total bases reached. In our data set, seven of the non-common players in this performance range are black.[22] This limited and weak result hardly represents robust evidence in light of the overall evidence uncovered by our study.

[Table 4b on page 18]

Pitchers

Table 5 presents the fixed effects and interaction specifications of the sample selection model for pitchers. In contrast to the hitters case, we impose homoskedasticity on the probit selection equation. The relatively few degrees of freedom dictated this decision since the heteroskedasticity-corrected probit model would not converge properly.

[Table 5 on page 19]

For both the fixed effects and interaction models, the asymptotic t-statistics for the race coefficients in the probit selection equation indicate that race does not significantly affect the probability that a player's card sells at the common price. This finding is particularly relevant for evaluating the evidence of consumer discrimination against Hispanic pitchers. Our tobit analysis revealed a negative fixed effect for Hispanic pitchers that was significant at the .01 level. The tobit model, however, does not distinguish between the separate effects of racial discrimination on the probability of a player's card selling above the common price and on the price of a non-common player's card. Thus, from the tobit coefficient alone, we could not determine whether the discrimination result applied to all pitchers or just non-commons. The sample selection model, though, enables us to address this issue. In the fixed effects model, the coefficient on *Hispanic* is significant at the .05 level in the mean equation but does not approach any conventional significance level in the selection equation. This finding indicates that the evidence of consumer discrimination is limited to non-common Hispanic pitchers. But the result may merely reflect an outlier effect, since the data contain only three such players.

In the OLS equations for the mean price of non-common pitchers, the black coefficients do not prove significant at any conventional level in either model. The Hispanic coefficients in the interaction model are individually insignificant but jointly significant at the .10 level. The joint significance of the *Hispanic* and *Hispanic*Performance* coefficients in the mean price equation of the sample selection model contrasts with the insignificance of these coefficients in the tobit model. This contrast highlights our overall finding that the evidence of consumer discrimination is limited to non-common Hispanic pitchers.[23]

[Table 6 on page 19]

V. Concluding Remarks

Using a data set preferable to those analyzed in previous studies, we find little evidence of consumer racial discrimination in the baseball card market. This general result proves robust over different variable specifications and econometric techniques. The only consistent evidence of consumer discrimination occurs in the case of non-common Hispanic pitchers. This finding suggests that consumers undervalue the cards of star Hispanic players, such as Luis Tiant. The substantive relevance of this finding, however, is minimal since our data include only three non-common Hispanic pitchers.

Our empirical results contradict those of Nardinelli and Simon (1990) and Andersen and LaCroix (1991). There are several possible explanations for why the empirical results of these two previous studies diverge from those presented here. First, the Nardinelli and Simon and Andersen and LaCroix studies analyzed data sets with serious flaws: variation in card supply, inclusion of active players, and measurement error in the performance regressors. As discussed above, these data flaws can produce inconsistent tobit estimates. Second, these studies used questionable estimation techniques. If the error term is heteroskedastic, tobit estimates are inconsistent. Neither Nardinelli and Simon nor Andersen and LaCroix accounted for this possibility, even though data flaws probably increased the severity of heteroskedasticity in their tobit analyses. Table 3 reflects the potential impact of heteroskedasticity on tobit results. When the tobit estimation imposes homoskedasticity, the Hispanic coefficients in the pitchers interaction model are jointly significant at the .02 level, but when the estimation accounts for heteroskedasticity, the marginal joint significance of these coefficients rises to .33. Additionally, the tobit model may be inappropriate and unnecessarily restrictive since it assumes, unlike the sample selection model, that the same causal process determines whether a card is non-common and the price of non-common cards. Finally, differences in the card sets and prices used may be partially responsible for the divergent results. Even if this is true, the weak evidence of racial discrimination in our analysis indicates that previous findings are sample specific and thus not generalizable.

Given the methodological flaws of previous research and the robustness of our empirical results, the validity of the claim that consumer racial discrimination exists should be questioned. This conclusion is consistent with recent research that has revealed no evidence of salary discrimination in the baseball labor market. In sum, the empirical evidence from the baseball labor and memorabilia markets indicates that consumers have little "taste" (to use Becker's phrase) for racial discrimination.

