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5 The Demographic Determinants of the Demand for Black Labor

George J. Borjas

5.1 Introduction

The voluminous literature on the labor market status of blacks has concentrated mostly on the measurement of wage differentials between (statistically) similar blacks and whites.[1] Most of these studies follow the standard methodology of trying to predict what the earnings of blacks would be if they were treated as whites are in the labor market. The difference between this prediction and the actual earnings of blacks is commonly labeled discrimination. It is of some importance to note that such calculations are conducted in a theoretical vacuum: the economic theory of racial discrimination is not used and is not needed in the standard empirical framework.

A few studies have tried to incorporate theoretical insights into the empirical analysis of black-white wage differences. These studies often estimate the demand function for black labor and then test whether the variables responsible for shifts in the demand curve behave as theoretically predicted. Probably the earliest example of this approach is the work of Landes (1968), who specifically tested whether fair employment laws have had an impact on discriminatory behavior.[2] These demand-based studies differ significantly from the descriptive research summarized above because they attempt to explain *how* racial wage differentials are created.

This paper extends the demand approach to analyze how the demand function for blacks responds to changes in the demographic composition of the labor market. In other words, the labor-demand framework is used to measure the extent of labor market competition between

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blacks and such other groups as Hispanics, immigrants, and women. The main methodological tool of the study is an estimation of the production technology in which various race, gender, and ethnic groups serve (along with capital) as inputs in the production function.[3] The parameters of the production function provide important information about the technological relationships among the various inputs. Hence, the estimated production function can be used to answer the following important policy questions: the extent to which black labor has been hampered by the growth of the Hispanic minority; the extent to which new immigrants replace black workers; and the impact of the rapid increase in female labor-force participation rates on black earnings.

The empirical analysis in this paper is based on data from the 1970 Public Use Sample of the U.S. Census. The main finding of the study is that although the demand for black labor is not adversely affected by competition from Hispanic or immigrant labor, it is adversely affected by the rapid increase in the number of women in the labor force. This finding is robust to major changes in the specification of the regression model, to changes in the definition of the labor inputs, and to whether the production technology is estimated using wage data or employment data.

Section 5.2 presents the theoretical framework used in the analysis. Section 5.3 describes the data base in detail and presents the basic estimates of the production technology. Section 5.4 replicates the main empirical analysis by focusing on the effects of labor market competition on the earnings of young blacks. In section 5.5, in which many of the assumptions underlying the model are relaxed, the main results are shown to be very robust to this type of sensitivity analysis. Section 5.6 indicates that although most existing estimates of production functions utilize wage data, it is quite easy to recover independent estimates of the production technology from information on labor-force participation. The demand function for black labor reveals qualitatively similar findings under both specifications. Section 5.7 illustrates an example of the usefulness of the model by simulating the response of the black-white wage ratio and black-white differences in labor-force participation rates to a specific change in the demographic characteristics of the labor force. Finally, Section 5.8 summarizes the results of the study.

5.2 Theoretical Framework

The analysis in this paper assumes that the production technology in the labor market can be characterized by the generalized Leontief production function (Diewert 1971), such that:

(1) $$\theta = \sum_j \sum_i \gamma_{ij}(X_i X_j)^{1/2}, \quad (i,j = 1, \ldots, n),$$

where θ is output; the X_i terms are the various inputs; and the γ_{ij} terms are the technology coefficients. It is easy to verify that the sign of γ_{ij} determines whether inputs i and j are substitutes ($\gamma_{ij} < 0$) or complements ($\gamma_{ij} > 0$). The production function in equation (1) is linearly homogeneous and restricts the values of the technology parameters so that $\gamma_{ij} = \gamma_{ji}$.[4]

The assumption that firms in this labor market maximize profits and face constant input prices leads to the following set of marginal productivity equations:

(2) $$w_i = \gamma_{ii} + \sum_{j \neq i} \gamma_{ij} (X_j/X_i)^{1/2}, \; i, j = 1, \ldots, n,$$

where w_i is the price of input i.

The system of equations in (2) dramatically shows the usefulness of the generalized Leontief technology: the functional form in (1) leads to linear-in-parameters wage equations. Thus, the generalized Leontief technology (which is, of course, a second-order Taylor's approximation to any arbitrary production function) can provide an important link between studies of wage determination and studies of input demand theory.

Although the signs of the parameters γ_{ij} contain information about the substitution possibilities among the n inputs, it is useful to transform these parameters into Hicks partial elasticities of complementarity (Hicks 1970). These elasticities are defined by:

(3) $$c_{ij} = \frac{\theta \theta_{ij}}{\theta_i \theta_j},$$

where $\theta_i = \partial\theta/\partial X_i$, $\theta_{ij} = \partial^2\theta/\partial X_i \partial X_j$. The Hicks elasticity of complementarity measures the effect on the relative price of factor i of a change in the relative quantity of that factor, holding marginal cost and the quantities of other factors constant. Since the analysis is concerned with the effects of changes in the quantities of inputs on relative factor prices, the elasticity of complementarity (rather than its dual, the elasticity of substitution) is the natural measure to quantify this impact.[5] In the generalized Leontief technology, the elasticities of complementarity are given by:

(4a) $$c_{ij} = \frac{\gamma_{ij}}{2(s_i s_j w_i w_j)^{1/2}}$$

(4b) $$c_{ii} = \frac{\gamma_{ii} - w_i}{2(s_i w_i)},$$

where $s_i = w_iX_i/\theta$. Note that the sign of c_{ij} depends on the cross-partial from the production function. Hence, it will be positive when the inputs are complements and negative when the inputs are substitutes.

The estimation of the demand system in (2) is affected by two major econometric problems. First, equations (2) are not wage-determination functions unless (relative) supply conditions are also specified. It is not uncommon in the input-demand literature (for example, Grant and Hamermesh 1981, 355) to estimate the production technology under the assumption that input supply is exogenous. The usual justification for this assumption is that the supplies of age-specific gender and race groups are essentially fixed at any given time. Nonetheless, this assumption ignores the fact that although the total stock of specific labor inputs may be treated as fixed, its distribution across labor markets is likely to be guided by input price differentials. It is therefore unlikely that (relative) input supplies can be treated as exogenous, and the correct estimation of (2) requires a more detailed specification of supply responses to geographic wage differentials and other labor market characteristics. The exact specification of the (relative) supply equation used in the analysis will be discussed in section 5.3.

The second econometric problem that has been ignored in the labor-demand literature is the aggregation of workers into the labor inputs X_i. An implicit assumption in specifying production functions such as equation (1) is that all group i workers are homogeneous within *and* across labor markets. Of course, there are marked differences in the skill levels of individuals within each of these groups, possibly resulting in group i individuals having different average skills across different labor markets. Hence, wage differentials (or income-share differences in the more common translog model) across labor markets may simply reflect an unequal distribution of skill levels, seriously biasing the estimates of the production function.

This problem can be approached in the generalized Leontief framework by characterizing an individual's effective labor supply in terms of a fixed effect indicating the skill level of the individual. In particular, the wage paid to individual l in group i, w_{il}, depends on the market-determined wage level for the average group i person, w_i and on how the skills of individual l vary from the skills of the average group i person, f_l. Thus, in general, $w_{il} = w_{il}(w_i, f_l)$, and the individual's wage rate depends both on market forces and on his (relative) skill level.

To make this approach useful, it is necessary to add structure to the model. Two possible simplifications are $w_{il} = w_if_l$ and $w_{il} = w_i + f_l$. The additive fixed effect assumes that the wage premium resulting from differential skills is independent of the demographic characteristics of the labor market, while the multiplicative specification allows for the possibility of such an interaction.[6] Both of these models were employed in preliminary work and the results were quite similar. For simplicity, therefore, the analysis in this paper uses the additive specification. If it is assumed that f_l can be written in terms of both observable socioeconomic characteristics, Z_l, and a random uncorrelated error, ϵ_l, the stochastic equivalent of equation (2) is given by:[7]

$$(5) \qquad w_{il} = Z_l\beta_i + \sum_{j \neq i} \gamma_{ij} (X_j/X_i)^{1/2} + \epsilon_l, \quad i,j = 1, \ldots, n.$$

Because of the definition of the skill fixed effect, the technology coefficient γ_{ii} is estimated by $\bar{Z}_i\beta_i$, where $\bar{Z}_i$ is the mean value of the socioeconomic characteristics for group i. Equation (5) specifies the wage-determination process at the individual level (given supply conditions) and will be used throughout the empirical analysis.[8]

5.3 Data and Basic Results

The data set used in this analysis is the 1970 1/100 Public Use Sample from the U.S. Census (5 percent SMSA and County Group Sample). The analysis was restricted to working-aged individuals ($18 \leq$ age ≤ 64) who were not in the military; were not self-employed or working without pay; were not residing in group quarters; and had records containing complete information on the variables used in the analysis. The local labor market is defined to be the SMSA in which the individual resided. Hence, the analysis is restricted to the 125 SMSAs identified in the census data.

There was considerable experimentation to determine the number and definition of the labor inputs to be included in the production process. It will be seen that most of the important results can be obtained from a breakdown of labor into six groups: black men *(BM)*, women *(F)*, Hispanic native men *(HNM)*, Hispanic immigrant men *(HIM)*, white native men *(WNM)*, and white immigrant men *(WIM)*. Several points should be made regarding this particular decomposition of the labor inputs. First, all women are aggregated into one group because previous research (for example, Smith 1977) suggests that earnings differentials among different types of women are much narrower than earnings differentials among different types of men. This fact implies that employer differentiation among women is likely to be less important than employer differentiation among men.[9] Second, the samples defined as "white" contain all relevant non-Hispanic, nonblack observations. The "white" samples therefore include Asian immigrants, native Filipinos, and other such non-Caucasians. Finally, although the six-group decomposition is the basis for the empirical analysis presented in this paper, alternative breakdowns are presented in section 5.4 below. The results presented in this section summarize the important technological relationships among the major labor groups.

The employment data necessary for the estimation of equations (5) are obtained from the 1/100 Public Use Samples. The labor input X_i (in the SMSA) is defined as the number of individuals in group i who were of working age and participated in the labor force in 1969.[10] Since the census data are quite extensive, it is expensive to include in the estimates all the observations in each of the labor groups. The analysis therefore contains all the observations of individuals classified as black, Hispanic, or immigrants, but uses random samples of women and white native men.

