EE-0026

EFFECTS OF AIR POLLUTION AND OTHER ENVIRONMENTAL VARIABLES ON OFFERED WAGES

by

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REVISED
November 10, 1980

I. Introduction

Much of the recent interest in the econometric estimation of labor supply models using individual or micro data has been stimulated by important policy questions such as the role of women in the labor force and the advisability of negative income tax programs. Frequently, these models have consisted of two interrelated equations that explain: (1) how an individual's offered wage rate is determined and (2) how this wage rate together with other factors affects the amount of time an individual chooses to work. Effects on wages and hours in response to changes in exogenous variables including the actual negative income tax rate faced or the number of pre-school children in the home can then be estimated through this framework. This general approach can be easily extended to make parallel estimates of the labor market effects of changes in environmental amenity levels. Such extensions would have obvious policy relevance in that the extent of reduced productivity due, for example, to air pollution could then be assessed.

The purpose of this report is to construct some exploratory estimates of the effect of changes in air pollution levels on offered wage rates. Repercussions on the work time choice are not explicitly considered. Specifically, hedonic equations are estimated that allow for an individual's offered wage rate to be determined by his own labor supply characteristics together with measures of amenity levels in the community in which he lives. In this type of analysis, supply characteristics such as education, work experience, and health status are frequently used exclusively to explain the variation in the offered wage.[1] This specification carries the restrictive implicit assumption that the demand schedule for classes of individuals possessing indentical values of these independent variables is infinitely elastic. That is, observed differences in individual wage rates are attributed only to supply characteristics. In order to circumvent this limitation, Nakamura, Nakamura, and Cullen (NNK) (1979), have suggested the inclusion of work environment variables such as the local unemployment rate and a local job opportunities index as additional regressors. These work environment variables, obviously, capture the fact that local labor demand conditions may influence offered wages after adjusting for the effect of individual labor supply characteristics. However, as recognized by other investigators, variables measuring working conditions and job related hazards (Lucas 1977, Hamermesh 1977, Thaler and Rosen 1975, Viscusi 1978, and Brown 1980), social infrastructure (Nordhaus and Tobin 1972, and Meyer and Leone 1977), as well as environmental amenities (Hoch 1977, Rosen 1979, and Cropper 1979) can also play an important role, in explaining the behavior of wage rates. For example, in the case of environmental amenities, if a community is located in an area that is subject to extreme temperatures or unusually high air pollution levels, employers may find it necessary to pay their workers a premium in order to induce them to remain there.

II. Specification and the Data Used in Estimation

The general form of the offered wage rate equation to be considered here is then

$$WAGE = f(P,W) \qquad (1)$$

where WAGE denotes the offered wage rate paid, P denotes a vector of personal labor supply characteristics, and W denotes a vector of work environment characteristics. Moreover, the vector P is assumed to contain measures of: (1) whether the individual is a union member (UNON),

(2) whether the individual is a veteran (HVET), (3) the size of the individual's family (FMSZ), (4) the individual's health status (HLTH), (5) the individual's prior educational achievement (EDC2, EDC3), and (6) the length of time the individual has spent on his present job (TOJ2).[2] Next, W contains measures of: (1) mean January and July temperature in the individual's area of residence (COLD, WARM), (2) the job accident rate in the industry where the individual works (JACR), (3) average rainfall in the individual's area of residence, and (4) levels of the air pollutants sulfur dioxide (SOXM), total suspended particulates (TSPM), and nitrogen dioxide (NOXM).

Unfortunately, this formulation may be subject to a specification error of unknown severity resulting from the omission of relevant explanatory variables. While the personal labor supply characteristics are fairly standard for analyses of this type, biased coefficient estimates may result from the exclusion of still other relevant work environment variables. That is, climate, job hazards, and air pollution do not exhaust the list of potential amenities that may affect the offered wage rate. (For good surveys of the role other variables may play, see Brown (1980) and Rosen (1977).) Proximity to recreational opportunities and the amount of local social infrastructure are but two examples of work environment variables that could in principle be measured and included. Also, the more labor market specific variables used by NNK have been excluded from consideration here. Due to budgetary and time constraints, no efforts were made to collect observations on these potentially relevant variables. The variables used to explain variations in the offered wage rate were simply chosen from those that had been collected previously by the Resource and Environmental Economics Laboratory at the University of Wyoming for use on other research projects.

More specifically, the basic data set used to estimate the wage equation consisted of observations drawn from the Panel Study of Income Dynamics (PSID) for the 1971 interview year. In total, there are observations for household heads on variables that can be used to construct a measure of their real wages, together with measures of the variables in the P vector defined previously in Equation (1). The exact definitions of all of these variables as well as their numerical codes used on the PSID tapes are provided in Table 1 entitled Variable Definitions. Table 1 also gives definitions of the variables appearing in the vector W. For the 1971 interview year, the PSID data gives the household's state and county of residence and two digit SIC industry of employment. Consequently, data were collected on COLD, WARM, HUMD, SOXM, NOXM, and TSPM by county and then were matched to the individual observations obtained from the PSID.

For the variables COLD, WARM, AND HUMD, this matching process was quite simple and requires no further elaboration. However, the matching of the air pollution variables to counties should be explained in greater detail.[3] The matching process was begun by listing each of the 669 counties in the 50 states where PSID families lived during 1970. Outdoor air pollution monitoring data existed for at least one of the three measures SOXM, NOXM, AND TSPM for 247 of these counties. In cases, where data from only one monitoring station in the county were available, those data were automatically assigned to all PSID families residing there. On the other hand, where data were available from multiple monitoring stations in the county, data from the single station that had operated for the greatest portion of the nine year period 1967-1975 were selected. The monitoring stations selected using this

Table 1

VARIABLE DEFINITIONS*

A. PECUNIARY VARIABLES

HOURS = (1839) (head's annual hours working for money)

AWGH = (1897) (head's money income from labor)

WAGH = 0 if HOURS = 0, otherwise WAGH = AWGH/HOURS

BDAL = Index of comparative living costs for a four person family for various areas as published by Bureau of Labor Statistics in the Spring 1967 issue of <u>Three Standards of Living for an Urban Family of Four Persons</u>. The lowest living standard was used. This index is published for the 39 largest SMSAs and by region for other SMSAs.

RWGH = WAGH/BDAL

B. SUPPLY CHARACTERISTIC VARIABLES

HLTH = 1 if (2121) = 1 or 3 or if (2122) = 1 or 3 or both.

= 0 otherwise (If HLTH = 1, there are limitations on amount or kind of work that the head can do)

UNON = 1 if (2145) = 1, zero otherwise (Head belongs to a labor union if UNON = 1)

EDC1 = 1 if (2197) = 0, 2, 3, or 9 zero otherwise (If EDC1 = 1, head has completed grades 0-8 or has trouble reading.)

EDC2 = 1 if (2197) = 3, 4, or 5 zero otherwise (If EDC2 = 1, head has completed grades 9-12 + possible non-academic training.)

EDC3 = 1 if (2197) = 6, 7, or 8 zero otherwise (If EDC3 = 1, head has completed at least some college.)

HVET = 1 if (2199) = 1 zero otherwise (If HVET = 1, head is a veteran.)