Table 1

Tobit Models with Heteroskedasticity of Card Price, Hitters

	Fixed Effects		Interaction	
Independent variables	Coefficient	T-statistic	Coefficient	T-statistic
Black	-0.18	-0.99	-0.54	-1.57
Black*Performance index	~~~		0.00016	1.60
Hispanic	-0.06	-0.30	0.13	0.31
Hispanic*Performance index	~~~		-0.00004	-0.31
Hits	0.00217**	2.37	~~~	
Doubles	-0.0002	-0.12	~~~	
Triples	-0.0086**	-1.97	~~~	
Home runs	0.0055***	6.72	~~~	
Bases on balls	-0.0005	-1.38	~~~	
Stolen bases	0.0019***	2.98	~~~	
At bats	-0.00049**	-2.26	-0.00012	-1.26
Seasons as manager	0.073***	2.88	0.071***	2.78
Seasons as player	0.043*	1.65	0.009	0.35
World Series games	0.013	1.49	0.013	1.38
First base	-0.44*	-1.77	-0.26	-1.26
Second base	-0.01	-0.06	-0.28	-1.10
Third base	-0.18	-0.76	-0.32	-1.52
Shortstop	0.45**	2.12	0.08	0.36
Catcher	0.41***	3.19	0.34**	2.52
Rookie card	0.46***	2.91	-1.16*	-1.86
Performance index	~~~		0.00061***	4.05
Rookie card*Performance index	~~~		0.00072***	2.78
Constant	-1.46***	-4.71	-1.18***	-4.20
Log-likelihood	-163.07		-167.02	
LR statistic	389.47		381.57	
N (non-limit/total)	125/341		125/341	

Note: Dependent variable is the difference between the natural logarithms of the player's card price and the minimum card price. The models were estimated with multiplicative heteroskedasticity; these additional terms are presented in the appendix. Performance index is total bases reached. *p<0.10, **p<0.05, ***p<0.01 (two-tailed asymptotic t-tests)

Table 2

Tobit Models with Heteroskedasticity of Card Price, Pitchers

	Fixed Effects		Interaction	
Independent variables	Coefficient	T-statistic	Coefficient	T-statistic
Black	-0.13	-0.08	0.003	0.01
Black*Performance index	~~~		-0.0004	-0.27
Hispanic	-0.75***	-2.75	-4.04	-0.39
Hispanic*Performance index	~~~		0.0120	0.29
Earned runs allowed	-0.00001	-0.01	-0.00014	-0.16
Strikeouts	0.00041*	1.70	0.00031	1.55
Wins	0.0149***	3.37	~~~	
Losses	-0.0281***	-4.81	~~~	
Saves	0.0043***	3.78	~~~	
Complete games	0.0032*	1.83	~~~	
Performance index	~~~		0.0068***	5.28
Innings pitched	0.00075	1.19	0.00014	0.33
World Series innings	0.001	0.35	0.016***	5.11
Rookie card	0.43*	1.65	0.49**	2.32
Constant	-1.49***	-7.38	-1.78***	-9.74
Log-likelihood	-50.55		-54.02	
LR statistic	251.50		244.57	
N (non-limit/total)	57/211		57/211	

Note: Performance index is the sum of wins, saves and complete games minus losses.
See note to table 1 for a description of the dependent variable and estimation.
*p<0.10, **p<0.05, ***p<0.01 (two-tailed asymptotic t-tests)

Table 3

Joint Significance Tests of the Race Coefficients in the Tobit Models

	Heteroskedasticity		Homoskedasticity	
	Statistic	P-value	Statistic	P-value
Hitters Models				
Fixed effects [2]	1.02	0.600	1.37	0.504
Interaction: all race coefficients [4]	3.15	0.533	2.16	0.706
Interaction: black coefficients [2]	2.64	0.267	1.75	0.417
Interaction: hispanic coefficients [2]	0.10	0.951	0.19	0.909
Pitchers Models				
Fixed effects [2]	7.67	0.022	7.36	0.025
Interaction: all race coefficients [4]	2.37	0.668	10.14	0.038
Interaction: black coefficients [2]	0.21	0.900	2.88	0.237
Interaction: hispanic coefficients [2]	2.23	0.328	8.06	0.018

Note: Cell entries are Wald statistics with chi-squared distributions. The degrees of freedom for the test statistics in each row are given in brackets. Test statistics are presented for two specifications of the tobit model. The tobit models with multiplicative heteroskedasticity are presented in tables 1 and 2. The tobit models estimated with homoskedasticity imposed are available from the authors upon request.