Finally, the capital data used in the analysis are obtained from Grant (1979). Those data describe the capital stock in manufacturing industries in 1969 and were constructed from the Census of Manufactures and the Annual Survey of Manufactures. The capital data, of course, present serious problems for the analysis, since capital-stock calculations are well known to be subject to large measurement errors. To complicate matters, the available capital data for SMSAs are calculated for manufacturing industries only. In this paper, most of the analysis will be conducted over all industries; hence, the manufacturing capital data will lead to biased parameter estimates unless it is assumed that the aggregate capital stock in the SMSA is (roughly) proportional to the manufacturing capital stock. Because of these measurement problems, the parameter estimates of the production function will be presented in two alternate ways: with the capital variable included in and excluded from the wage equation. The latter restriction is equivalent to assuming a strong separability between capital and the various labor inputs in the generalized Leontief technology.[11]

Table 5.1 presents the means of the wage variables and socioeconomic characteristics of each of the six groups. The variables in the vector Z include years of schooling, years of labor market experience (age minus education minus 6), years of labor market experience squared, whether health limits work activity, and whether married with spouse present.[12] The two wage variables used are the 1969 wage rate and 1969 annual earnings.[13] The means in the table simply iterate what is already known about the various groups: blacks tend to do slightly worse than Hispanics, who in turn do worse than whites. It is easy to see, however, that a significant fraction of these wage differentials may be caused by major differences in educational attainment and labor market experience across the various groups.

To illustrate the types of jobs held by persons in each of the groups, table 5.1 also provides statistics summarizing the occupation and industry mix of each of the groups. There are dramatic differences in the industry mix across the groups. Blacks, for example, are overrepre-

Table 5.1 **Means of Wage Variables and Socioeconomic Characteristics**

Variable	*BM*	*F*	*HNM*	*HIM*	*WNM*	*WIM*
EARNINGS	6,149.7	4,147.0	6,767.1	6,321.0	9,258.3	9,310.3
WAGE	3.559	3.084	3.816	3.542	4.904	5.050
EDUC	10.423	11.349	10.063	9.434	12.358	11.447
EXPER	21.842	20.695	19.063	22.542	20.569	26.056
HLTH	.071	.052	.071	.071	.072	.063
MSP	.686	.530	.775	.729	.775	.796
Industry Mix, % in:						
Agriculture	1.5	1.0	2.8	6.1	1.1	1.3
Mining	.3	.1	.7	.3	.7	.4
Construction	9.2	.6	9.4	7.6	8.4	8.2
Manufacturing	31.2	20.6	34.1	36.8	32.7	35.7
Transportation	11.3	3.9	9.4	6.4	9.7	7.6
Trade	15.4	20.1	18.3	18.9	17.9	18.7
Finance	3.0	6.1	3.2	4.3	4.7	4.7
Business	3.6	2.7	4.0	4.1	3.7	3.5
Personal Service	3.2	12.8	2.5	4.2	1.4	2.6
Entertainment	1.0	.9	.9	1.0	1.0	.9
Professional	9.9	25.4	7.0	7.7	9.9	11.9
Public Administration	9.4	5.2	7.2	2.1	8.5	4.2

Table 5.1 (continued)

Variable	*BM*	*F*	*HNM*	*HIM*	*WNM*	*WIM*
Occupation Mix, % in:						
Professional	5.9	11.8	6.5	9.2	18.0	20.2
Managerial	2.4	1.9	3.8	3.7	10.6	8.5
Sales	2.2	5.9	3.8	3.3	7.7	5.4
Clerical	9.9	31.4	9.2	8.3	9.8	7.5
Crafts	15.6	1.7	22.4	18.8	22.6	23.6
Operative	20.5	18.9	21.3	24.1	12.8	14.7
Transport Operative	10.1	.3	8.2	4.7	5.7	3.0
Nonfarm Laborer	15.3	1.2	10.5	9.6	5.6	5.3
Farmers	.02	.01	.03	.1	.04	.04
Farm Laborer	1.0	.7	2.1	5.0	.6	.7
Service	16.2	19.0	11.8	13.1	6.8	10.8
Private Household	.4	6.8	.04	.1	.03	.2
% of Group in Population	5.5	38.9	2.0	.9	49.5	3.2
Sample Size	22,738	9,188	8,338	3,627	21,038	11,789

Note: The variables are defined as follows. *EARNINGS* = 1969 annual earnings, in dollars; *WAGE* = 1969 wage rate, in dollars; *EDUC* = Years of schooling; *EXPER* = *AGE* − *EDUC* − 6; *HLTH* = 1 if health limits working, O otherwise; *MSP* = 1 if married and spouse present, 0 otherwise.

sented in the public sector, while women are underrepresented in manufacturing. Similarly, the occupation-mix statistics reveal that women are crowded into clerical occupations, while all minority groups (blacks and Hispanics) tend to be overrepresented in the operative and laborer occupations.

Finally, table 5.1 also provides data on the relative size of the six labor groups examined in the analysis. Their relative sizes vary significantly. Women and white native men, for instance, make up 38.9 percent and 49.5 percent of the labor force, respectively; Hispanic groups, on the other hand, make up less than 3 percent of the labor force.

Using the 1969 wage rate as the dependent variable, equation (5) was estimated (after imposing the symmetry restrictions that $\gamma_{ij} = \gamma_{ji}$) using ordinary least squares (OLS). Table 5.2 presents the estimated technology coefficients. The top panel of the table omits the capital variable from the equation, while the bottom panel includes the manufacturing capital stock as one of the inputs. It is important to note that the OLS estimation implicitly assumes an exogenous relative supply for the various inputs in the labor market.

The results are quite interesting. Almost all entries in the γ vector are statistically significant, and many of them are numerically large. Of particular interest is the fact that only one group has a negative impact on the wage rate of blacks: women. All other groups, whether Hispanic or white male, whether immigrant or native, have actually increased the black wage rate. In the context of the generalized Leontief model, the data reveal that blacks and women are strong labor substitutes, whereas black men and all other men are complements in production. The results in table 5.2 therefore indicate that an important impediment to black economic progress has been the rapidly increasing labor-force participation of women and not, as is usually thought, the emergence of the Hispanic minority or the increased number of immigrants in the United States.[14] This finding holds in both panels of table 5.2, so that controlling for the capital stock is not an important factor in determining the production relationship between black men and other groups in the labor force.[15]

The remaining rows in table 5.2 contain a variety of interesting findings. First, women are substitutes with *all* labor inputs and seem to be weak complements with capital, though this last result is not statistically significant. Thus, the entry of women into the labor market has adversely affected all other labor inputs. But it will be seen below that the impact has been much stronger on black men than on the other groups. Second, neither Hispanic immigrants nor Hispanic natives have adversely affected the wage rates of any of the male labor inputs. Hence, the growth of the Hispanic minority (either through relatively

Table 5.2 OLS Estimates of Technology Coefficients, with the Wage Rate as the Dependent Variable

Group	*F*	*HNM*	*HIM*	*WNM*	*WIM*	*K*
			A. Omitting Capital (K)			
BM	−1.5151	.1255	.1971	1.0099	.8780	
	(−9.91)	(1.84)	(2.60)	(8.86)	(12.56)	
F		− .5902	− .2873	−1.5603	−1.3087	
		(−3.58)	(−1.46)	(−1.46)	(−7.72)	
HNM			.1421	.4799	.2445	
			(1.37)	(3.81)	(2.92)	
HIM				.2493	.1119	
				(1.65)	(1.18)	
WNM					.7134	
					(5.51)	
			B. Including Capital (K)			
BM	−1.6313	.1870	.1559	1.1075	.8670	−.0182
	(−7.20)	(2.08)	(1.57)	(5.85)	(9.50)	(−.81)
F		−.7675	−.4343	−2.1077	−1.3160	.0776
		(−3.41)	(−1.59)	(−3.68)	(−5.72)	(.95)
HNM			.2880	.5680	.0771	.0313
			(2.32)	(3.00)	(.71)	(1.30)
HIM				.3279	.0833	.0267
				(1.43)	(.74)	(1.16)
WNM					.8358	.1074
					(4.29)	(1.55)
WIM						−.0619
						(−2.48)

Note: t-ratios are in parentheses.

high fertility rates or immigration rates) has not been a major hindrance to the economic progress of most groups in the labor market. Finally, white immigrants have also not had a negative impact on the economic status of other male groups.

The most salient result in table 5.2, therefore, is that the production parameters reveal a high degree of labor market competition between men and women.[16] This result is not entirely consistent with the results of Freeman (1979) or of Grant and Hamermesh (1981), though the latter authors do find a strong degree of substitution between adult white women and youths. The results, however, are more in line with the recent findings of Berger (1983). He has shown that women are substitutes with all other labor inputs, although he did not include blacks or Hispanics as separate labor inputs in his specifications.

One serious objection to the findings in table 5.2 (and, in fact, to most of the results in the labor-substitution literature) is that the estimation technique used views (relative) labor supplies as exogenously determined. It is likely, however, that the wage differentials created across labor markets by the interactions among labor inputs lead to internal migration patterns by which the various groups move to those areas where they are likely to do relatively well. The presence of mobility costs or imperfect information suggests that the wage differentials do not vanish in the long run and that the correct estimation of the production technology requires that the supply of the inputs to labor markets be modeled more fully.

There are several ways of accounting for the endogeneity of the relative supply variables. The methodology chosen in this paper assumes that the selection of a labor market by individual l in group i is a function of a vector of socioeconomic variables. Those variables measure both individual characteristics (such as l's education) and area characteristics (such as the market's unemployment rate). Hence, relative supplies in the labor market have a reduced-form system, given by:

$$(6) \qquad (X_j/X_i)_l^{1/2} = I_l\beta_1 + A\beta_2 + \epsilon ,$$

where $(X_j/X_i)_l^{1/2}$ is the relative supply of group j in the area chosen by individual l of group i; I_l is a vector of individual-specific characteristics; and A is a vector of area-specific characteristics. The vector I_l includes the individual's education, age, and (if immigrant) years since immigration. The vector A includes the labor market's male and female unemployment rates, the proportions of the male and female labor force employed in the public sector, the proportions of men and women who are high school graduates, the fraction of the labor force that is employed in the manufacturing sector, the proportions of white-collar and blue-collar workers, and measures of the extent of public housing and welfare assistance in the locality.[17]

Equation (6) was estimated for each of the relative employment variables in each group. These regressions were quite successful in explaining the dependent variables: The R^2 values ranged between .3 and .6 for most of the samples. Thus, the instrument obtained, $(\overline{X_i/X_j})^{1/2}$, is not dominated by random noise. Table 5.3 presents the technology parameters estimated by using these instruments for the employment variables.