FMSZ = (1868) (Family size in 1971)

TOJ1 = 1 if (1987) = 1, 2, or 3 zero otherwise (head's length of time on present job is 3 years or less if TOJ1 = 1)

TOJ2 = 1 if (1987) = 4, 5, or 6 zero otherwise (head's length of time on present job is longer than 3 years if TOJ2 = 1)

Variable Definitions (continued)

C. WORK ENVIRONMENT VARIABLES

WARM = Mean annual July temperature in the county of residence in 1970 in F° x 10.0. These data are from the U.S. Bureau of Census, County and City Data Book, 1971.

COLD = Mean annual January temperature in the county of residence in 1970 in F° x 10.0. These data are from U.S. Bureau of Census, County and City Data Book, 1971.

JACR = Number of disabling work injuries in 1970 for each million employee hours worked by 2- and 3- digit SIC code. The data were obtained from Table 163 of Bureau of Labor Statistics, Handbook of Labor Statistics, 1973, Bulletin 1735, U.S. Department of Labor, Washington, DC., USGPO, 1972.

SOXM = Annual 24 hour geometric mean sulfur dioxide micrograms per cubic meter as measured by the Gas Bubbler Pararosaniline -- Sulfuric Acid Method. These data were obtained from the annual USEPA publication, Air Quality Data -- Annual Statistics, and refer to a monitoring station in the county of residence for 1970.

HUMD = Mean annual precipitation in inches x 100.0. These data are taken from the U.S. Bureau of Census, County and City Data Book, 1971.

NOXM = Annual 24 hour geometric mean nitrogen dioxide in micrograms per cubic meter as measured by the Salzman Method. These data were obtained from the annual USEPA publication, Air Quality Data -- Annual Statistics and refer to a monitoring station in the county for residence for 1975.

TSPM = Annual 24 hour geometric mean total suspended particulates in micrograms per cubic meter as measured by the Hi-Vol Gravimetric Method. These data were obtained from the annual USEPA publication, Air Quality Data -- Annual Statistics and refer to a monitoring station in the county for residence for 1970.

SOXM** = $SOXM^2$

P**2 = $TSPM^2$

N**2 = $NOXM^2$

D. PARTITIONING VARIABLES

AGE = (1972) (head's age in years)

OCCP = 1 if (1984) = 1, 2, 4, or 5 otherwise = 0 (head is a white collar worker if OCCP = 1 and, a blue collar worker if OCCP = 0)

SEX = 1 if (1943) = 1 otherwise = 0 (head is male if SEX = 1)

RACE = 1 if (2202) = 1 zero otherwise (If RACE = 1, head is white.)

Variable Definitions (continued)

E. AUXILLIARY VARIABLES

REG1 = 1 if (2284) = 1	otherwise = 0	(head lives in a northeastern state if REG1 = 1)
REG2 = 1 if (2284) = 2	otherwise = 0	(head lives in a northcentral state if REG2 = 1)
REG3 = 1 if (2284) = 3	otherwise = 0	(head lives in a southern state if REG3 = 1)
REG4 = 1 if (2284) = 4	otherwise = 0	(head lives in a western state if REG4 = 1)
PRX1 = 1 if (2210) = 1	zero otherwise	(If PRX1 = 1, head's dwelling unit is within 5 miles of center of city of 50,000 or more.)
PRX2 = 1 if (2210) = 2	zero otherwise	(If PRX2 = 1, head's dwelling unit is between 5-14.9 miles of city center.)
PRX3 = 1 if (2210) = 3	zero otherwise	(If PRX3 = 1, head's dwelling unit is between 15-29.9 miles of city center.)
PRX4 = 1 if (2210) = 4	zero otherwise	(If PRX4 = 1, head's dwelling unit is between 30-49.9 miles from city center.)
PRX5 = 1 if (2210) = 5	zero otherwise	(If PRX5 = 1, head's dwelling is greater than 50 miles from city center.)

AVGT = Average annual temperature for counties in degrees centigrade for 1970.

*Variable numbers from the PSID tape code book are given for the data collected from the PSID interviews. For the remaining data, no variable numbers are given.

rule tended to be at central city locations. Finally, since no pollution data were available for 422 counties (699-247), values were assigned to the air quality variables for these counties using one of two procedures for handling missing observations that will be described momentarily.

For the purpose of estimating the hedonic wage equation, the data set was reduced from the roughly 3300 possible observations to 1395 observations after excluding all housholds where: (1) any family member received transfer income, (2) the head's annual hours of working for money was less than 400 hours. The first of these exclusions was made in order to reduce the statistical problem created by families that may be facing non-convex budget constraints while the second was made in order to eliminate casual workers, who may be out of equilibrium because their asking wage may exceed offered wage, from the sample. Curiously, after making these two exclusions, there were no families remaining in the sample where the head: (1) received income from overtime, bonuses or commissions, or (2) was self employed.

The restricted sample used here is quite similar to that used by Wales and Woodland (1976, 1977, 1978) in their numerous papers on the empirical determinants of labor supply using PSID data. However, by excluding household heads who worked less than 400 hours, the estimates reported in the next section are subject to sample selection bias, a problem dicussed at length by Heckman (1976, 1979). Essentially, Heckman contends that the estimates resulting from such a sample do not apply to the general population. Instead, they apply only to those in the population having the same characteristics of those in the sample. In short, the estimates say little about the wage rate that would be paid to an individual working 400 hours or less had that individual have chosen to work, for example, full time. An excellent survey of the sample selection problem as it relates hedonic wage and labor supply estimates is contained in the recent paper by Wales and Woodland (1980).

The exact specification of the wage equation used in the present study is shown in Equation (2).

$$\begin{aligned}\text{Ln(RWGH)} = \text{f(}&\text{UNON, HVET, FMSZ, HLTH, EDC2, EDC3, TOJ2, WARM,}\\ &\text{JACR, COLD, HUMD, SOXM, TSPM, NOXM, P**2, SOXM**2,}\\ &\text{N**2, CONSTANT).}\end{aligned} \qquad (2)$$

In Equation (2), the function f is linear in the parameters and RWGH denotes the real wage. Also, note that the squares of the levels of the three pollution variables are included as regressors in order to allow for possible nonlinearities in the way that air pollution affects the real wage. This equation was estimated by ordinary least squares for both the complete sample of 1395 observations and for selected partitions of this sample constructed on the basis of age (AGEH), race (RACE), sex (SEXH), and occupation (OCCP). In particular, there were three age categories (17-29, 30-49, 50-69), two race categories, (white, non-white), two sex categories (male, female), and two occupation categories (white collar, blue collar). The total number of possible partitioned regressions was therefore 24(3x2x2x2). However, not all of these possible regressions were actually estimated because for certain partitions the number of available observations was insufficient.