Table 4a

Sample Selection Model of Card Price, Hitters (Fixed Effects)

	Probit, Heteroskedastic		Ordinary Least Squares	
Independent variables	Coefficient	T-statistic	Coefficient	T-statistic
Black	0.11	0.70	-0.21	-1.30
Hispanic	0.10	0.41	-0.29	-1.38
Hits	0.00272*	1.89	0.00326***	4.26
Doubles	-0.0098**	-2.52	-0.0021	-0.92
Triples	-0.0019	-0.39	-0.0040	-0.99
Home runs	0.0097***	2.85	0.0044***	5.50
Bases on balls	-0.0008	-1.37	-0.0001	-0.48
Stolen bases	0.0025*	1.89	0.0013**	2.28
At bats	-0.00024	-0.84	-0.00065***	-2.96
Seasons as manager	0.253***	2.88	-0.023	-0.78
Seasons as player	0.047	1.47	0.0059	0.19
World Series games	0.009	0.92	0.018**	2.36
First base	-0.85**	-2.37	-0.38**	-1.99
Second base	0.10	0.32	0.41	1.40
Third base	-0.56**	-2.10	-0.01	-0.004
Shortstop	0.49	1.57	0.73**	2.59
Catcher	0.37*	1.76	0.89***	4.32
Rookie card	0.07	0.28	1.94***	7.02
Inverse Mills Ratio	~~~		0.276	1.59
Constant	-2.05***	-3.40	-1.40***	-3.50
Rho	~~~		0.430	
Log-likelihood	-66.59		-118.47	
LR statistic/R-squared	314.97		0.715	
N	341		125	

Note: The dependent variable in the probit model is dichotomous, coded 1 for non-common players. The dependent variable in the OLS model is the difference between the natural logarithms of the non-common player's card price and the minimum card price. The probit model was estimated with multiplicative heteroskedasticity; these additional terms are presented in the appendix. The t-statistics for the OLS model were calculated using a consistent coefficient covariance matrix defined by Greene (1993).
*p<0.10, **p<0.05, ***p<0.01 (two-tailed t-tests)

Table 4b

Sample Selection Model of Card Price, Hitters (Interaction)

	Probit, Heteroskedastic		Ordinary Least Squares	
Independent variables	Coefficient	T-statistic	Coefficient	T-statistic
Black	-4.18	-1.01	-0.91**	-2.03
Black*Performance index	0.00170	1.02	0.00020*	1.85
Hispanic	-0.04	-0.02	0.12	0.19
Hispanic*Performance index	0.00009	0.11	-0.00007	-0.38
At bats	-0.00042	-0.78	0.00004	0.37
Seasons as manager	1.199*	1.68	0.011	0.14
Seasons as player	-0.074	-0.81	-0.032	-1.01
World Series games	0.055*	1.77	0.024	1.26
First base	-2.09*	-1.69	-0.04	-0.15
Second base	-1.21	-1.17	-0.29	-1.01
Third base	-1.22	-1.14	-0.30	-1.10
Shortstop	-0.24	-0.28	0.15	0.52
Catcher	0.25	0.47	0.69***	2.72
Rookie card	-3.88	-0.25	-0.75	-0.87
Performance index	0.00220*	1.75	0.00050***	2.73
Rookie card*Performance index	0.00184	0.25	0.00065***	3.47
Inverse Mills Ratio	~~~		0.444**	2.24
Constant	-2.46***	-4.16	-1.20***	-2.76
Rho	~~~		0.675	
Log-likelihood	-82.79		-115.44	
LR statistic/R-squared	282.56		0.728	
N	341		125	

Note: Performance index is total bases reached. See note to table 4a for a description of the dependent variables and estimation. *p<0.10, **p<0.05, ***p<0.01 (two-tailed t-tests)