The results indicate that the very strong negative effect of female employment on black wage rates remains (in both panels), even though its magnitude and significance is attenuated. In fact, the estimates in table 5.3 reveal that even after accounting for the endogeneity of (relative) labor supply, women and all male groups remain substitutes. The one major change between tables 5.2 and 5.3 is in the relationship

Table 5.3 **2SLS Estimates of Technology Coefficients, with the Wage Rate as the Dependent Variable**

Group	*F*	*HNM*	*HIM*	*WNM*	*WIM*	*K*
			A. Omitting Capital (K)			
BM	−.7355	−.7943	.0935	.6795	1.1966	
	(−2.23)	(−4.03)	(.48)	(3.13)	(11.20)	
F		.3862	.0120	−.7325	−1.4536	
		(.87)	(.03)	(−1.28)	(−5.93)	
HNM			.3000	.0508	.2647	
			(1.45)	(.18)	(1.63)	
HIM				.0210	.1262	
				(.08)	(.92)	
WNM					.6873	
					(3.81)	
			B. Including Capital (K)			
BM	−1.4925	−.7306	.3639	1.1940	1.3121	−.0199
	(−2.82)	(−2.61)	(1.34)	(3.35)	(9.88)	(−1.32)
F		−.3936	−.1396	−1.6118	−1.7709	−.0059
		(−.63)	(−.21)	(−1.61)	(−5.09)	(−.07)
HNM			.5101	.5585	.5295	.0245
			(2.00)	(1.38)	(2.31)	(1.92)
HIM				.0008	−.0171	.0414
				(.00)	(−.08)	(3.97)
WNM					.8616	.1932
					(3.30)	(2.78)
WIM						−.0017
						(−.08)

Note: t-ratios are in parentheses.

between black men and Hispanic native men. The OLS results revealed the two inputs were complements; results in table 5.3 indicate the two inputs are strong substitutes. The two tables clearly show that of the 21 coefficients this parameter is the only one that changes signs (and remains statistically significant) in the 2SLS methodology.

Interestingly, the magnitude of the effect of women's employment on men's earnings is generally smaller (in absolute value) when labor supply is treated as endogenous. One possible explanation for this result lies in the process of labor-supply determination within the household. In particular, it is well known that the married woman's labor-force participation probability is a negative function of her husband's wage rate.[18] The regressions that fail to account for this labor-supply effect will, in estimating equation (5), yield relatively large negative effects of female employment on male wage rates, if it is true that men and women are substitutes. The correction for the endogeneity of labor supply nets out the labor-supply effect and leads to numerically smaller effects.

It should be noted that these results are obtained from wage-rate regressions, whereas most of the literature that uses the translog production function in effect uses a measure of the (relative) annual earnings of the various groups as the dependent variable. Table 5.4 presents the estimated technology coefficients from annual-earnings regressions. Both panels include capital as an input (since its exclusion does not have a major impact on the coefficients); the top panel presents the OLS estimates, while the bottom panel presents the 2SLS estimates.

The results in table 5.4 confirm all the findings from the wage-rate regressions. In the OLS regressions, for example, black men and all other men are complements, while black men and all women are sub-

Table 5.4 OLS and 2SLS Estimates of Technology Coefficients, with Annual Earnings as the Dependent Variable

Group	*F*	*HNM*	*HIM*	*WNM*	*WIM*	*K*
			A. OLS Estimates			
BM	−2081.5	232.2	187.9	1212.3	1502.6	55.5
	(−9.28)	(2.61)	(1.92)	(6.47)	(16.63)	(2.50)
F		−715.8	−41.5	−1677.2	−2635.8	22.4
		(−3.22)	(−.15)	(−2.96	(−11.59)	(.28)
HNM			−13.4	581.4	260.8	20.1
			(−.11)	(3.11)	(2.43)	(.85)
HIM				−19.3	484.1	4.4
				(−.09)	(4.33)	(.19)
WNM					1772.1	436.4
					(9.20)	(6.35)
WIM						−77.0
						(−3.12)
			B. 2SLS Estimates			
BM	−2882.0	−1135.5	737.8	2175.6	2351.4	−4.6
	(−5.51)	(−4.10)	(2.74)	(6.18)	(17.90)	(−.31)
F		145.9	−947.1	−3711.5	−4108.0	12.8
		(.24)	(−1.47)	(−3.73)	(−11.95)	(.16)
HNM			501.6	382.7	504.8	36.1
			(1.99)	(.95)	(2.22)	(2.86)
HIM				456.7	616.8	27.4
				(1.07)	(2.99)	(2.65)
WNM					2418.1	481.2
					(9.35)	(7.00)
WIM						1.4
						(.06)

Note: t-ratios are in parentheses.

stitutes. The instrumental variable technique again changes the sign of the relationship between black men and Hispanic native men, making them strong substitutes. In fact, a comparison of table 5.4 with the wage-rate regressions reveals a striking similarity with respect to the sign of the γ_{ij} terms.

The usefulness of the annual-earnings results is that, when translated into relevant units, they are directly comparable with the findings in the labor-substitution literature. This comparison can be made by calculating the elasticities of complementarity (see equations [4]). The elasticities calculated from the annual-earnings results in table 5.4 are presented in table 5.5. Again, the top panel presents the elasticities calculated from the OLS coefficients, while the bottom panel calculates the elasticities from the instrumental variable coefficients. All elasticities, of course, are evaluated at the mean of the relevant variables.[19]

There are several major findings revealed by the calculations in table 5.5. First, even though the female and almost all of the male inputs are substitutes, the degree of substitution (as measured by the elasticity of complementarity) is exceptionally high between women and black men. For example, the OLS results reveal an elasticity of -3.1 between women and black men, but an elasticity of only $-.6$ between women and white native men. The results therefore indicate that black men have been one of the groups particularly hurt by the entry of women into the labor market. Second, the magnitude of the calculated elasticities seems to be very sensitive to the estimation procedure used. For example, the elasticities between black men and other inputs increase (numerically) by a factor of 2 or 3 when instrumental variables are used. This difference suggests that since changes in the estimation technique lead to large fluctuations in the γ_{ij}, some caution must be used in interpreting the numerical results. Third, the large negative coefficients for the γ_{ij} terms that are associated with female employment create serious problems in evaluating the own elasticities of complementarity. Since c_{ii} is proportional to $(\gamma_{ii} - w_i)$, it is clear that the sign of the elasticity is determined by $-\left[\sum_{j \neq i} \gamma_{ij}(X_j/X_i)^{1/2}\right]$. If there are "too many" negative γ_{ij} coefficients in this summation, the own elasticity will be positive. This is precisely what happens, for example, in the case of women: The calculation of c_{ii} leads to large positive numbers, since practically all the γ_{ij} coefficients in the female wage equation are large and negative.

The fundamental problem, of course, arises from a major disadvantage of the generalized Leontief technology: the estimation procedure does not provide direct estimates of γ_{ii}. Instead, $(\gamma_{ii} - w_i)$ is calculated as a residual from the part of the wage explained by the demographic

Table 5.5 **Elasticities of Complementarity, Estimated from Annual-Earnings Equations**

Group	*BM*	*F*	*HNM*	*HIM*	*WNM*	*WIM*	*K*
			A. OLS Estimates				
BM	1.017	−3.098	.933	1.209	.717	3.468	1.417
	(3.62)	(−9.28)	(2.61)	(1.92)	(6.47)	(16.63)	(2.50)
F		2.899	−1.605	−.149	−.552	−3.396	.319
		(5.24)	(−3.22)	(−.15)	(−2.96)	(−11.59)	(.28)
HNM			−2.661	−.130	.518	.908	.773
			(−3.34)	(−.11)	(3.11)	(2.43)	(.85)
HIM				−11.985	−.027	2.686	.270
				(−4.40)	(−.09)	(4.33)	(.19)
WNM					−.033	.906	2.467
					(−.50)	(9.20)	(6.35)
WIM						1.019	−1.702
						(3.37)	(−3.12)
K							—
			B. 2SLS Estimates				
BM	.064	−4.287	−4.562	4.745	1.389	5.427	−.117
	(.01)	(−5.51)	(−4.10)	(2.74)	(6.18)	(17.90)	(−.31)
F		5.313	3.18	−3.388	−1.222	−1.078	.182
		(4.61)	(.24)	(−1.47)	(−3.73)	(−11.95)	(.16)
HNM			−10.311	4.857	.583	1.754	1.389
			(−3.67)	(1.99)	(.95)	(2.22)	(2.86)
HIM				−13.993	.649	3.422	1.682
				(−1.75	(1.07)	(2.99)	(2.65)
WNM					.131	1.237	2.720
					(2.61)	(9.35)	(7.00)
WIM						2.452	.031
						(5.12)	(.06)
K							—

Note: The t-ratios in parentheses refer to the parameter γ^{ij} in the cross-elasticity estimates and to $(\gamma^{ii} - w^i)$ in the own-elasticity estimates. The own elasticity for *K* is unavailable since a capital equation was not estimated.

employment variables. This methodology is likely to lead to substantially more errors than if γ_{ii} were estimated directly, and this possibility may explain why many of the own elasticities in table 5.5 are of the unexpected sign.

In any case, the cross-elasticities presented in table 5.5 do tend to support some of the findings in recent labor-demand studies. For example, Berger (1983) estimated the elasticity of complementarity between women and men with less than a college diploma to be between −.4 and −1.3. This range is not too unreasonable in view of the fact that the OLS elasticity between women and white native men in table 5.5 is −.6.

In summary, the analysis presented in this section reveals three important findings. First, men and women are substitutes in production, with the degree of substitution between women and black men being particularly high. Second, neither of the immigrant groups, Hispanic or non-Hispanic, have had a negative impact on the earnings of black men. Finally, even though the nature of the technological relationship between different inputs is generally not affected by the method of estimation used, the numerical magnitudes of the elasticities of complementarity are quite sensitive to the specification of the labor-supply function.