Before turning to a discussion of the results of these regressions, two additional points should be made regarding the pollution variables. First, as previously indicated, observations on these variables were not available for each of the 669 counties of residence for families in the PSID data set. In these cases, the missing observations were either replaced by the means of the observed values for the pollutants or estimated using a technique suggested by Dagenais (1973). A brief discussion of the replacement with means method is outlined in Maddala (1977). The Dagenais procedure involves running a regression of each pollution variable on: (1) all remaining (non-pollution) explanatory variables in Equation (2), and (2) relevant auxilliary variables that may be selected and then predicting the values of the missing observations from these regressions.[5] Predicting equations for each of the three pollutants are shown in Tables 21, 22, and 23. As shown in these tables, the auxilliary variables used are dummies relating to the distance of a family's residence from a city center (PRX1, PRX2, PRX3, PRX4, PRX5), the region of the country where the family lives (REG1, REG2, REG3, REG4) and a measure of the average temperature in the family's county of residence (AVGT). Unfortunately, the R^2's for these regressions ranged from .33 for NOXM to .37 for TSPM to .54 for SOXM indicating that their forecasting power may not be particularly high. An alternative to either the replacement with means or the Dagenais' procedures would be to restrict the sample to only those observations where actual measurements were available on all variables, including the pollutants. Even though this restriction reduces the available data set to 112 observations, it was employed in the estimation of one equation for illustrative purposes.[6]

A further problem with the SOXM data is that they were obtained using the Gas Bubbler Pararosaniline--Sulfuric Acid Method. This method has been shown to result in estimates of SO_2 levels that are biased downward. Mathtech, however, has supplied a conversion equation that corrects for the bias in the original data. That conversion equation is given below.

$$\text{CSOX} = 10.625 + 1.97269(\text{SOXM}) - 0.10891[\text{SOXM} \cdot \text{AVGT}] \qquad (3)$$

where CSOX is the converted sulfur dioxide measure. In estimating Equation (2), CSOX was substituted in place of SOXM, and its square, CSOX^2 = S**2 was used in place of SOXM**2.

III. Empirical Results

As previously indicated, three basic versions of Equation (2) were estimated where: (1) the restricted sample of 112 observations was employed, (2) the Dagenais procedure was used to construct the pollutants, and (3) the replacement with means procedure was used. All regressions were estimated by OLS.

Table 2 reports the results from estimation with the restricted data set. In this equation, all of the supply characteristic variables are significant at the 1 percent level except HLTH and TOJ2. However, the work environment variables are all insignificant at conventional levels. In fact, the t-statistics on the pollution variables in no case exceed 1.1 in absolute value. Using the replacement with means procedure, the quality of the estimated coefficients improves considerably. These results are shown in Table 3. With the increase in the number of observations employed from 112 to 1395, all of the supply characteristic variables turn out to be significant at the 1 percent level and have the correct sign. Differences in data sets and in equation specifications make it difficult to directly compare these results to those obtained in previous studies. Nevertheless, their general pattern of the estimates presented in Table 3 corresponds closely to those obtained by other investigators.

The estimates of the coefficients on the work environment variables also tend to be more highly significant and are more plausibly signed than in the case where the restricted sample of 112 observations is used. Also, they are generally consistent with the findings of other investigators. As indicated in Table 3, the variables WARM and COLD enter with a significant negative sign. In the case of WARM, the negative sign indicates that the individuals in the sample are willing to accept a lower wage in order to live in an area with hot summers. That same qualitative result has been obtained by Rosen (1979) using individual data from the Current Population Survey together with SMSA specific attributes and by Hoch (1977) and Cropper (1979) using aggregate SMSA data exclusively. On the other hand, the negative sign on COLD suggests that individuals must be paid a premium to live in areas where mean January temperatures are low and winter weather is probably severe. Of the three studies just mentioned, only the one by Hoch employs a similar variable. The coefficient on "winter temperature" is positive in his regressions on Samples I and II and negative in his regression on Sample III (see Hoch's Table 5, p. 39).

Next, the coefficient on JACR is positive and significant supporting Viscusi's (1978) result that employers must pay a premium in order to induce workers to accept jobs where the probability of accidents is higher. Also, this result is consistent with the findings of other investigators who measured other dimensions of working conditions. For example, Lucas (1977), Hammermesh (1977), and Thaler and Rosen (1975) consider the effect of wages of variables including: (1) a generalized measure of poor working conditions, (2) the presence of hazardous materials and/or equipment, and (3) deaths per 1,000 man years of work. All three of these variables have been found to be positively and significantly related to similar dependent variables to the one used in the present study.

With respect to the HUMD variable, Table 3 shows that its coefficient is negative but statistically insignificant at the 5 percent level. Although this negative sign is intuitively implausible, that same result was obtained in Hoch's regressions on each of his three samples. Rosen, however, obtains the more appealing result that increases in precipitation are positively associated with real wages. The precipitation variable that Rosen uses, which is defined as number of rainy days, was always positive and usually statistically significant in each of 29 different equation specifications (see Rosen's Table 3.3, p. 94).

The pollution variables do not perform quite as well as the other variables in the equation. Both the linear and quadratic terms for CSOX and for NOXM are statistically insignificant at the 5 percent level. The result for CSOX conflicts with those of Cropper (1979). In her regression for all earners and in four of her eight occupation specific regressions, a measure of SO_2 turned out to be positively and significantly related to median earnings of males who were employed full time. However, in the Cropper study SO_2 was the only pollution measure used and, therefore, this variable could also be proxying the effects of other pollutants. Rosen's results show that this conjecture is a real possibility. His SO_2 measure occasionally has the right sign, but is more frequently negative and significant. Particulates, on the other hand, exhibit superior performance in Rosen's equation. This variable was positive in each of the 32 cases where it was used and had a t-statistic exceeding 2 in 27 cases (again, see Rosen's Table 3.3, p.94). The results on the TSPM variable used in the present study compares favorably with the findings of Rosen. As Table 3 shows, the linear TSPM term has a positive and statistically significant coefficient and the quadratic TSPM term has a smaller negative but significant coefficient.

The elasticity of the real wage with respect to a change in TSPM can be computed from the estimates presented in Table 3 according to

$$e_{TSPM} = \frac{\partial RWGH}{\partial TSPM} \; \frac{TSPM}{RWGH} = \alpha \cdot TSPM + 2\beta \cdot TSPM^2 \qquad (4)$$

where e_{TSPM} denotes the elasticity, α denotes the estimated coefficient on the linear term and β denotes the coefficient on the quadratic term. Evaluated at the mean of the <u>observed</u> values for TSPM, $e_{TSPM} = -0.0367$, evaluated at the national primary standard, $e_{TSPM} = .1322$, and evaluated at the national secondary standard, $e_{TSPM} = .2005$. The mean of the actually observed values of TSPM = 96.56 and the national primary and secondary standards for TSPM are shown in Table 27. The comparatively high value for the mean of TSPM can be attributed to a relatively small number of counties in the data set where total suspended particulates was considerably in excess of 100. In any case, these results suggest that in the neighborhood of the national air quality standards benefits from reducing TSP concentrations are likely to exist.

Illustrative calculations of benefits of national pollution abatement programs are presented for two SMSAs, Denver and Cleveland. These calculations are derived from the pooled regression estimates in Table 3. In particular:

(i) SMSA specific means for the variables EDC2, EDC3, HVET, and FMSZ were obtained from the 1970 U.S. Census 1 in 100 public use sample tapes and substituted into the equation reported.

(ii) SMSA specific averages for the variables WARM, COLD, and HUMD were obtained from other sources and substituted into the equation reported.

(iii) For the remaining non-pollution variables, UNON, HLTH, TOJ2, and JACR, the sample means reported in Table 25 were substituted into the equation reported. This procedure was used because of the difficulties in obtaining meaningful SMSA specific means for these variables.

These means, which are reported in Table 26, were then multiplied by their respective coefficients in order to obtain a predicted wage <u>exclusive</u> of pollution effects.

For the pollution variables, it was assumed that neither community would have air pollution levels higher than the primary standards for SO_2, NO_2 and TSP by 1985 and that the secondary standards for all three pollutants would be met by 1987. In cases where current (1978) pollution concentrations are lower than the secondary standards, those current concentrations were assumed to prevail throughout the forseeable future. As previously indicated, Table 27 reports the national primary and secondary standards legislated to take effect in 1985 and Table 28 reports 1978 pollution concentrations for Denver and Cleveland.