Table 5

Sample Selection Models of Card Price, Pitchers

	Fixed Effects				Interaction			
	Probit, Homoskedastic		Ordinary Least Squares		Probit, Homoskedastic		Ordinary Least Squares	
Independent variables	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Black	-0.62	-1.06	-0.36	-1.17	0.002	0.003	0.07	0.15
Black*Performance	~~~		~~~		-0.0086	-1.29	-0.0023	-1.05
Hispanic	-1.85	-1.16	-0.81**	-2.09	-8.22	-0.10	-3.42	-1.63
Hispanic*Performance	~~~		~~~		0.0385	0.07	0.0095	1.28
Earned runs allowed	-0.00211	-0.79	-0.00134	-1.10	-0.00323	-1.11	-0.00101	-0.90
Strikeouts	0.00143*	1.82	0.00089***	4.72	0.00133*	1.68	0.00088***	4.71
Wins	0.0373**	2.12	0.0214**	2.69	~~~		~~~	
Losses	-0.0121	-0.71	-0.0057	-0.75	~~~		~~~	
Saves	0.0044	0.93	0.0054***	3.35	~~~		~~~	
Complete games	0.0076	0.67	0.0034***	3.32	~~~		~~~	
Performance	~~~		~~~		0.0073**	2.00	0.0069***	4.67
Innings pitched	-0.00080	-0.38	-0.00049	-0.58	0.00130	0.91	0.00015	0.30
World Series innings	0.053***	2.66	0.009*	1.77	0.056***	3.09	0.014***	2.79
Rookie card	1.46***	3.10	0.55**	2.14	1.38***	2.87	0.51*	1.95
Inverse Mills Ratio	~~~		0.691***	4.26	~~~		0.664***	-4.31
Constant	-3.11***	-6.26	-2.06***	-5.21	-3.34***	-6.98	-2.00***	5.38
Rho	~~~		1.191		~~~		1.152	
Log-likelihood	-47.22		-32.12		-48.36		-32.94	
LR statistic/R-squared	151.76		0.842		149.48		0.837	
N	211		57		211		57	

Note: The probit equations were estimated with homoskedasticity imposed. Performance is the sum of wins, saves and complete games minus losses. See the note to table 4a for a description of the dependent variables and estimation.
*p<0.10, **p<0.05, ***p<0.01 (two-tailed t-tests)

Table 6

Joint Significance Tests of the Race Coefficients in the Mean Equations of the Sample Selection Models

	Heteroskedasticity		Homoskedasticity	
	Statistic	P-value	Statistic	P-value
Hitters Models				
Fixed effects [2]	2.55	0.279	2.56	0.278
Interaction: all race coefficients [4]	4.86	0.302	3.92	0.417
Interaction: black coefficients [2]	4.11	0.128	3.46	0.177
Interaction: hispanic coefficients [2]	0.31	0.856	0.28	0.869
Pitchers Models				
Fixed effects [2]	~~~		5.20	0.074
Interaction: all race coefficients [4]	~~~		8.23	0.084
Interaction: black coefficients [2]	~~~		2.68	0.262
Interaction: hispanic coefficients [2]	~~~		6.28	0.043

Note: Cell entries are Wald statistics with chi-squared distributions. The degrees of freedom for the test statistics in each row are given in brackets. The test statistics were calculated using a consistent coefficient covariance matrix defined by Greene (1993). For the hitters models, Wald statistics are reported for two specifications of the selection equation. The sample selection models using probit with heteroskedasticity are presented in tables 4a and 4b. The sample selection models using probit with homoskedasticity imposed are available from the authors upon request.

Table A1

Heteroskedasticity Terms for the Tobit and Sample Selection Models

	Tobit		Sample Selection	
	Fixed Effects	Interaction	Fixed Effects	Interaction
Hitters Models				
Hits	0.00093***	~~~	~~~	~~~
Doubles	~~~	~~~	0.0393***	~~~
Bases on balls	~~~	~~~	-0.0028*	~~~
At bats	~~~	0.00018***	-0.00167***	~~~
Seasons as manager	~~~	~~~	~~~	0.157
Seasons as player	-0.090***	-0.059**	~~~	~~~
World Series games	~~~	0.012	~~~	-0.051**
Performance	~~~	~~~	~~~	0.00030**
Sigma	0.534***	0.469***		
LR statistic	26.54***	8.79**	29.70***	14.42***
Pitchers Models				
Earned runs allowed	0.00243	0.00211		
Strikeouts	0.00104**	0.00122***		
Losses	0.0266*	~~~		
Innings pitched	-0.00312***	-0.00175*		
World Series innings	0.022***	0.010		
Sigma	0.475***	0.613***		
LR statistic	30.35***	25.43***		

Note: The tobit and sample selection models are presented in tables 1, 2, 4 and 5. Sigma is standardized to one in the probit equation of a sample selection model. The LR statistics are tests of homoskedasticity. *p<0.10, **p<0.05, ***p<0.01