5.4 The Impact of Competition on Young and Old Black Men

In the previous section the breakdown of the various labor inputs was defined along racial, gender, and native versus immigrant lines, despite the fact that most of the labor-substitution literature prefers to disaggregate labor inputs by age. The age breakdown is one way of controlling for the fact that not all individuals within a given group (such as blacks) are of equal skills. The decomposition of blacks into "young" and "old" blacks partially takes account of the within-group skill variance.

The methodology used in this paper obviously already controls for skill differences that may arise due to age differentials. It is of great policy interest, however, to investigate whether the impact of labor market competition has differentially affected the economic status of young and old black men. To consider this possibility, the black male labor input was segmented into two groups: young black men *(YBM)* and old black men *(OBM)*, defined as 24 years old or younger and over 24, respectively. The technology coefficients estimated in the black male equations are presented in table 5.6. To conserve space the table presents only a subsample of the matrix of coefficients γ_{ij}, namely, those coefficients that enter the two black male wage equations.[20] The table does include, however, the resulting estimates under various methodological assumptions. Panel A presents both the OLS and 2SLS coefficients when capital is omitted from the equation, while panel B presents the estimates from the equations that include capital.

Table 5.6 offers several interesting findings. First, women have a negative impact on the earnings of both young and old black men. The direction of this effect is unaffected by either the choice of the estimation technique (OLS or 2SLS) or the inclusion of the capital variable in the equation. Nonetheless, adding the capital measure to the young black men's regression reduces the significance of practically all the technology coefficients in that equation. The fact that these increases in the standard errors of the coefficients occur (at the same time as capital has an insignificant effect on the earnings of young black men) suggests a sizable degree of collinearity among the input variables in the young black men's equation.

A second interesting finding in table 5.6 is that the impact of immigrants seems to vary significantly between young blacks and old blacks. In the case of Hispanic immigrants, the γ_{ij} coefficients in the young black wage equations tend to be insignificant and sometimes negative, while in the case of non-Hispanic immigrants, the technological coefficients are consistently larger for older blacks. These results suggest that younger black men are more vulnerable to competition from immigrants than are older black men, although it should be emphasized that there is no evidence that any immigrant group has had a significantly adverse impact on the wages of young black men.

Table 5.7 uses the results in table 5.6 and calculates the elasticities of complementarity for the young and old samples of black men. As with the earlier results, the estimated elasticities based on the 2SLS coefficients seem to be quite sensitive and are usually significantly larger (in absolute value) than the corresponding elasticities calculated from the OLS coefficients. Table 5.7 reveals that the estimated elasticities of complementarity between women and black men tend to be larger for young men when 2SLS estimates are used, but somewhat smaller when OLS estimates are used. Thus, the calculation of the elasticities does not conclusively indicate which of the two black age groups has been most affected by the increase in female labor-force participation. This important problem will be addressed in section 5.7 below.

5.5 Extensions of the Empirical Analysis

In this section many of the restrictive assumptions underlying the earlier results are relaxed. Among the issues that will be addressed are the nature of the technological relationships within the manufacturing industry; the North-South differential in the demand function for black

Table 5.6 OLS and 2SLS Estimates of the Technology Coefficients for Young and Old Black Men

	Young Black Men (*YBM*)				Old Black Men (*OBM*)			
	OLS		2SLS		OLS		2SLS	
Group	*Wage*	*Earnings*	*Wage*	*Earnings*	*Wage*	*Earnings*	*Wage*	*Earnings*
				A. Omitting Capital				
YBM	—	—	—	—	.5026	80.4	1.7416	749.4
					(1.53)	(.25)	(1.07)	(.47)
OBM	.5026	80.4	1.7416	749.4	—	—	—	—
	(1.53)	(.25)	(1.07)	(.47)				
F	−.6882	−772.8	−1.0424	−1507.0	−1.3744	−2338.2	−.3064	−764.9
	(−2.91)	(−3.31)	(−2.04)	(−2.97)	(−7.79)	(−13.39)	(−.94)	(−2.02)
HNM	.1653	−6.4	.4429	−163.1	.0644	78.0	−1.0324	−1298.0
	(1.32)	(−.05)	(.98)	(−.36)	(.76)	(.93)	(−3.84)	(−4.87)
HIM	−.1200	70.4	−.6465	371.3	.2670	276.8	.3504	−147.8
	(−.67)	(.40)	(−1.31)	(.76)	(2.39)	(2.50)	(1.24)	(−.53)
WNM	.5169	544.9	.7857	1106.4	.9031	1581.5	.4163	779.9
	(2.93)	(3.12)	(2.23)	(3.17)	(6.85)	(12.11)	(1.62)	(3.06)
WIM	.2644	320.2	.5291	503.8	.8052	1509.4	1.0447	2127.3
	(2.24)	(2.74)	(2.29)	(2.20)	(9.73)	(18.4)	(7.43)	(3.06)

				B. Including Capital (K)				
YBM	—	—	—	—	.5427 (1.32)	91.0 (.22)	1.3207 (.64)	1762.8 (.86)
OBM	.5427 (1.32)	91.0 (.22)	1.3207 (.64)	1762.8 (.86)	—	—	—	—
F	−.1436 (−.38)	260.9 (−.70)	−.5226 (−1.50)	−1465.8 (−1.42)	−1.7356 (−6.48)	−2254.4 (−8.47)	−1.7537 (−2.60)	−2287.8 (−3.41)
HNM	.3039 (1.89)	−43.5 (−.27)	.3561 (.60)	−215.3 (−.37)	.0810 (.74)	268.1 (2.45)	−1.0026 (−2.79)	−1197.3 (−3.36)
HIM	−.3284 (−1.51)	−30.3 (−.14)	−1.5902 (−2.23)	52.2 (.07)	.3091 (2.23)	214.5 (1.56)	1.0471 (2.59)	699.6 (1.74)
WNM	.0464 (.15)	69.2 (.22)	−.3533 (−.50)	1116.9 (1.61)	1.2129 (5.44)	1385.5 (6.25)	1.4154 (3.07)	1766.6 (3.86)
WIM	.0671 (.44)	223.5 (1.47)	.4764 (1.72)	489.4 (1.78)	.8630 (8.06)	1472.9 (13.86)	1.1396 (6.65)	2262.8 (13.29)
K	.0301 (1.00)	39.3 (1.32)	.0053 (.30)	−20.0 (−1.16)	−.0335 (−1.36)	40.1 (1.64)	−.0239 (−1.45)	3.9 (.24)

Note: t-ratios are in parentheses. *WAGE* and *EARNINGS* are as defined in table 5.1 (n.).

Table 5.7 Elasticities of Complementarity for Young and Old Black Men, Estimated from Annual-Earnings Equations

	Young Black Men (*YBM*)				Old Black Men (*OBM*)			
	Omitting *K*		Including *K*		Omitting *K*		Including *K*	
Group	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
YBM	6.964	−18.720	4.557	−66.186	.682	6.360	.772	14.960
	(.75)	(−2.40)	(.93)	(−2.83)	(.25)	(.47)	(.22)	(.86)
OBM	.682	6.360	.772	14.960	1.093	−4.052	1.467	−3.306
	(.25)	(.47)	(.22)	(.86)	(2.80)	(−.53)	(2.97)	(−.53)
F	−3.436	−6.700	−1.160	−6.517	−3.705	−1.212	−3.572	−3.625
	(−331)	(−2.97)	(−.70)	(−1.42)	(−13.39)	(−2.02)	(−8.47)	(−3.41)
HNM	−.077	−1.960	−.523	−2.587	.334	−5.558	1.148	−5.127
	(−.05)	(−.36)	(−.27)	(−.37)	(.93)	(−4.87)	(2.45)	(−3.36)
HIM	1.350	7.120	−.581	1.001	1.892	−1.010	1.466	4.781
	(.40)	(.76)	(−.14)	(.07)	(2.50)	(−.53)	(1.56)	(1.74)
WNM	.962	1.953	.122	1.972	.995	.491	.872	1.111
	(3.12)	(3.17)	(.22)	(1.61)	(12.11)	(3.06)	(6.25)	(3.86)
WIM	.395	.622	.276	.604	3.714	5.234	3.624	5.568
	(2.74)	(2.20)	(1.47)	(1.78)	(18.4)	(3.06)	(13.86)	(13.29)
K	—	—	2.997	−1.525	—	—	1.090	.107
			(1.32)	(−1.16)			(1.64)	(.24)

Note: The t-ratios in parentheses refer to the parameter γ^{ij} in the cross-elasticity estimates and to $(\gamma^{ii} - w^{i})$ in the own-elasticity estimates.

men; the impact of cost-of-living differences across SMSAs on the estimates; the disaggregation of the female labor input into white women and black women; the impact of outlying observations on the estimates; and the importance of the cross-equation symmetry restrictions in generating the main results of the analysis. Since the results in the previous section indicated that the breakdown of black men by age group did not essentially alter the major findings, most of the experiments in this section are conducted using the six labor groups defined in section 5.3.

5.5.1 Results for Manufacturing

The analysis in this paper has pooled all workers over all industries, whereas most of the labor-substitution literature has focused on the manufacturing sector. This sample selection is common because of the availability of data on manufacturing capital stocks. Nevertheless, such a selection may ignore important substitution effects as labor groups enter the labor market and other labor inputs are pushed out of particular industries and crowded into particular occupations.

In any case, the estimation procedure was replicated for the subsample of workers in the manufacturing industry. The estimated γ_{ij} coefficients in the black wage equation are presented in table 5.8. The results are by now familiar. In the OLS estimation black men and all other men are complements, while women and black men are substitutes. The 2SLS results, as before, reverse the relationship between black men and Hispanic native men, making them substitutes.

Table 5.8 OLS and 2SLS Estimates of Black Male Technology Coefficients, Manufacturing Industry

	OLS		2SLS	
Group	*WAGE*	*EARNINGS*	*WAGE*	*EARNINGS*
F	−2.2185	−2991.0	−1.7805	−3593.1
	(−6.51)	(−8.09)	(−2.12)	(−3.94)
HNM	.4179	455.9	−.5767	−1136.5
	(3.18)	(3.20)	(−1.42)	(−2.57
HIM	.1286	269.0	−.0065	966.1
	(.78)	(1.50)	(−.01)	(1.91)
WNM	1.5152	2011.3	1.4759	2809.7
	(5.29)	(6.48)	(2.60)	(4.56)
WIM	.9545	1457.8	1.3804	2305.1
	(7.19)	(10.12)	(6.87)	(10.58)
K	−.0306	17.2	−.0342	8.7
	(−.92)	(.48)	(−1.52)	(.35)

Note: t-ratios are in parentheses. *WAGE* and *EARNINGS* are as defined in table 5.1.