In Denver, for example, the change in the predicted RWGH associated with a reduction in total suspended particulate concentrations was obtained holding constant the values of the other pollution and non-pollution variables. The values for the remaining pollution variables were held constant because Denver is already meeting the national secondary standards for them. Also, the values of the non-pollution variables were assumed to remain unchanged over time. Projected benefits were then obtained by multiplying the change in the hourly real wage by annual hours of full time work and then multiplying this result by an estimate of the number of affected household heads in each SMSA. Annual hours of full time work were assumed to be 2000 and the 1 in 100 Census Bureau public use sample indicated that there were approximately 382,700 household heads in Cleveland and 218,100 household heads in Denver with the hours of work and employment characteristics required for inclusion in the sample used to make the pooled regression estimates.

Annual benefit estimates from pollution abatement in the two cities are positive according to the calculations made here. For Denver, meeting the national secondary standards for TSP results in a reduction in the offered real wage, from $4.1758/hr. to $3.9626/hr. Multiplying this difference of $.2136/hr. by the number of persons affected times 2000 hours yields an estimated annual benefit for Denver of $92,968,935. A similar calculation for Cleveland reveals that meeting the national secondary air quality standards causes the real wage to fall from $3.8756/hr. to $3.7693/hr. implying a benefit of $81,360,489. Note that benefits per <u>household head</u> in the two cities are $426.35 for Denver and $212.60 for Cleveland. Simple calculations using the estimates in Table 3 and the mean values in Table 26 show that reductions in TSP levels would be responsible for all of these estimated benefits.

The larger value for benefits for all of these estimated benefits per person in Denver arises because greater reductions must be achieved as compared with Cleveland, in order to achieve the national secondary standards.

Finally, the results from estimating Equation (2) using the Dagenais procedure to construct the missing observations on the pollution variables are reported in Tables 4 through 20.[7] Tables 4 through 19 contain various partitions of Equation (2) based upon age, race, and sex and Table 20 contains the pooled sample regression. The coefficients on the supply characteristic variables reported in Table 20 are very similar to those reported in Table 3. However, both the linear and quadratic terms for all three pollutants enter the pooled regression insignificantly at the 5 percent level using a two-tailed test. In the partitioned regression equations, the air pollution variables are seldom significantly different from zero either.[8] More specifcally, there are five of these regressions where one of the pollution variables entered significantly. These are: (1) the Male, White, White Collar Worker, Age 50-69 partition (TSPM), (2) the Male, White, Blue Collar Worker, Age 30-49 partition (TSPM), (3) the Male, White, Blue Collar Worker, Age 17-69 partition (CSOX), (4) the Male, Non-White, Blue Collar Worker, Age 30-49 partition (CSOX), (5) the Female, White, White Collar Worker, Age 17-69 partition (TSPM). Neither the linear nor the quadratic term on NOXM was ever significantly different from zero at the 5 percent level. In the five cases where a pollution variable was significant, the elasticity of the real wage with respect to a change in the pollution was computed using the method shown in Equation (4). All of these elasticities were evaluated at the grand mean (computed over all 1395 observations) of the pollution variables. These means, together with the means and standard deviations of all variables used in this analysis are shown in Table 25. Finally, the results of the elasticity calculations are presented beneath the coefficient estimates for the equations to which they pertain. As indicated there, three of the calculated elasticities are positive while two are negative.

The relatively weaker performance of the pollution variables in the equations estimated using the Dagenais procedure can perhaps be attributed to several factors. First, although Dagenais shows that his method produces consistent prediction of the missing observations, this asymptotic property may say little about the finite sample properties of such a procedure, particularly when a large fraction of the observations are missing. Table 29 shows how this missing observations problem relates to each of the 16 partitional equations estimated. In particular, this table presents the number of observations for each partition for which actual pollution data were available. As can be seen, four of these partitions had no observations where data on all three pollutants were available. Second, the consistency of Dagenais' method depends upon the use of a generalized least squares procedure to estimate the hedonic wage relation that requires the solution of a set of simultaneous, nonlinear equations. Because of computational difficulties, OLS was used instead. In this setting, it is not clear what statistical properties can be claimed for the Dagenais approach. Two other reasons for weak performance, which are common to the replacement with means procedure can also be offered: (1) observations that do exist on the air pollutants may be measured with so much error that they provide a great deal of misinformation, (2) after adjusting for the other factors included in each regression, air pollution, even if measured perfectly, may not be an important determinant of wages paid.

Illustrative benefit calculations were also made for Denver and Cleveland using the estimates presented in Table 20. The procedure for making these calculations was the same as that described previously. For Denver, meeting the national secondary standards for TSP results in a reduction in the offered wage from $4.3545/hr. to $4.0490/hr. implying that annual benefits per household head are $611 and total benefits are $133,198,000. For Cleveland, on the other hand, meeting the national secondary air quality standards causes the real wage to fall from $3.3251/hr to $3.2336/hr so that annual benefits per household head are $183 and total benefits are $70,034,100.

Table 2

Restricted Sample Regression

Estimates

VAR	B	T
UNON	.313	2.920
HVET	.265	2.991
FMSZ	.0302	2.074
HLTH	-.202	-1.324
EDC2	.205	2.136
EDC3	.495	4.477
TOJ2	.0801	.957
WARM	.942	1.050
JACR	.0000594	.0433
COLD	-.291	-1.357
HUMD	.0102	1.388
CSOX	.532	.895
TSPM	-.832	-1.060
NOXM	.0394	.117
P**2	.00000334	1.066
S**2	-.00000305	- .538
N**2	.000000526	.198
CONSTANT	-30.473	- .818

R^2 = .59 DF = 94

Table 3

Pooled Sample Regression--

Replacement with means

VAR	B	T
UNON	.127	4.576
HVET	.187	7.179
FMSZ	.0218	3.969
HLTH	-.107	-2.873
EDC2	.0726	2.153
EDC3	.491	12.747
TOJ2	.133	4.929
WARM	-.00977	-2.865
JACR	.00145	3.561
COLD	-.00807	-3.148
HUMD	-.00192	-1.589
CSOX	-.00298	- .609
TSPM	.00945	2.045
NOXM	.00206	.268
P**2	-.0000509	-2.203
S**2	-.00000548	- .0805
N**2	-.0000252	- .294
CONSTANT	1.505	3.237

R^2 = .30   DF = 1377

Table 4

Male, White, White Collar Worker,

Household Heads Aged 17-29

VAR	B	T
X10-UNON	.17476	1.4327
X12-HVET	-.66795D-01	-.60872
X19-FMSZ	.11798	2.7474
X26-HLTH	-.48627D-01	-.27860
X28-EDC2	-.36504	-.97654
X29-EDC3	-.32479D-01	-.89856D-01
X40-TOJ2	-.47591	-.81308
X43-WARM	.34974D-02	.36132
X44-JACR	.31325D-02	1.9076
X45-COLD	-.71370D-02	-1.0911
X46-HUMD	.21394D-02	.40559
X41-CSOX	.33653D-04	.25623D-02
X47-TSPM	-.40187D-02	-.31493
X49-NOXM	-.90972D-02	-1.2980
X 1-P**2	.19683D-04	.33616
X 2-S**2	.31803D-04	.11465
X 3-N**2	.85521D-04	1.7349
CONSTANT	1.3185	1.0201