Table A2

Descriptive Statistics by Race

	Black		Hispanic		White	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Hitters Models						
Log of card price	0.527	1.107	0.238	0.520	0.279	0.740
Hits	1377.2	846.7	1200.4	787.0	921.6	770.3
Doubles	226.4	151.5	190.2	137.2	148.6	133.4
Triples	39.1	30.5	34.0	25.5	22.0	21.7
Home runs	154.8	146.8	74.9	90.1	93.0	115.4
Bases on balls	506.9	370.1	317.5	242.6	393.5	367.5
Stolen bases	133.2	150.3	114.0	153.7	38.8	63.1
Performance index	2786.4	1819.6	2114.6	1506.6	1825.6	1606.5
At bats	4999.4	2858.9	4437.6	2768.6	3577.7	2769.9
Seasons as manager	0.16	1.20	0.07	0.34	0.43	1.73
Seasons as player	13.6	4.6	12.9	4.9	12.2	4.9
World Series games	6.3	7.1	4.9	7.0	4.8	7.2
First base	0.132		0.093		0.116	
Second base	0.099		0.209		0.111	
Third base	0.022		0.047		0.121	
Shortstop	0.011		0.209		0.159	
Catcher	0.033		0.070		0.227	
Rookie card	0.066		0.047		0.097	
N (non-limit/total)	46/91		15/43		64/207	
Pitchers Models						
Log of card price	0.360	0.844	0.166	0.493	0.215	0.664
Earned runs allowed	802.4	409.2	442.4	417.1	637.3	442.2
Strikeouts	1404.6	898.2	842.5	811.2	976.2	828.2
Wins	124.9	78.4	83.4	81.8	95.4	74.8
Losses	111.1	56.7	64.5	56.1	89.4	60.4
Saves	11.3	21.1	35.5	28.0	32.4	54.3
Complete games	83.7	83.5	52.5	86.6	50.8	59.4
Performance index	108.8	108.4	106.9	105.9	89.1	81.7
Innings pitched	2101.0	1181.6	1337.9	1196.1	1633.6	1198.8
World Series innings	13.3	21.6	6.9	12.5	6.4	12.0
Rookie card	0.071		0.154		0.098	
N (non-limit/total)	4/14		3/13		50/184	

Note: Standard deviations are not reported for the position and rookie card indicators since they are dichotomous variables.

[Tables A1 and A2]

Notes

1. See Raimondo (1983) and Cymrot (1983) for further evidence of no racial discrimination in baseball salaries. Scully (1974) found that, ceteris paribus, racial composition affects team revenue. This evidence, however, is contradicted by Sommers and Quinton (1982).

2. Baseball cards trade in relatively well-developed and competitive secondary markets. Baseball cards are liquid assets, bought and sold by fans and dealers across the nation. Monthly publications quote current market prices. For further details on the baseball card market see Nardinelli and Simon (1990) and Andersen and LaCroix (1991).

3. For example, one goal of the professional baseball players' union is to eliminate discrepancies between player salaries and performance. Given the union's past success in collective bargaining, the union might successfully prevent racial salary differences even in the presence of consumer discrimination.

4. Gabriel, Johnson, and Stanton (1995) also find no significant evidence of discrimination, but their analysis considers only the prices of rookie cards (those featuring players in their initial season) issued over a period of several years.

5. Evidence indicates that card supply is correlated with both race and performance in the 1970 Topps card set used by Nardinelli and Simon. Topps issued the 1970 card set in seven subseries. Each player's card was included in only one subseries and the number of cards printed decreases in each successive subseries. The cards of minority players comprise 31% of the first subseries but only 14.8% of the last subseries. The null hypothesis that the proportion of minority player cards is equal across the supply categories can be rejected at the .13 level. Additionally, the proportion of common cards varies from 50% to 72% across the seven subseries. The null hypothesis that the proportion of common cards is the same across the supply categories can be rejected at the .01 level.

6. Only three of the 565 players in the 1974 set were still active in 1994: Dave Winfield, Goose Gossage and Charlie Hough.

7. Andersen and LaCroix do not explicitly state the source of their performance data, and cite only the 1985 edition of the Macmillan *Baseball Encyclopedia*. The 1985 statistics

underestimate the career performances of active players. This implies that the performance regressors contain measurement error which leads to inconsistent estimates regardless of whether the measurement error is correlated with race.