It is worthwhile to note the striking similarity in the results obtained in table 5.8 and those obtained earlier. Not only is the nature of the technological relationship unaffected by focusing on the manufacturing industry, but the numerical magnitude of the coefficients is roughly constant. For example, the estimated effect of female employment on black annual earnings in table 5.8 is −3593.1 (using the 2SLS results), while in table 5.4 the relevant statistic is −2882.0. Similarly, the impact of Hispanic native men on black annual earnings is −1136.5 in table 5.8 and −1135.5 in table 5.4. This similarity of estimates is remarkable given the fact that only 31 percent of black men are employed in the manufacturing industry.

5.5.2 The North-South Differential

The results in the previous sections are based on a comparison of how blacks do in different SMSAs, where the main shift variable across labor markets is the demographic composition of the labor force. Of course, it is likely that many other factors that may lead to wage differentials vary across labor markets; and to the extent that these factors are correlated with the relative supplies of the inputs, the results may be biased. To correct in part for this problem it would be useful to conduct the analysis within geographic areas where SMSAs tend to be roughly similar in such characteristics as cost of living, amenities, and industrial composition. One such breakdown is to analyze separately the demographic determinants of the demand for blacks in the South and in the North.[21]

Table 5.9 presents the technology coefficients from the black male wage equation. Due to space constraints only the OLS regressions that include capital are shown in the table; the coefficients from regressions using alternative specifications generally follow the same patterns that have been indicated throughout this analysis. The main insight provided by the results is that the relative employment variables tend to have qualitatively similar effects in both the South and the North. For example, the coefficient of the female employment variable is negative throughout. Thus, the finding that black men have been adversely affected by the entry of women into the labor market is invariant with the choice of region. The only coefficient whose sign appears to be sensitive to the region variable is the γ_{ij} between black men and white immigrant men. In the North this coefficient is numerically large and statistically significant, while in the South the effect is of smaller magnitude and sometimes reversed in sign (though it is insignificant). The main lesson from table 5.9, therefore, is that the demographic determinants of the demand for black labor are roughly similar in the North and the South. In both regions women have adversely affected the earnings of blacks, while nonblack men tend to be complements with black men.

Table 5.9 **OLS Estimates of Black Male Technology Coefficients, for South and North**

	South		North	
Group	*WAGE*	*EARNINGS*	*WAGE*	*EARNINGS*
F	−1.8878	−2786.4	−1.5625	−1955.8
	(−2.75)	(−4.13)	(−5.72)	(−7.20)
HNM	.0306	173.4	.0918	165.9
	(.12)	(.67)	(.84)	(1.53)
HIM	.5774	1051.7	.1659	73.4
	(1.95)	(3.12)	(1.27)	(.57)
WNM	1.4334	2139.1	1.1332	1206.2
	(2.81)	(4.27)	(4.92)	(5.27)
WIM	.2111	−227.9	.6301	1156.4
	(.47)	(−.52)	(5.37)	(9.91)
K	−.1108	−149.5	−.0510	14.6
	(−2.20)	(−3.02)	(−1.76)	(.51)

Note: t-ratios are in parentheses. *WAGE* and *EARNINGS* are as defined in table 5.1.

5.5.3 Cost-of-Living Differentials

An alternative way to account for the possibility that wage differentials across SMSAs simply reflect cost-of-living differences is to use a price index, such as the consumer price index (CPI), as a deflator in the regressions. Although the CPI does not measure prices for SMSAs, the U.S. Bureau of Labor Statistics has, in recent years, constructed a cost-of-living index for 40 of the largest SMSAs in the country.[22] This index is used in the regressions reported in this section, estimated, of course, only among those observations for whom the cost-of-living index is available.

There are two ways of using the BLS cost-of-living index in the regressions. The first is to add the index, *C*, as one of the regressors in the wage equations. The second is to deflate the dependent variable by the index. The estimated technology coefficients for the black male OLS wage equations using both methods are presented in table 5.10. These results strongly indicate that the demographic determinants of the demand for black labor are independent of any wage differentials caused by cost-of-living differences across labor markets. The effect of female employment on black male wages remains strongly negative, while the effects of all the male groups remain positive. The results therefore show that the wage differentials that are the focus of this paper cannot be totally explained by factors unrelated to the demographic composition of the labor market. Table 5.10 clearly demonstrates that the relative employment variables have a major impact on the *real* wage rate of black men.

Table 5.10 **OLS Estimates of Black Male Technology Coefficients Accounting for Cost-of-Living (*C*) Differentials**

	Dependent Variable			
Group	*WAGE*	*EARNINGS*	*WAGE/C*	*EARNINGS/C*
F	−1.8939	−2344.7	−2.1524	−3099.9
	(−7.58)	(−9.44)	(−9.19)	(−13.29)
HNM	.1911	228.0	.2045	266.3
	(2.04)	(2.45)	(2.27)	(2.97)
HIM	.2090	227.3	.2996	486.9
	(1.88)	(2.05)	(2.85)	(4.64)
WNM	1.3543	1469.5	1.6107	2184.4
	(6.41)	(7.00)	(8.21)	(11.17)
WIM	.6546	1221.9	.3909	666.9
	(5.74)	(10.78)	(4.36)	(7.46)
K	−.0211	56.4	−.0257	36.2
	(−.86)	(2.30)	(−1.09)	(1.54)

Note: t-ratios are in parentheses. *WAGE* and *EARNINGS* are as defined in table 5.1. The regressions in the first two columns included the cost-of-living index as one of the regressors.

5.5.4 The Effects of Black Women and White Women

Up to this point the analysis has aggregated all women into a single labor input. The pooling is justified by the usual finding that wage differentials among different types of women (such as women of different races) are substantially narrower than wage differentials among different men. This finding is consistent with the hypothesis that employers tend to view women as a more homogeneous group; and thus, treating all women as a single labor input may provide a useful first-order approximation.

Nevertheless, before conducting such a pooling, the analysis experimented with various breakdowns of the female input. The changes in specification did not change the qualitative conclusions presented in the previous sections. Consider, for example, the case in which the female group (*F*) is divided into two labor inputs: black women (*BF*) and white (that is, nonblack) women (*WF*). The resulting technology coefficients (γ_{ij}) from the black male wage equation are presented in panel A of table 5.11. Again, for the sake of brevity the table presents only the coefficients estimated by OLS; the estimation by instrumental variables did not introduce any unusual differences.

The results show that both groups of women are substitutable with black men and that, as before, all nonblack men are complements with black men. It is of some interest to note that the impact of women on black male wages is always significantly negative for the *WF* input, but sometimes insignificant for the *BF* input. This finding suggests that the

Table 5.11 OLS Estimates of Black Male and Black Female Technology Coefficients

Group	*WAGE* (1)	*WAGE* (2)	*EARNINGS* (1)	*EARNINGS* (2)
	A. Black Male Technology Coefficients			
BF	.1717	−.2161	−522.9	−1875.6
	(.33)	(−.33)	(−1.01)	(−2.87)
WF	−1.6068	−1.6751	−2040.0	−1756.4
	(−6.00)	(−4.33)	(−7.68)	(−4.56)
HNM	.1942	.0989	139.7	277.8
	(1.64)	(.67)	(1.18)	(1.89)
HIM	.1844	.2788	−35.0	44.8
	(1.08)	(1.34)	(−.21)	(.22)
WNM	1.1136	1.1921	1379.3	1029.6
	(5.42)	(3.73)	(6.76)	(3.23)
WIM	.9903	.9724	1795.1	1565.7
	(8.68)	(6.69)	(15.85)	(10.82)
K	—	−.0194	—	42.9
		(−.73)		(1.63)
	B. Black Female Technology Coefficients			
BM	.1717	−.2161	−522.9	−1875.6
	(.33)	(−.33)	(−1.01)	(−2.87)
WF	.9800	1.0997	877.4	1005.9
	(3.07)	(2.45)	(2.77)	(2.26)
HNM	−.2941	−.1480	−277.5	−334.8
	(−2.15)	(−.87)	(−2.05)	(−1.98)
HIM	−.0909	−.2797	334.7	148.3
	(−.48)	(−1.23)	(1.79)	(.65)
WNM	−.5789	−.6880	−405.8	−484.0
	(−2.33)	(−1.84)	(−1.65)	(−1.30)
WIM	−.6221	−.6296	−1112.3	−1055.2
	(−4.68)	(−3.76)	(−8.44)	(−6.34)
K	—	−.0069	—	−35.2
		(−.14)		(−.73)

Note: t-ratios are in parentheses. *WAGE* and *EARNINGS* are as defined in table 5.1.

negative correlation between black male wage rates and female labor supply *cannot* be explained by the intrafamily substitution effect. Since there is a very small incidence of interracial marriage, there is little likelihood that high labor-force participation rates among white women are caused by relatively low earnings among their black male husbands. The results in table 5.11 therefore unambiguously show the major impact that the increasing labor-force participation of women has had on black male earnings.

An additional insight from the breakdown of black and white women is presented in panel B of table 5.11, which gives the γ_{ij} technology coefficients from the black female wage equation. Not surprisingly, black women are substitutes with practically all groups of men. This, of course, simply reconfirms the findings in the previous sections. What is of interest in table 5.11, however, is the relationship between black and white women. The technology coefficient is positive, indicating that these two inputs are complements. Hence, the increasing labor-force participation rate of white women has not adversely affected all blacks equally; it has been detrimental to black male economic progress, but it has not had a negative impact on black female wage rates.

5.5.5 The Impact of Outlying Observations

Since the generalized Leontief specification uses relative proportions, $(X_j/X_i)^{1/2}$, as independent variables, the independent variables are likely to take on extremely large values for observations residing in SMSAs containing few individuals of particular groups. These outlying values may lead to serious estimation problems and could, in principle, be the mechanism driving the strong results presented in this paper. A simple solution for this problem is to estimate the model for the subset of those SMSAs that contain a relatively large number of inhabitants of the relevant minority groups.