R-SQUARE= 0.2104

SSR= 21.60 DF= 95

Table 5

Male, White, White Collar Worker,

Household Heads Aged 30-49

VAR	B	T
X10-UNON	.26432D-01	.50824
X12-HVET	.10866	2.3615
X19-FMSZ	-.15115D-01	-1.3827
X26-HLTH	-.21725	-3.5129
X28-EDC2	.16370	2.3367
X29-EDC3	.46052	6.1510
X40-TOJ2	.11154	2.4769
X43-WARM	-.99376D-02	-1.6578
X44-JACR	.83032D-03	1.0669
X45-COLD	.42689D-04	.11088D-01
X46-HUMD	.30551D-02	1.2979
X41-CSOX	-.26112D-02	-.39982
X47-TSPM	.16092D-01	1.4245
X49-NOXM	.26707D-02	.69860
X 1-P**2	-.55353D-04	-.91941
X 2-S**2	-.10503D-03	-.81162
X 3-N**2	-.16092D-04	-.56085
CONSTANT	.96252	1.4981

R-SQUARE= 0.2632

SSR= 53.12 DF= 346

Table 6

Male, White, White Collar Worker,

Household Heads Aged 50-69

VAR	B	T
X10-UNON	.75762D-01	.85593
X12-HVET	-.90192D-01	-1.1334
X19-FMSZ	-.95895D-02	-.44268
X26-HLTH	-.68573D-01	-.81402
X28-EDC2	.27338	2.5788
X29-EDC3	.51817	4.8639
X40-TOJ2	-.32128D-01	-.43872
X43-WARM	-.16985D-01	-1.9505
X44-JACR	-.14722D-02	-1.2219
X45-COLD	.38514D-02	.56162
X46-HUMD	.50936D-03	.11387
X41-CSOX	.67178D-02	.53131
X47-TSPM	.10101	3.3604
X49-NOXM	-.66079D-02	-1.0324
X 1-P**2	-.52137D-03	-3.1102
X 2-S**2	-.50256D-04	-.20280
X 3-N**2	.31952D-04	.72943
CONSTANT	-1.9436	-1.5904

R-SQUARE= 0.3777

SSR= 14.07 DF= 108

$e_{TSPM} = 4.884$

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Endnotes

1. See, for example, papers by Hall (1973), Heckman (1976), Rosen (1976), and Wales and Woodland (1980).

2. The variables contained in P and W will be defined more explicitly momentarily.

3. The procedure used to assign air pollution measures to the individual observations is similar to that used by Crocker, Schulze, et al. (1979).

4. Regressions for partitions containing less than 50 observations were not estimated. For these cases, the observations from two or more partitions were pooled and one regression was run on the combined data sheet.

5. Dagenais also suggests using a generalized least squares approach to estimate the hedonic wage equation. However, the approach recommended required that a system of k simultaneous non-linear equations be solved in order to obtain estimates of the slope coefficients where k denotes the number of regressors. Because of the computational burden involved in using the procedure, it was abandoned in favor of the simpler OLS approach.

6. Additionally, even if the NOXM variable was eliminated from consideration, there would still have been only 432 families for whom data on both SOXM and TSPM could have been matched.

7. Note that in some of these partitioned regressions, variables such as UNON and HVET are excluded because all observations on them are equal to zero. For example, HVET has been excluded for this reason in Table 17.

8. The regressions used to construct the missing values for the pollution variables are shown in Tables 21, 22, and 23.

Table 7

Male, White, Blue Collar Worker,

Household Heads Aged 17-29

VAR	B	T
X10-UNON	.22126	1.5232
X12-HVET	.11507	.77295
X19-FMSZ	.67060D-01	1.0862
X26-HLTH	-.11194D-01	-.29284D-01
X28-EDC2	.50214	1.4339
X29-EDC3	.37717	1.0469
X40-TOJ2	-.85560D-01	-.13650
X43-WARM	.26415D-01	1.3533
X44-JACR	.14590D-02	.65186
X45-COLD	-.21866D-01	-2.0895
X46-HUMD	-.12347D-01	-1.3453
X41-CSOX	-.26390D-01	-1.7609
X47-SPM	-.54343D-01	-1.7497
X49-NOXM	-.59654D-02	-.56895
X 1-P**2	.30447D-03	1.8053
2-S**2	.55753D-03	1.8201
X 3-N**2	.57881-04	.79457
ONSTANT	2.1767	1.1070

-QUARE= 0.3239

SR= 9.739 DF= 45

Table 8

Male, White, Blue Collar Worker,

Household Heads Aged 30-49

VAR	B	T
X10-UNON	.14275	1.3955
X12-HVET	.11510	1.4074
X19-FMSZ	-.11188D-01	-.48891
X26-HLTH	-.21963D-02	-.18383D-01
X28-EDC2	-.64656D-01	-.66772
X29-EDC3	.66018D-01	.40793
X40-TOJ2	.28272	3.2842
X43-WARM	-.73856D-02	-.49400
X44-JACR	.17985D-02	1.1995
X45-COLD	.50207D-02	.58515
X46-HUMD	-.43683D-03	-.77757D-01
X41-CSOX	-.13004D-01	-1.0804
X47-TSPM	.25542D-01	2.1776
X49-NOXM	.48542D-02	.79327
X 1-P**2	-.11023D-03	-1.9741
X 2-S**2	.17094D-03	.75189
X 3-N**2	-.48756D-04	-1.3613
CONSTANT	.19701	.13496

R-SQUARE= 0.4280

SR= 4.471 DF= 56

$e_{TSPM} = 1.4204$

Table 9

Male, White, Blue Collar Worker,

Household Heads Aged 17-69

VAR	B	T
X10-UNON	.16463	2.3087
X12-HVET	.13518	2.1021
X19-FMSZ	.19745D-01	1.0386
X26-HLTH	-.18033D-01	-.18505
X28-EDC2	.69451D-02	.83603D-01
X29-EDC3	.26313D-01	.25971
X40-TOJ2	.35908	5.1153
X43-WARM	-.12433D-01	-1.6865
X44-JACR	.29094D-03	.28674
X45-COLD	-.89463D-02	-1.7421
X46-HUMD	-.99736D-03	-.27515
X41-CSOX	-.24192D-01	-2.8544
X47-TSPM	.85630D-02	.83961
X49-NOXM	.18851D-02	.35982
X 1-P**2	-.29044D-04	-.55213
X 2-S**2	.46754D-03	2.7702
X 3-N**2	-.24129D-04	-.69613
CONSTANT	1.9040	2.4022

R-SQUARE= 0.3457

SSR= 23.65 DF= 160

$e_{CSOX} = -.3125$

Table 10

Male, Non-White, White Collar Worker,

Household Heads Aged 30-49

VAR	B	T
X10-UNON	.23558	2.3992
X12-HVET	.10339	.96532
X19-FMSZ	.93703D-02	.43587
X26-HLTH	.15968	.89901
X28-EDC2	-.19323D-02	-.13398D-01
X29-EDC3	.33745	1.9824
X40-TOJ2	-.84307D-01	-.88253
X43-WARM	.39743D-02	.29485
X44-JACR	-.25733D-02	-1.7306
X45-COLD	.88710D-03	.15121
X46-HUMD	.12822D-02	.21563
X41-CSOX	.14184D-01	.69880
X47-TSPM	.43585D-01	1.5422
X49-NOXM	-.43509D-03	-.52820D-01
X 1-P**2	-.20806D-03	-1.3906
X 2-S**2	.57166D-04	.18097
X 3-N**2	.21693D-04	.34107
CONSTANT	-1.6930	-1.1465