8. Card prices are obtained from Beckett (1994) and performance data compiled from Wolff (1993). Players are identified as Hispanic if born in Latin America. Black players are identified by inspecting photographs in Slocum (1985). The 1974 Topps set features a total of 565 players. We delete from the data set 13 San Diego players whose cards were printed in reduced numbers due to anticipation that the team would relocate to Washington, DC.

9. The least squares residuals from the estimation of equation (6) are heteroskedastic by construction (Heckman 1976). Specifically, $E\left[v^2\right] = \sigma_2^2\left[1 - \rho^2 IMR\left(IMR + \beta_1' x\right)\right]$. Therefore, we compute the corrected asymptotic covariance matrix as derived by Greene (1981, 1993, pp. 712-3). Estimation of (6) using weighted least squares produces essentially the same results as those presented in this paper. Our application of the sample selection model also accounts for heteroskedasticity in the probit selection equation. Our corrected coefficient standard errors incorporate the additional source of variation due to the estimation of the probit heteroskedasticity terms.

10. A disadvantage of the single index approach is that the weights imposed on the various aspects of hitting performance may not correspond to fans' subjective preferences. For example, a player who hits 100 home runs with a .300 batting average may objectively produce more runs than a player who hits 300 home runs with a .240 batting average, yet fans may prefer the latter player simply because they have a relative preference for home runs.

11. Regardless of this fact, we also estimated a tobit model using offensive average as the performance index. Andersen and LaCroix's specification did not produce any evidence of racial discrimination and reduced the overall fit of the model. These results are available from the authors upon request.

12. Previous studies use a variable for total post-season games, including both world series and league championship series (LCS) games. We use only world series games because the world series offers players greater exposure than the LCS. Moreover, the LCS originated in 1969 and did not exist over the entire careers of most of the players in our data set.

13. With the exceptions of the *Rookie card* and *Seasons as manager* variables, our variable specification matches that employed by Nardinelli and Simon (1990). See Nardinelli and Simon for a discussion of the expected signs of the coefficients of the performance and position variables.

14. We chose this specification approach to save degrees of freedom. Likelihood ratio (LR) tests rejected the null hypothesis of homoskedasticity at the 5% level or better for all of the tobit models estimated (see table A1). Changes in the heteroskedasticity specification did not alter the inferences regarding the effects of race.

15. Since the black coefficients in the interaction specification are individually significant at the .15 level, we conducted Wald tests of no price differential for various levels of performance. These tests reveal that the estimated racial difference in card price is not significant at the .10 level for any level of hitting performance. The black price differential switches from negative to positive at 3450 total bases reached. A positive price differential indicates that the cards of black players sell at a premium.

16. Nardinelli and Simon's model also includes bases on balls and hits allowed. These control variables are redundant, however, since they are strongly correlated with earned runs allowed. For our data, a regression of earned runs allowed on bases on balls and hits allowed has an R-squared of .982. Therefore, we omit these control variables to reduce multicollinearity and save degrees of freedom. We also omit the *Seasons as manager* variable since no pitchers in our data set served as managers.

17. If you believe that a complete game is analogous to a save, our performance index can be interpreted as net decisions. The strength of this index is that it incorporates performance variables for both starters and relievers. Andersen and LaCroix adopt a different approach by allowing the effect of race to vary only with wins. We estimated a tobit model using Andersen and LaCroix's specification and found no statistically significant evidence of consumer racial discrimination. These results are available from the authors upon request.

18. As with hitters, the heteroskedasticity specification retains only variables with t-statistics greater than one in magnitude; these additional terms are presented in table A1.

19. We obtained the following Lin and Schmidt statistics: in the hitters case, $\chi^2[19] = 1409$ for the fixed effects model and $\chi^2[17] = 1059$ for the interaction model; in the pitchers case, $\chi^2[12] = 4917$ for the fixed effects model and $\chi^2[11] = 4587$ for the interaction model. Lin and Schmidt test statistics are derived using residuals from tobit models that assume homoskedasticity. We also performed the test on heteroskedasticity-corrected tobit residuals and obtained similar results.

20. See Yatchew and Griliches (1984) for an explanation of how heteroskedastic errors produce inconsistent probit estimates. As in the tobit analysis, the heteroskedasticity specification retains only variables with t-statistics greater than one in magnitude; these additional terms are presented in the appendix. LR tests reject the null hypothesis of homoskedasticity at the 1% level for the fixed effects and interaction models (see table A1). Changes in the heteroskedasticity specification do not alter the inferences regarding the effects of race.