To test for the importance of this problem, the model was estimated after deleting all observations living in SMSAs where the labor force was less than either one percent Hispanic or one percent black. These deletions reduced the number of SMSAs in the analysis from 125 to 58. Table 5.12 presents the resulting black male technology coefficients, using both the wage rate and annual earnings as dependent variables. It is remarkable that the changes induced by this radical sample selection are so insignificant. The technological parameter measuring the extent of substitution between women and black men is -1.49 in table 5.12 (using the wage rate as the dependent variable) and -1.52 in table 5.2. When annual earnings are used, the coefficient estimated over the entire sample is -2082 (see table 5.4), while in the restricted sample it becomes -2661. In other words, the deletion of SMSAs that contain very few blacks or Hispanics, if anything, *reinforces* the negative impact of female labor-force participation on black male earnings.

The only coefficient in table 5.12 that has a different sign from those in the earlier results is the γ_{ij} between black men and Hispanic native men. This parameter becomes negative, but insignificant, in table 5.12. Recall, however, that this is also the coefficient that turned negative in the 2SLS regressions. The regressions therefore indicate that this parameter cannot be robustly estimated using the 1970 census data.

Table 5.12 **OLS Estimates of Black Male Technology Coefficients, Deleting Outlying Observations**

	Omitting Capital (*K*)		Including Capital (*K*)	
Group	*WAGE*	*EARNINGS*	*WAGE*	*EARNINGS*
F	−1.4865	−2660.6	−1.7204	−2793.3
	(−5.69)	(−10.58)	(−4.37)	(−7.27)
HNM	−.0749	−126.2	−.0750	−9.4
	(−.66)	(−1.15)	(−.48)	(−.06)
HIM	.2905	289.5	.2873	392.4
	(2.21)	(2.29)	(1.69)	(2.36)
WNM	1.0172	1778.5	1.1894	1723.3
	(5.28)	(9.59)	(3.71)	(5.50)
WIM	.9660	1932.1	1.0057	1842.3
	(9.05)	(18.78)	(6.91)	(12.98)
K	—	—	.0011	61.7
			(.04)	(2.04)

Note: t-ratios are in parentheses. *WAGE* and *EARNINGS* are as defined in table 5.1.

5.5.6 The Symmetry Restrictions

Finally, it is worthwhile to address the question whether the results in this analysis are sensitive to the cross-equation symmetry constraints ($\gamma_{ij} = \gamma_{ji}$) that have been employed throughout. After all, given the relatively large samples used in the estimations, all tests of the null hypothesis that the symmetry restrictions hold are rejected by the data. A more fruitful approach is to investigate whether the black male labor-demand function would change substantially (in terms of the signs of the technology parameters) if the symmetry constraints were removed.

To illustrate the importance of the symmetry constraint, table 5.13 presents the unconstrained black male technology coefficients, using annual earnings as the dependent variable and including capital in the equation. The results show that, in general terms, the symmetry constraint does not play a major role in determining the qualitative nature of the conclusions of the analysis. For example, the technology parameter (using OLS) between women and black men is −2082 when the constraint is imposed and −2692 when it is not imposed. Roughly similar comparisons can be made for the other labor inputs, as well as for the young and old black male samples. It is safe to conclude, therefore, that the imposition of the symmetry restrictions is not hiding results that would contradict the earlier conclusions about the demographic determinants of the demand for black labor.

Table 5.13 The Impact of the Symmetry Constraint on the Technology Coefficients, with Annual Earnings as the Dependent Variable

	All Black Men		Young Black Men		Old Black Men	
Group	OLS	2SLS	OLS	2SLS	OLS	2SLS
YBM	—	—	—	—	103.4	−945.2
					(.12)	(−.23)
OBM	—	—	75.1	1982.5	—	—
			(.16)	(.84)		
F	−2691.6	−5311.6	−761.6	−3001.1	−2735.3	−4527.5
	(−8.12)	(−5.33)	(−1.85)	(−2.63)	(−7.63)	(−4.20)
HNM	396.1	−561.1	−36.9	233.1	459.4	−677.0
	(2.61)	(−.97)	(−.21)	(.36)	(2.76)	(−1.09)
HIM	68.5	1021.3	31.7	235.5	23.8	747.6
	(.33)	(1.52)	(.13)	(.30)	(.11)	(1.05)
WNM	1542.6	3655.7	396.4	2025.1	1069.1	3166.1
	(5.62)	(5.47)	(1.16)	(2.63)	(5.43)	(4.36)
WIM	2235.0	3334.0	650.1	1016.3	2170.2	3158.8
	(16.33)	(18.74)	(3.92)	(3.32)	(14.08)	(12.72)
K	40.7	−14.9	20.0	−26.4	32.4	−8.3
	(1.62)	(−.98)	(.65)	(−1.52)	(1.19)	(−.49)

Note: t-ratios are in parentheses.

5.6 The Labor-Force Participation of Black Men

The analysis in the previous sections focused on the effects of labor market competition on the wage of blacks. Although the results are quite useful they do not directly address the issue of whether particular groups replace blacks in the labor market. This section directly examines the impact of other groups on the participation rate of blacks.

One important advantage of the generalized Leontief production function is its flexibility in allowing independent tests of the robustness of the results. In particular, the demand framework summarized in section 5.2 does not require data on wages for its estimation. It is possible instead to estimate the technology parameters by studying the determinants of the labor-force participation decision. The independent estimation of the technology coefficients by using participation data can thus be used to determine the robustness of the wage results described in the previous sections.

Suppose that the participation decision for individual l in group i is based on a comparison of his market wage, w_{il}, and his reservation wage, w^*_{il}. The participation decision is determined by:

$$I_{il} = w_{il} - w^*_{il}. \tag{7}$$

The individual will participate in the labor force if $I_{il} > 0$. The generalized Leontief production function generates a linear-in-parameters wage equation. Using equation (5) and assuming that the same vector of socioeconomic characteristics, Z_{il}, helps determine the reservation-wage rate, equation (7) becomes:

$$I_{il} = Z_{il}\alpha + \sum_{j \neq i} \gamma_{ij}(X_j/X_i)^{1/2} + v_i, \tag{8}$$

where v_i is a statistical residual. The coefficient vector α estimates the net impact of the socioeconomic characteristics on the participation decision. If it is assumed that the relative supplies of the various labor inputs do not affect individual l's reservation wage rate, the estimation of (8) identifies the technology parameters γ_{ij}. In effect, this requires that such factors as the (relative) numbers of women, immigrants, and other groups do not have an impact on the household productivity of the individual.

It is easy to understand why labor-force participation data can be used to recover information about the labor demand for specific groups. Shifts in the wage level caused by, say, an increased participation of women in the labor market will induce changes in the profitability of market work versus household work for blacks. Thus, if women and black men are strong substitutes in production, as found in the previous sections, the estimation of equation (8) should reveal that the labor-force participation of black men falls as the relative number of women in the labor market increases.

Because of the large sample sizes it is not practical to estimate the system in equation (8) using maximum-likelihood methods. The analysis therefore uses the linear-probability model. This estimation method has the additional advantage that cross-equation symmetry restrictions can be easily imposed. The basic results for the black male labor-force participation regression are presented in table 5.14.[23] The findings for the constrained regressions (the first four columns in the table) are quite interesting. The coefficients reveal that an increase in the labor-force participation rate of women will lead to lower black male participation rates. This finding holds regardless of the estimation procedure (OLS or 2SLS) and regardless of the inclusion of the capital variable in the equation. The fact that additional women in the labor market lower the black male participation rate is consistent with the findings discussed above that women and black men are substitutes in production. It is important to stress that the finding in table 5.14 suggesting that women do "take jobs away" from blacks is an entirely independent test of the robustness of the wage regressions in the previous sections.

Table 5.14 also reveals that Hispanic immigrant men and white native men are complements with black men. These results again corroborate the findings in the wage regressions. The technological relationship between Hispanic native men and black men is less clear-cut: the coefficient is positive when OLS is used, but negative when 2SLS is used.

Table 5.14 **Black Male Technology Coefficients from the Labor-Force Participation Regressions**

	OLS		2SLS		Unconstrained 2SLS
Group	(1)	(2)	(1)	(2)	(2′)
F	−.0291	−.0172	−.0272	−.0777	−.2117
	(−2.90)	(−1.17)	(−1.24)	(−2.27)	(−3.07)
HNM	.0082	.0014	−.0019	−.0179	.0594
	(1.90)	(.25)	(−.15)	(−1.03)	(1.48)
HIM	.0050	.0108	.0175	.0355	.0560
	(1.01)	(1.64)	(1.36)	(1.99)	(1.20)
WNM	.0162	.0050	.0216	.0609	.1439
	(2.16)	(.41)	(1.49)	(2.63)	(3.10)
WIM	−.0035	−.0126	−.0053	−.0065	−.0108
	(−.79)	(−2.21)	(−.77)	(−.76)	(−.88)
K	—	.0023	—	−.0024	−.0024
		(1.55)		(−2.40)	(−2.26)

Note: t-ratios are in parentheses.

This switch in the sign of the coefficient also occurred in the wage regressions (see tables 5.2 and 5.3). Finally, the relationship between white immigrant men and black men suggests some substitution, though the coefficient is seldom significant. This result is not consistent with the strong complementarity found in the wage regressions and is the only major anomaly in table 5.14. Despite this problem it should be noted that, in general, the labor-force participation rate of blacks behaves in a way consistent with the technological relationships revealed by the wage analysis.[24]

Finally, the last column of table 5.14 shows the unconstrained γ_{ij} vector from the black male labor-force participation regression. For the sake of brevity only the counterpart to column 2 of the 2SLS regression is shown. The similarity in signs between the symmetry constrained and unconstrained coefficients is, on the whole, quite reasonable. For instance, the impact of women on black male labor-force participation remains strongly negative, while that of white native men and Hispanic immigrant men remains positive. The unconstrained results therefore show that the symmetry constraints are not unreasonably restricting the parameters of the black male labor-demand function.

One of the most significant labor-force changes in the postwar period has been the decline in the labor-force participation rate of young black men. For example, the participation rate of black men aged 20 to 24 dropped from 91.1 percent in 1954 to 78.0 percent in 1978. It is therefore of great interest to investigate whether the results in table 5.14 are sensitive to the breakdown of the black male input into the young and old categories defined in section 5.4. Table 5.15 replicates the labor-force participation analysis for each of the two black male samples. The results are very instructive. The effect of women on the black male participation rate is usually negative and significant in the young sample and insignificant in the older sample. The table thus reveals that the entry of women into the labor market has been an important determinant of the participation probability of young black men. It is not surprising that their effect on the labor supply of older black men is insignificant, since it is well known that prime-aged men have relatively inelastic labor-supply functions.