R-SQUARE= 0.3789

SSR= 11.87 DF= 78

Table 11

Male, Non-White, White Collar Worker, Household Heads Aged 17-69

VAR	B	T
X10-UNON	.18604	2.5040
X12-HVET	.10293	1.4498
X19-FMSZ	-.30211D-02	-.22040
X26-HLTH	.75768D-01	.49945
X28-EDC2	.77325D-01	.80932
X29-EDC3	.26636	2.2519
X40-TOJ2	.66240D-01	.93804
X43-WARM	-.41372D-02	-.34556
X44-JACR	-.13921D-02	-1.2404
X45-COLD	.25076D-02	.47568
X46-HUMD	.17020D-02	.33027
X41-CSOX	.13801D-01	.88935
X47-TSPM	.44063D-01	1.8041
X49-NOXM	-.86660D-02	-1.3842
X 1-P**2	-.19905D-03	-1.5454
X 2-S**2	-.20679D-03	-.92285
X 3-N**2	.64510D-04	1.2350
CONSTANT	-.96187	-.76367

R-SQUARE= 0.2669

SSR= 18.95 DF= 130

Table 12

Male, Non-White, Blue Collar Worker,

Household Heads Aged 17-29

VAR	B	T
X10-UNON	.24384	1.4211
X12-HVET	.18565	1.2596
X19-FMSZ	.32341D-01	1.4966
X26-HLTH	.20859D-01	.54665D-01
X29-EDC3	1.1371	2.0847
X28-EDC2	1.0898	2.1051
X43-WARM	.95153D-01	1.7411
X44-JACR	.38772D-02	1.9116
X45-COLD	.24412D-01	1.0601
X46-HUMD	-.55684D-02	-.24360
X41-CSOX	.11290	1.7170
X47-TSPM	-.32904D-01	-.76046
X49-NOXM	-.18104D-01	-.89497
X 1-P**2	.14430D-03	.93513
X 2-S**2	-.12056D-02	-1.4387
X 3-N**2	.26047D-03	1.1785
CONSTANT	-7.8120	-1.5632

R-SQUARE= 0.4325

SSR= 8.388 DF= 41

Table 13

Male, Non-White, Blue Collar Worker,

Household Heads Aged 30-49

VAR	B	T
X10-UNON	.34653	5.5150
X12-HVET	-.59878D-01	-.93846
X19-FMSZ	.25630D-01	2.3752
X26-HLTH	-.20026	-2.1214
X28-EDC2	-.49395D-01	-.77176
X29-EDC3	-.32436D-01	-.28477
X40-TOJ2	.62105D-02	.95739D-01
X43-WARM	-.79103D-02	-.96984
X44-JACR	.22691D-02	2.3888
X45-COLD	.89463D-02	1.9652
X46-HUMD	.68790D-02	2.2345
X41-CSOX	.19598D-01	1.9061
X47-TSPM	.10988D-01	1.1272
X49-NOXM	-.19917D-04	-.46344D-02
X 1-P**2	-.28270D-04	-.56956
X 2-S**2	-.31317D-03	-2.1435
X 3-N**2	.74386D-05	.20174
CONSTANT	-.40612	-.44776

R-SQUARE= 0.5342

SSR= 9.055 DF= 109

$e_{CSOX} = .2959$

Table 14

Male, Non-White, Blue Collar Worker,

Household Heads Aged 50-69

VAR	B	T
X10-UNON	.15722	1.7283
X12-HVET	-.35557D-01	-.38795
X19-FMSZ	-.56542D-02	-.28441
X26-HLTH	-.47119	-2.9557
X28-EDC2	.71372D-01	.87034
X29-EDC3	-.21025	-.70450
X40-TOJ2	-.13163D-01	-.12876
X43-WARM	-.24253D-02	-.91059D-01
X44-JACR	-.37103D-03	-.29262
X45-COLD	-.11073D-02	-.10988
X46-HUMD	-.15479D-01	-1.7323
X41-CSOX	.76148D-02	.43807
X47-TSPM	.12786D-01	.35004
X49-NOXM	-.22636D-02	-.21454
X 1-P**2	-.11832D-03	-.52261
X 2-S**2	.19079D-03	.95534
X 3-N**2	.48949D-04	.43614
CONSTANT	1.5146	.63855

R-SQUARE= 0.5976

SSR= 2.774 DF= 42

Table 15

Male, Non-White, Blue Collar Worker,

Household Heads Aged 17-69

VAR	B	T
X10-UNON	.29899	5.7490
X12-HVET	.18808D-01	.37703
X19-FMSZ	.25626D-01	2.8439
X26-HLTH	-.25763	-3.2402
X28-EDC2	-.25874D-01	-.50980
X29-EDC3	.10841	1.2425
X40-TOJ2	-.70438D-01	-1.3048
X43-WARM	-.28275D-03	-.35284D-01
X44-JACR	.20377D-02	2.9009
X45-COLD	.32852D-02	.87020
X46-HUMD	.31924D-02	1.0831
X41-CSOX	.12347D-01	1.4095
X47-TSPM	.29400D-02	.40219
X49-NOXM	.27822D-03	.71365D-01
X 1-P**2	.70330D-05	.19892
X 2-S**2	-.18161D-03	-1.4782
X 3-N**2	.18663D-04	.52094
CONSTANT	-.16171	-.19144

R-SQUARE= 0.3625

SSR= 26.29 DF= 227

Table 16

Female, Non-White, White Collar Worker,

Household Heads Aged 17-69

VAR	B	T
X10-UNON	.28245D-01	.13581
X19-FMSZ	.15921D-03	.38146D-02
X26-HLTH	-.34959	-.80497
X29-EDC2	-.69257D-01	-.28711
X28-EDC3	.27565	1.0931
X40-TOJ2	.65836D-01	.26232
X43-WARM	-.72320D-01	-1.5014
X44-JACR	-.36093D-03	-.15408
X45-COLD	-.20614D-01	-1.8159
X46-HUMD	.18623D-01	1.5996
X41-CSOX	-.36696D-01	-1.4803
X47-TSPM	.25308D-01	.31477
X49-NOXM	-.12947D-01	-.16447
X 1-P**2	-.78498D-04	-.20411
X 2-S**2	.14024D-03	.61354
X 3-N**2	.17971D-03	.22569
CONSTANT	5.8280	1.4665

R-SQUARE= 0.6192

SSR= 1.432 DF= 20

Table 17

Female, White, White Collar Worker,

Household Heads Aged 17-69

VAR	B	T
X10-UNON	.14677	1.1279
X19-FMSZ	-.94193D-02	-.17481
X26-HLTH	-.15632	-1.0157
X28-EDC2	.15746	.77163
X29-EDC3	.39268	1.8461
X40-TOJ2	-.13249D-01	-.12433
X43-WARM	.55006D-02	.46904
X44-JACR	-.10702D-03	-.55790D-01
X45-COLD	-.11995D-01	-1.3461
X46-HUMD	-.70804D-03	-.13109
X41-CSOX	.23905D-02	.17903
X47-TSPM	-.51187D-01	-2.7607
X49-NOXM	-.15296D-01	-1.7858
X 1-P**2	.30097D-03	2.8592
X 2-S**2	-.27198D-03	-1.0910
X 3-N**2	.71798D-04	1.2893
CONSTANT	3.7946	3.0696