21. In the sample selection model, *Seasons as manager* proves significant in the selection election but not the mean equation. This result squares with the casual observation that managerial exposure can elevate a player's card price to just above the common price, but only star players with extraordinary performance statistics achieve high card prices.

22. The estimated price differential is positive for non-common black players with more than 4466 total bases reached, suggesting that these players' cards sell for a premium.

23. Wald tests reveal that the estimated Hispanic price differential is significant at the .10 level for non-common pitchers with fewer than 295 net decisions (i.e., the sum of wins, saves and complete games minus losses). In our data set, two of the non-common pitchers in this performance range are Hispanic.

References

Andersen, Torben, and LaCroix, Sumner J. "Customer Racial Discrimination in Major League Baseball." *Economic Inquiry* 29 (1991): 665-77.

Arrow, Kenneth J. "The Theory of Discrimination." In *Discrimination in Labor Markets*, edited by Orley Ashenfelter and Albert Rees. Princeton, NJ: Princeton University Press, 1973.

Becker, Gary M. *The Economics of Discrimination*. Chicago: University of Chicago Press, 1957.

Beckett, James. *Official 1994 Price Guide to Baseball Cards*. New York: The House of Collectibles, 1994.

Christiano, Kevin. "Salaries and Race in Professional Baseball: Discrimination 10 Years Later." *Sociology of Sport Journal* (1988): 136-49.

Cragg, John G. "Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable Goods." *Econometrica* 39 (1971): 829-44.

Cymrot, Donald J. "Migration Trends and Earnings of Free Agents in Major League Baseball, 1976-1979." *Economic Inquiry* 21 (1983): 545-56.

Gabriel, Paul E.; Johnson, Curtis; and Stanton, Timothy J. "An Examination of Customer Racial Discrimination in the Market for Baseball Memorabilia." *Journal of Business* 68 (1995): 215-30.

Greene, William H. "Sample Selection Bias as a Specification Error: Comment." *Econometrica* 49 (1981): 795-8.

----------. *Econometric Analysis*. 2nd ed. New York: Macmillan Publishing Co., 1993.

Heckman, James J. "The Common Structure of Statistical Models of Truncation, Sample Selection, and Limited Dependent Variables and a Simple Estimator for Such Models." *Annals of Economic and Social Measurement* 5 (1976): 475-92.

----------. "Sample Selection Bias as a Specification Error." *Econometrica* 47 (1979): 153-61.

Hill, James Richard, and Spellman, William. "Pay Discrimination in Baseball: Data from the Seventies." *Industrial Relations* 23 (1984): 103-12.

Kahn, Lawrence M. "Customer Discrimination and Affirmative Action." *Economic Inquiry* 29 (1991): 555-71.

----------. "Managerial Quality, Team Success, and Individual Player Performance in Major League Baseball." *Industrial and Labor Relations Review* 46 (1993): 531-47.

Lin, Tsai-Fen, and Schmidt, Peter. "A Test of the Tobit Specification against an Alternative Suggested by Cragg." *Review of Economics and Statistics* 66 (1984): 174-7.

Maddala, G. S. *Limited-Dependent and Qualitative Variables in Econometrics.* New York: Cambridge University Press, 1983.

Nardinelli, Clark, and Simon, Curtis. "Customer Racial Discrimination in the Market for Memorabilia: The Case of Baseball." *Quarterly Journal of Economics* 105 (1990): 575-95.

Raimondo, Henry J. "Free Agents' Impact on the Labor Market for Baseball Players." *Journal of Labor Research* 4 (1983): 183-93.

Scully, Gerald W. "The Economics of Discrimination in Professional Sports: The Case of Baseball." In *Government and the Sports Business*, edited by R. G. Noll. Washington, DC: Brookings Institution, 1974.

Slocum, Frank. *Topps Baseball Cards: The Complete Picture Collection, 1951-1985*. New York: Warner Books, 1985.

Sommers, Paul M., and Quinton, Noel. "Pay and Performance in Major League Baseball: The Case of the First Family of Free Agents." *Journal of Human Resources* 17 (1982): 426-36.

Wolff, Rick, ed. *The Baseball Encyclopedia*. 9th ed. New York: Macmillan Publishing Co., 1993.

Yatchew, A., and Griliches, Z. "Specification Error in Probit Models." *Review of Economics and Statistics* 66 (1984): 134-9.