The estimates in table 5.15 indicate that these findings are not sensitive to the method of estimation used, to the inclusion of the capital measure in the regressions, or to the imposition of the symmetry constraints. The table leaves little doubt that the rapid entry of women into the labor force has been an important factor causing the decline of the labor-force participation rate of young black men.

It should be noted that the qualitative nature of the labor-force participation results are robust to the variety of sensitivity tests carried out in section 5.5. Although space constraints prohibit a complete rep-

Table 5.15 **Technology Coefficients from Labor-Force Participation Regressions Young and Old Black Male Samples**

Group	OLS (1)	OLS (2)	2SLS (1)	2SLS (2)	Unconstrained (2SLS)
			A. Young Black Male Coefficients		
OBM	−.1077	−.0888	.0420	.2267	.3160
	(−5.56)	(−3.57)	(.42)	(1.81)	(2.25)
F	−.0404	−.0234	−.0687	−.1209	−.1907
	(−2.96)	(−1.09)	(−2.17)	(−1.90)	(−2.75)
HNM	−.0050	.0046	.0274	.0423	.0754
	(−.67)	(.48)	(.97)	(1.17)	(1.93)
HIM	.0391	.0383	.0150	.0329	.0419
	(3.61)	(2.93)	(.49)	(.75)	(.87)
WNM	.0239	.0065	.0419	.0955	.1418
	(2.35)	(.37)	(1.92)	(2.24)	(3.04)
WIM	.0082	−.0031	.0051	−.0229	−.0295
	(2.35)	(−.35)	(.35)	(−1.36)	(−1.60)
K	—	.0038	—	−.0015	−.0016
		(2.16)		(−1.43)	(1.54)
			B. Old Black Male Coefficients		
YBM	−.1077	−.0888	.0420	.2267	.0124
	(−5.56)	(−3.57)	(.42)	(1.81)	(.04)
F	−.0069	−.0066	.0112	.0059	−.0985
	(−.60)	(.39)	(.44)	(1.14)	(−1.35)
HNM	.0122	−.0005	.0112	−.0492	.0124
	(2.20)	(−.07)	(.44)	(−2.12)	(.30)
HIM	−.0141	−.0085	−.0151	.0137	.0141
	(−1.97)	(−.95)	(−.86)	(.53)	(.29)
WNM	.0024	.0028	.0112	−.0009	.0669
	(.28)	(.20)	(.60)	(−.03)	(1.36)
WIM	−.0080	−.0116	−.0026	.0014	−.0106
	(−1.46)	(−1.66)	(−.15)	(.12)	(−.64)
K	—	.0004	—	−.0018	−.0020
		(.24)		(−1.62)	(−1.75)

Note: t-ratios are in parentheses.

lication of the various models in that section, the labor-force participation analogue to the wage models generally confirmed the results of the wage regressions. Thus, for example, women "take jobs away" from black men in the South and in the North, and both white and black women adversely affect the participation rate of black men. The labor-force participation results therefore provide a strong independent confirmation of the validity of the results discussed in the previous sections.

5.7 The Impact of Women on Black Earnings and Participation Rates

To illustrate the implications of the results presented earlier, it is useful to investigate the future behavior of black male earnings as the entry of women into the labor market continues. In 1970, the proportions of the six basic groups in the labor market were $p_{BM} = .055$, $p_F = .389$, $p_{HNM} = .020$, $p_{HIM} = .009$, $p_{WNM} = .495$ and $p_{WIM} = .032$, where p_i is the percentage of the labor force belonging to group i. Since the generalized Leontief technology estimated in this paper imposes constant returns to scales, all that is needed for a simulation of the black male wage rate is a prediction of the employment shares for each of the groups. By 1980 the proportion of women in the labor force had increased to .424. If the same rate of increase continues over the next decade, p_F will exceed .45 by 1990.

Of course, it is even harder to predict what will happen to the relative shares of the male groups, except that, as a whole, they must decline. A reasonable approximation to these p_i's can be obtained if the purpose of the simulation is to isolate how the rise in the female labor-force participation rate will affect black male wage rates. A natural experiment would hold constant the ratio p_i/p_j $(i,j = BM, HNM, HIM, WNM, WIM)$ across the five male groups. Hence, none of the male groups will increase its relative importance in the labor force. Under these conditions the predicted employment vector is given by: $p_{BM} = .050$, $p_F = .450$, $p_{HNM} = .018$, $p_{HIM} = .008$, $p_{WNM} = .446$, $p_{WIM} = .029$.

Using these employment shares and the regression results in section 5.3, we can easily predict what will happen to the wages of black men as women become a more significant part of the labor force. The top panel of table 5.16 summarizes the results of such simulations, throughout which the regressions that omit capital were used.

The first column of the table reveals that in OLS regressions, the black male wage rate will drop 14.7 percent as the labor-force participation of women increases. The 2SLS estimates moderate this decline to 7 percent. Similar magnitudes appear in the annual-earnings analysis. Of course, these numbers may not be very meaningful, since the estimates of the production function revealed that all the male groups are likely to suffer from increased female employment. The last two columns control for this fact by considering how the ratio between black male and white native male wages responds to the changing employment shares. These statistics also show a decline in (relative) black male economic status. The OLS results predict about a 10 percent decline in relative black wages, while the 2SLS results predict a 4 percent drop.

The remaining two panels in table 5.16 repeat the simulation analysis for each of the two black age groups.[25] The impact of the increased

Table 5.16 **Predicted Changes in Black Male Wages Resulting from Women's Increased Participation in the Labor Force**

Estimation METHOD	% Change in Wage Levels		% Change in *BM/WNM* Wage Ratio	
	WAGE	*EARNINGS*	*WAGE*	*EARNINGS*
			A. All Blacks	
OLS	−14.7	−13.0	−10.8	−10.2
2SLS	−7.0	−6.6	−4.1	−4.4
			B. Young Blacks	
OLS	−18.8	−17.3	−15.7	−15.2
2SLS	−22.4	−31.9	−24.9	−30.7
			C. Old Blacks	
OLS	−14.1	−13.3	−10.8	−11.1
2SLS	−4.1	−4.5	−2.6	−2.7

Note: WAGE and *EARNINGS* are as defined in table 5.1.

labor-force participation of women will obviously be particularly adverse for young black men. For example, the simulation using the OLS estimates reveals that the relative wage of young black men will drop by about 15 percent, while that of older black men will drop only 11 percent. These differences are, of course, exaggerated when the 2SLS estimates are used in the simulation. The table then shows that the relative wage of young black men will drop about 25 percent, while that of older black men will fall by only 3 percent.

The simulation results presented in table 5.16 therefore reveal that increased female employment is an important factor in the determination of the black relative wage. In fact, the magnitudes suggested by the simulation indicate that the increased labor-force participation of married women in the postwar period may well have prevented the equalization of black and white wage rates in the U.S. labor market.

The analysis in the previous sections has also indicated that the entry of women into the labor force is partly responsible for the decline in the labor-force participation rates of black men. It is thus of interest to investigate how the black participation rate would respond to the assumed change in the demographics of the labor market. The first column of table 5.17 presents the labor-force participation rates calculated from the census data, and the remaining columns present the predicted labor-force participation rates. Again, the simulation reveals that the increased labor-force participation of women will have a major impact on the participation rate of young black men but only a negligible impact on the participation rate of older black men. In particular, the results indicate that the labor-force participation rate of young black men will drop about 5 percentage points by 1990 if current trends in female labor-force participation continue. The sizable magnitude of this change indicates that the entry of women into the labor market in the postwar period may have been the most important factor causing the declining participation rates of young black men.

5.8 Summary

This paper has attempted to estimate how the demand for black labor is affected by changes in the demographic characteristics of the local labor market. The main tool of the analysis was the use of the generalized Leontief production technology. This functional form has the advantage of yielding linear-in-parameters marginal productivity equations, so that wage regressions at the individual level can be interpreted in terms of a labor-demand framework. From data in the 1970 Public Use Samples of the U.S. Census, several important empirical results were obtained.

First, women are strong substitutes for black men in the production process. In fact, women tend to be substitutes for all groups of men, but black men are particularly vulnerable to the increased enıry of women in the labor market.

Second, black men have not been adversely affected by the entry of immigrants in the labor market. This complementarity holds for both Hispanic and non-Hispanic immigrants.

Third, these results are not sensitive to major changes in the specification, samples, or estimation methodology. Thus, the adverse effect on black earnings of increased female employment, for example, is true both for wage rates and annual earnings, in the North and in the South, among young black men and older black men, and in the manufacturing sector.

Table 5.17 Predicted Changes in the Black Male Labor-Force Participation Rate Resulting from the Increased Participation of Women

Group	Actual Participation Rate	Predicted Participation Rate	
		OLS	2SLS
All Black Men	.915	.902	.905
Young Black Men	.835	.788	.782
Old Black Men	.939	.938	.942

Fourth, the analysis shows that estimates of the production-function parameters can also be obtained by studying the labor-force participation of individuals. These employment regressions indicate that women do "take jobs away" from black men, since increased female employment leads to lower black male participation rates.

Fifth, the simulation of the estimated production function reveals that the current trends in female labor-force participation will result in a 4 to 10 percent decline in the black male wage (relative to the white native male wage).

Finally, the simulation analysis also reveals that the continuing entry of women into the labor market will have a particularly adverse impact on the earnings and labor-force participation rates of young black men. In fact, much of the decline in the participation rates of young black men in the postwar period can be directly attributed to the rapid increase in the number of working women.

Of course, it is important to stress that much further study needs to be conducted before the demographic determinants of the demand for black labor are fully understood. For example, future research should determine whether the time-series paths of female employment and black wage rates are consistent with the technological relationships suggested by this paper. Similarly, researchers should investigate how the entry of women into the labor market affects the job distribution of black men along narrowly defined occupation and industry categories. The insights from these future studies should indicate that much can be gained by the introduction of economic theory in the empirical study of blacks' performance in the labor market.