R-SQUARE= 0.3900

SSR= 6.044 DF= 50

e_{TSPM} = -2.158

Table 18

Female, White, Blue Collar Worker,

Household Heads Aged 17-69

VAR	B	T
X10-UNON	.26862	.75532
X12-HVET	.10974	.25750
X19-FMSZ	.26944D-01	.19444
X26-HLTH	.39030D-01	.82491D-01
X28-EDC2	.41989	.92274
X29-EDC3	.89085D-01	.13941
X40-TOJ2	.21485	.55869
X43-WARM	.62321D-02	.87444D-01
X44-JACR	.80756D-02	.97336
X45-COLD	.10648D-01	.27562
X46-HUMD	-.78924D-02	-.21904
X41-CSOX	.14246D-01	.22577
X47-TSPM	.12046	1.6627
X49-NOXM	.20425D-01	.82539
X 1-P**2	-.66602D-03	-1.7580
X 2-S**2	-.12062D-03	-.94019D-01
X 3-N**2	-.10477D-03	-.81019
CONSTANT	-6.8873	-.84302

R-SQUARE= 0.6809

SSR= 1.515 DF= 8

Table 19

Female, Non-White, Blue Collar Worker,

Household Heads Aged 17-69

VAR	B	T
X10-UNON	.17380	1.4829
X19-FMSZ	.57971D-01	2.6227
X26-HLTH	-.13370	-1.0388
X28-EDC2	-.68295D-01	-.36591
X29-EDC3	-.21311	-.54462
X40-TOJ2	.66039D-01	.90064
X43-WARM	-.10159D-02	-.46797D-01
X44-JACR	.41026D-02	2.0654
X45-COLD	-.40113D-02	-.46224
X46-HUMD	-.88367D-02	-1.3698
X41-CSOX	.97514D-02	.34591
X47-TSPM	-.79619D-02	-.48790
X49-NOXM	-.39782D-02	-.46345
X 1-P**2	.16793D-04	.23902
X 2-S**2	.30708D-04	.10661
X 3-N**2	.31297D-04	.54398
CONSTANT	1.4636	.95992

R-SQUARE= 0.4377

SSR= 8.861 DF= 74

Table 20

Pooled Sample Regression

VAR	B	T
X10-UNON	.12826	4.5299
X12-HVET	.18686	7.1260
X19-FMSZ	.22907D-01	4.1336
X26-HLTH	-.99943D-01	-2.6863
X28-EDC2	.74755D-01	2.2167
X29-EDC3	.49221	12.708
X40-TOJ2	.12811	4.7644
X43-WARM	-.77862D-02	-2.4942
X44-JACR	.14097D-02	3.4679
X45-COLD	-.73928D-02	-4.1044
X46-HUMD	-.78358D-04	- .56596D-01
X41-CSOX	.18462D-02	.55284
X47-TSPM	.82340D-02	1.8694
X49-NOXM	.16475D-02	.84763
X 1-P**2	-.37398D-04	-1.6590
X 2-S**2	-.97076D-04	-1.5851
X 3-N**2	-.40546D-05	- .28572
CONSTANT	1.1411	3.5403

R-SQUARE = 0.3065
SSR = 281.1 DF = 1377

Table 21

Regression to Construct SOXM

VAR	B	T
X10-UNON	3.0550	3.5062
X12-HVET	-2.5744	-3.0967
X19-FMSZ	.27915	1.7229
X26-HLTH	- .69527	- .57786
X28-EDC2	.35916	.35429
X29-EDC3	-1.3497	-1.1199
X40-TOJ2	-1.6145	-1.9672
X42-AVGT	-2.2513	-3.3839
X43-WARM	- .96528D-01	- .52877
X44-JACR	- .32979D-01	-2.6856
X45-COLD	.46237	1.9103
X46-HUMD	- .39650	-5.1329
X35-REG1	30.051	10.556
X36-REG2	9.0446	3.3579
X37-REG3	21.416	6.9766
X30-PRX1	-3.6440	-1.0700
X31-PRX2	-4.0488	-1.2150
X32-PRX3	-2.9865	- .86171
X33-PRX4	-6.1270	-1.3064
CONSTANT	40.391	2.9248

R-SQUARE = 0.5420
SSR = .3229D + 05 DF = 482

Table 22

Regression to Construct TSPM

VAR	B	T
X10-UNON	- .27108	- .17266
X12-HVET	.13148	.88505D-01
X19-FMSZ	.20762	.65983
X26-HLTH	.11578	.57456D-01
X28-EDC2	-1.2855	- .65959
X29-EDC3	-5.3022	-2.3759
X40-TOJ2	- .62307	- .41121
X42-AVGT	-4.2312	-7.9669
X43-WARM	.78601	2.9667
X44-JACR	- .96968D-02	- .41621
X45-COLD	1.5041	8.9149
X46-HUMD	-1.1924	-10.784
X35-REG1	39.444	8.8559
X36-REG2	32.932	7.7270
X37-REG3	29.224	5.8749
X30-PRX1	14.834	3.6951
X31-PRX2	17.663	4.4771
X32-PRX3	13.110	3.0617
X33-PRX4	-2.0068	- .36068
CONSTANT	41.964	2.2201

R-SQUARE = 0.3727

SSR = .2241D + 06 DF = 691

Table 23

Regression to Construct NOXM

VAR	B	T
X10-UNON	4.0234	1.8520
X12-HVET	-3.1084	-1.6117
X19-FMSZ	- .65904	-1.8977
X26-HLTH	-5.6057	-1.9463
X28-EDC2	-2.8367	-1.2861
X29-EDC3	- .42449	- .16104
X40-TOJ2	.58784	.31671
X42-AVGT	10.479	4.5831
X43-WARM	-3.5136	-3.2760
X44-JACR	.61724D-02	.22688
X45-COLD	-1.6996	-2.6106
X46-HUMD	- .29514	- .74684
X35-REG1	7.1282	.67026
X36-REG2	8.1533	1.0176
X37-REG3	-15.842	-1.3853
X30-PRX1	-3.4347	- .59532
X31-PRX2	- .47142	- .83510D-01
X32-PRX3	-7.1744	-1.2183
X33-PRX4	-31.613	-2.8677
CONSTANT	271.03	3.6656