Notes

1. See, for example, the recent studies by Gwartney and Long (1978), Haworth, Gwartney, and Haworth (1975), Smith (1977), and Weiss and Williamson (1972).

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2. More recent examples in this tradition include the work of Ashenfelter (1972), Butler and Heckman (1977), Borjas (1982), Freeman (1981), and Smith and Welch (1977). Each of these papers attempts to determine whether exogenous factors (such as the unionization of the firm's workers, passage of the 1964 Civil Rights Act, or the racial prejudices of voters) determine black-white wage differentials.

3. Thus, the analysis in this paper is closely related to the emerging literature that estimates empirically tractable production technologies. Examples of this work are Berger (1983), Borjas (1983), Freeman (1979), and Grant and Hamermesh (1981). An instructive survey of the main results in the literature is given by Hamermesh and Grant (1979). It should be noted that only two recent papers (Grant and Hamermesh 1981;

Borjas 1983) treat black labor as a separate input in the production process. The findings in these and related studies will be discussed below.

4. Another restriction implied by the functional form in equation (1) is that diminishing marginal productivity for input l requires that not all γ_{lj} ($j = 1, \ldots, l-1, l+1, \ldots, n$) be negative. In other words, some inputs must be complements with input l. It turns out that a somewhat similar restriction is implied by the second-order conditions of the profit-maximization model in terms of the elasticities of complementarity (defined below): not all cross-elasticities can be negative. For a discussion of these issues see Diewert (1971) and Sato and Koizumi (1973). Several studies discussing the properties of a variety of multifactor production functions, including the generalized Leontief, are contained in Fuss and McFadden (1978).

5. Recall that the elasticity of substitution measures the effect of a change in the relative price of a factor on the relative quantity of that factor, holding output and the prices of other factors constant. See Sato and Koizumi (1973) for an extended discussion of the duality between the elasticity of substitution and the elasticity of complementarity.

6. Note that the definition of the fixed effect requires that $E(f_l) = 1$ in the multiplicative specification and that $E(f_l) = 0$ in the additive model.

7. An alternative derivative of equation (5) can be easily obtained. Suppose we pool all i observations within and across the m labor markets and estimate the regression:

$$w = Z\beta + M\delta + v, \tag{n1}$$

where $M = (M_1 \ldots M_m)$, $\delta = (\delta_1 \ldots \delta_m)'$, $M_l = 1$ if the individual lives in labor market l, and the subscript i for the group is omitted for simplification. The vector of coefficients δ will measure geographic differences in group i's wage rate *net of any skill differentials*. The demand framework outlined in this section predicts that the vector δ depends on the demographic characteristics of the labor market, $\tilde{X}$, so that:

$$\delta = \tilde{X}\gamma + u. \tag{n2}$$

Substituting equation (n2) into equation (n1) yields:

$$w = Z\beta + (M\tilde{X})\gamma + \epsilon. \tag{n3}$$

Since the vector M is of the form $(0 \ldots 0\ 1\ 0 \ldots 0)$, the term $M\tilde{X}$ will yield the values of the demographic variables for the labor market where the individual resides. By appropriate specification of $\tilde{X}$, equation (n3) is therefore equivalent to equation (5) in the text.

8. It is worth noting that the wage-generating equation predicted by the generalized Leontief model differs substantially from the log-linear specification derived in the human capital framework. The human capital model does not account, however, for any employer objectives in its derivation; it is entirely based on an accounting equation defining earnings growth over time and the individual's incentive to invest less in human capital as he ages. Moreover, of all commonly used production functions only the Cobb-Douglas leads to a linear-in-parameters log wage equation. Unfortunately, the Cobb-Douglas builds in a unitary elasticity of substitution among the various inputs.

9. Further, the results in Freeman (1979) suggest a high degree of substitution among women of different age groups. Thus, the aggregation of women into one labor input can be viewed as a reasonable first-order approximation.

10. An alternative definition of X_i would be based on the number of working-aged persons in the SMSA rather than on the number of labor-force participants in the SMSA. In the case of male groups the difference between the two definitions is minimal. The introduction of women as a separate labor input, however, would lead to serious biases in the measurement of the (relative) employment variables if a population-based measure of X_i were used.

11. Grant (1979) constructed the capital stock index for only 84 of the 125 SMSAs identified in the 1970 census data. The inclusion of the capital variable therefore introduces an important sample restriction. Furthermore, the 84 SMSAs Grant selected are not a random sample of the 125 markets available in the data. Rather they tend to include only the largest SMSAs in the United States.

12. In the female sample, the vector Z also includes whether the woman is an immigrant and the number of years since her immigration. In the Hispanic and white immigrant samples the vector Z includes the number of years since immigration.

13. Actually, because of the particular construction of the census data, the 1969 wage rate is defined in terms of weeks worked in 1969 and hours worked last week (in 1970).

14. The complementarity between Hispanics and blacks confirms the results obtained by Borjas (1983) using the 1976 Survey of Income and Education.

15. It is of some interest to compare these results with those obtained from a more conventional analysis that simply adds the employment proportions to the typical human capital earnings function. The estimated equation for the black male (ln) wage rate (t-ratios in parentheses) is given by:

$$\ln(WAGE) = Z\beta \underset{(-7.1)}{-2.12p_F} \underset{(-4.9)}{-1.36p_{HNM}} + \underset{(.32)}{.11p_{HIM}}$$

$$+ \underset{(3.2)}{.45p_{WNM}} + \underset{(21.0)}{5.27p_{WIM}}, \quad R^2 = .11,$$

where p_i is the proportion of group i individuals in the SMSA's labor force, and p_{BM} is the omitted proportion. Note that female employment has the strongest negative impact on black male wage rates, so that the generalized Leontief results parallel those obtained from this descriptive regression.

16. The very strong negative coefficients in the female equation are actually somewhat troublesome, since they will certainly lead, in the generalized Leontief framework, to perversely sloped labor-demand curves for women. As was noted earlier an important requirement for concavity of the production function in equation (1) is that not all γ_{ij} variables in the marginal productivity equation be negative. The women's wage equation clearly contradicts this restriction, and this fact will lead to severe problems in the calculation of own elasticities of complementarity below.

17. Most of these aggregate variables were constructed from the Census 1/100 data. The exceptions were the measures of public housing and welfare assistance, which were obtained from the 1976 Survey of Income and Education. See Borjas (1983) for details.

18. See, for example, Ashenfelter and Heckman (1974) and Schultz (1980).

19. The calculation of the elasticities of complementarity requires data on the value of average product. It is defined by the gross national product per person in the labor force in 1969. This quantity was $11,105.

20. The remaining coefficients in the matrix are available from the author.

21. The labor market is defined to be in the South if the SMSA is located *entirely* in the census definition of the South; otherwise the SMSA is defined to be in the North.

22. The August 1973 cost-of-living index is available in U.S. Department of Labor (1975). Note that although the wage data are for 1969, the deflator is for 1973. This difference in dates is not likely to cause major problems, since cost-of-living differences across SMSAs are correlated over time.

23. The participation variable is obtained from the "Employment Status Recode" variable in the Public Use Samples. It is set equal to unity if the individual was in the labor force during the reference week and zero otherwise. To ensure that the sample contained only individuals who seriously considered employment as an alternative, the labor-force participation regressions were restricted to persons who had worked at some point since 1959. The mean participation rate in the black male sample was .92.

24. The labor-force participation analysis has the additional advantage of avoiding the problems arising from the fact that cost-of-living differentials across labor markets create spurious wage differentials. Since behavior is invariant to changes in the nominal price level, any nonzero effects of the relative employment variables must reflect the impact of demographic characteristics on the real wage rate.

25. To conduct these simulations it is assumed that the relative proportions of blacks in the two age groups remain fixed after the entry of women in the labor force occurs. In other words, p_{YBM}/p_{OBM} is constant over the period of simulation.

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Comment Daniel S. Hamermesh

There has been far too little empirical work on the demand for labor, in general, and on labor-labor substitution, in particular. Borjas's paper is a major addition to these literatures, a contribution that is at least as important as its implications regarding how minorities fare in the labor market. Borjas's primary contribution to the literature on demand is his confirmation of results explicit in Grant and Hamermesh (1981) and implicit in Freeman (1979) on the q-substitutability of women and other workers with relatively little human capital (youths and minorities). Although three empirical studies do not a fact make, I am fairly confident that this result will be robust to tests using other sets of data and methods using other specifications. Since there are very few established facts characterizing the demand for labor, this contribution is important.

The accretion to our knowledge of the position of minorities in the labor market is twofold. Clearly, Borjas's finding of q-substitution between women and black men, and especially between women and young

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black men, is important, as he stresses. Just as important is the remarkable confirmation of his earlier results (Borjas 1983) on the lack of q-substitution between blacks and Hispanics. Although the methods employed are the same in both papers, the data sets are quite different, as are the periods during which they were collected. This replication quite strongly suggests that attempts to enhance employment opportunities for one of the two largest minority groups in the United States will not necessarily hurt the economic status of the other.

Borjas is to be commended for the extreme care he has taken to address the problems of estimating systems of equations based on cost or production functions. He is one of the few scholars studying labor demand who actually consider whether labor is separable from capital. (It is gratifying to see that ignoring capital changes his labor-labor substitution parameters little, even if he does not formally test for strong substitutability). Borjas is, in fact, the first to address the simultaneity problem in estimating relations of this sort. His attempts to use standard simultaneous-equations methods to solve the problem are most worthwhile. Despite his valiant effort, however, I do not believe the standard approach to the problem will be very fruitful. We may have good models specifying labor supply at the microeconomic level, but equations characterizing supply responses across geographic areas are quite poorly specified. Thus, although Borjas does include the standard variables in his first-stage equations explaining X_i/X_j, it seems unlikely that much of the simultaneity is removed or that the variation that is removed necessarily should be. The problem will not be solved unless the units of observation used in estimating cost or production relations are very small, particularly at the level of establishments. Let me stress, though, that the problem is with the entire literature, not simply with Borjas's study.

This important objection not withstanding, part of the study's contribution is its exposition of a number of useful paths for future research on the subject, using different sets of data and examining competition among subgroups in the labor force disaggregated differently from those used here. Also, by stressing the ease of using the generalized Leontief specification, Borjas succeeds in reversing the reliance on the translog specification. This should help further in producing some consensus about the signs of substitution parameters, and perhaps even about their magnitudes.

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