R-SQUARE = 0.3337
SSR = .4039D + 05 DF = 236

Table 24

Correlation Matrix

	1 P**2	2 S**2	3 N**2	10 UNON	12 HVET	19 FMSZ	22 OCCP	25 RHWG	26 HLTH	28 EDC2	29 EDC3	40 TOJ2	41 CSOX	43 WARM	44 JACR	45 COLD	46 HUMD	47 TSPM	49 NOXM
1P**2	1.00	0.26	0.08	-0.05	0.14	0.06	0.08	-0.09	-0.04	0.05	0.06	-0.03	-0.03	0.02	0.02	-0.02	-0.03	-0.03	-0.04
2S**2	0.26	1.00	-0.00	-0.02	0.30	0.08	0.44	0.85	-0.05	-0.17	0.40	0.13	-0.00	-0.22	0.02	-0.23	-0.15	0.05	0.02
3N**2	0.08	-0.00	1.00	0.04	0.16	-0.07	0.01	0.00	-0.03	0.26	-0.22	-0.01	0.02	-0.06	0.04	-0.06	-0.05	0.01	-0.04
10UNON	-0.05	-0.02	0.04	1.00	0.07	0.08	-0.13	0.11	-0.02	0.14	-0.21	0.12	0.08	-0.06	0.27	-0.11	-0.06	0.07	0.08
12HVET	0.14	0.30	0.16	0.07	1.00	0.12	0.16	0.28	-0.01	0.09	0.07	0.12	-0.02	-0.16	0.11	-0.08	-0.12	0.02	-0.01
19FMSZ	0.06	0.08	-0.07	0.08	0.12	1.00	-0.01	0.09	-0.01	-0.02	-0.11	0.14	-0.02	0.08	0.14	0.02	0.09	0.02	-0.10
22OCCP	0.08	0.44	0.01	-0.13	0.16	-0.01	1.00	0.46	0.01	-0.14	0.32	0.06	-0.05	-0.13	-0.07	-0.15	-0.11	-0.00	0.00
25RHWG	-0.09	0.85	0.00	0.11	0.28	0.09	0.46	1.00	-0.05	-0.16	0.36	0.17	0.03	-0.22	0.08	-0.25	-0.15	0.07	0.02
26HLTH	-0.04	-0.05	-0.03	-0.02	-0.01	-0.01	0.01	-0.05	1.00	-0.05	-0.02	0.08	-0.00	-0.12	-0.03	-0.07	-0.08	0.04	-0.05
28EDC2	0.05	-0.17	0.26	0.14	0.09	-0.02	-0.14	-0.16	-0.05	1.00	-0.65	-0.01	0.08	0.01	0.07	-0.05	-0.02	0.08	-0.06
29EDC3	0.06	0.40	-0.22	-0.21	0.07	-0.11	0.32	0.36	-0.02	-0.65	1.00	-0.04	-0.04	-0.13	-0.20	-0.06	-0.14	-0.04	0.07
40TOJ2	-0.03	0.13	-0.01	0.12	0.12	0.14	0.06	0.17	0.08	-0.01	-0.04	1.00	0.03	-0.06	0.05	-0.10	-0.00	0.02	-0.02
41CSOX	-0.03	-0.00	0.02	0.08	-0.02	-0.02	-0.05	0.03	-0.00	0.08	-0.04	0.03	1.00	-0.10	-0.08	-0.23	0.06	0.28	-0.07
43WARM	0.02	-0.22	-0.06	-0.06	-0.16	0.08	-0.13	-0.22	-0.12	0.01	-0.13	-0.06	-0.10	1.00	0.03	0.36	0.42	-0.12	-0.18
44JACR	0.02	0.02	0.04	0.27	0.11	0.14	-0.07	0.08	-0.03	0.07	-0.20	0.05	-0.08	0.03	1.00	-0.03	0.07	-0.03	-0.04
45COLD	-0.02	-0.23	-0.06	-0.11	-0.08	0.02	-0.15	-0.25	-0.07	-0.05	-0.06	-0.10	-0.23	0.36	-0.03	1.00	0.15	-0.25	0.37
46HUMD	-0.03	-0.15	-0.05	-0.06	-0.12	0.09	-0.11	-0.15	-0.08	-0.02	-0.14	-0.00	0.06	0.42	0.07	0.15	1.00	-0.42	-0.26
47TSPM	-0.03	0.05	0.01	0.07	0.02	0.02	-0.00	0.07	0.04	0.08	-0.04	0.02	0.28	-0.12	-0.03	-0.25	-0.42	1.00	-0.08
49NOXM	-0.04	0.02	-0.04	0.08	-0.01	-0.10	0.00	0.02	-0.05	-0.06	0.07	-0.02	-0.07	-0.18	-0.04	0.37	-0.26	-0.08	1.00

STOP

TIME 13.8 SECS

Table 25

Means and Standard Deviations

of Variables

VAR	MEAN	SD
X 1-P**2	9261.2	3391.5
X 2-S**2	423.37	430.09
X 3-N**2	3546.6	2470.7
X 4-OTBC	0.	0.
X 5-TINC	0.	0.
X 6-AGEH	41.107	5.5200
X 7-SEXH	1.0000	0.
X 8-HLT1	4.4780	1.3287
X 9-HLT2	4.7582	.94289
X10-UNON	.30769	.46217
X11-EDUC	4.9588	1.9641
X12-HVET	.63462	.48220
X13-RACE	1.0000	0.
X14-CITY	.72253	.44837
X15-PROX	2.3984	1.1538
X16-REG	2.2445	1.0950
X17-SELF	1.0000	0.
X18-SIZE	.80495	.39679
X19-FMSZ	4.7335	2.0049
X20-LTOJ	3.9588	1.3385
X21-INDX	1.0091	.39053D-01
X22-OCCP	1.0000	0.
X23-CIDC	24090.	12428.
X24-AHWG	5.8680	2.7355
X25-RHWG	1.6620	.44564
X26-HLTH	.14835	.35594
X27-EDC1	.13462	.34178
X28-EDC2	.43407	.49632
X29-EDC3	.43132	.49594
X30-PRX1	.22527	.41834
X31-PRX2	.38736	.48782
X32-PRX3	.23352	.42365
X33-PRX4	.71429D-01	.25789
X34-PRX5	.82418D-01	.27538
X35-REG1	.32143	.46767
X36-REG2	.29670	.45743
X37-REG3	.19780	.39889
X38-REG4	.18407	.38807
X39-TOJ1	.60989	.48845
X40-TOJ2	.39011	.48845
X41-CSOX	25.456	11.258
X42-AVGT	11.431	3.9808
X43-WARM	74.316	4.8543
X44-JACR	58.464	30.979
X45-COLD	31.723	11.083
X46-HUMD	35.935	11.221
X47-TSPM	74.513	18.148
X48-SOXM	17.771	10.386
X49-NOXM	56.763	18.040

Table 26

MEANS OF NON-POLLUTION VARIABLES
USED IN BENEFIT CALCULATIONS

VARIABLE	MEAN	
	Denver	Cleveland
UNON	.307	.307
HVET	.402	.556
FMSZ	3.40	3.46
HLTH	.148	.148
EDC2	.456	.567
EDC3	.449	.298
TOJ2	.390	.390
WARM	72.00	71.90
JACR	58.46	58.46
COLD	30.60	18.90
HUMD	13.73	33.66
CONSTANT	1.00	1.00

Table 27

NATIONAL AIR POLLUTION STANDARDS
(In Micrograms Per Cubic Meter)

	PRIMARY STANDARD	SECONDARY STANDARD
SO_2	75	60
NO_2	100	100
TSP	75	60

Table 28

1978 POLLUTION CONCENTRATIONS
IN DENVER AND CLEVELAND
(In Micrograms Per Cubic Meter)

	DENVER	CLEVELAND
SO_2	16.9	61.49
NO_2	100	65.0
TSP	86	72.2

Table 29

Cross-Tabulation of Incidence of

Actual Pollution Data By Partition

Table Number	TSPM	SOXM	NOXM	TSPM,SOXM	TSPM,NOXM	SOXM,NOXM	TSPM,NOXM,SOXM
4	58	30	17	26	5	5	4
5	164	94	48	87	25	18	15
6	59	49	22	42	10	14	10
7	28	19	2	16	1	2	1
8	28	17	5	11	0	1	0
9	22	15	10	12	6	5	4
10	59	39	19	33	13	17	13
11	78	60	36	46	22	29	19
12	40	36	23	30	13	17	11
13	80	61	32	50	17	24	14
14	25	23	11	19	9	10	8
15	145	120	66	99	39	51	23
16	24	18	6	18	6	6	6
17	32	22	7	19	3	4	2
18	16	6	5	6	0	0	0
19	57	52	32	43	21	27	18