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ENVIRONMENTAL PROTECTION AND ITS EFFECTS ON THE DISTRIBUTION OF ENVIRONMENTAL QUALITY

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ABSTRACT

A high level of environmental quality is often regarded as a matter of concern directed primarily to higher income groups. In this paper an attempt has been made to analyze the problem of distribution of environmental quality—here air pollution for the Montreal region. The results of this study support the hypothesis that low levels of air quality are more likely to impinge on the lower than the middle and upper income groups.

Introduction

After the initial broad public support for environmental issues the "environmentalist lobby" appears to have lost some of its momemtum. Recently the movement for environmental protection is being accused of serving predominently the interests of the middle and upper-income groups.[1] A high level of environmental quality is often being regarded as a matter of concern mostly for higher income groups, since they have already reached a sufficient level of consumption of private goods and can now direct their attention to improvement of environmental quality [1, 2].

[1] This, however, does not necessarily mean that there exists a different preference map of poor and rich for environmental quality—the alleged greater emphasis on the improvement of environmental quality may simply be the result of a positive income effect.

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This kind of attack on environmental protection has not been restricted to the national scene but also has entered the international discussion of environmental issues. Proposals by the industrialized countries to ban the use of DDT received hostile reactions from most of the predominantly poor, developing countries, since they understood it as an antigrowth recommendation [3]. However, for an economist this reaction is not unexpected. If environmental quality can be regarded as a normal good, then, obviously, one would expect a positive relationship between income and expenditure for environmental quality.

The purpose of the paper is to present some evidence which indicates that the incidence of air pollution may be regressive.

Location and Environmental Quality

Environmental quality is generally considered as an "imperfect" public good. Air quality, for example, varies considerably even within the boundaries of a single urban area. Consequently, an individual does have some option with respect to his physical environment and can execute this choice by his selection of location.[2] Given the level and composition of environmental quality in a particular metropolitan area, an individual consumer has a set of various options to consume more of the wanted environmental characteristics by a) spending a larger fraction of his income to rent or to buy a location with a desired quality; b) spending a larger fraction of his income for the complementary inputs required for the consumption of the desired characteristic; c) changing his profession, place of work, etc.; d) substituting privately produced services for the unavailable environmental services (e.g., a highrise with swimming pool may substitute for residence in the countryside close to a clean lake); or e) moving to a different site, which has more of the desired environmental characteristics but less of some other. Options a) and b) suggest that consumers from higher income classes will probably enjoy a higher level of environmental quality. Option c) depends predominantly on the range of factor supply alternatives. Persons with a higher degree of mobility may have an advantage. However, changing profession, residence etc., might also inflict some income

[2] If one assumes a Tiebout-type of world then there is available a continuum of environmental quality at different points in space [16]. See further Freeman's approach to integrate environmental quality into Lancaster's theory of consumer behavior [4, pp. 250-252, 5].

loss. Option d) shows again that consumers from higher income classes have more possibilities to protect themselves against environmental damages. Option e) appears to be neutral with respect to the distribution of environmental quality. Concluding, according to this analysis we may expect that the consumption of environmental quality will be positively related with income and wealth.

Distribution of Air Quality in Montreal

It is evident that the value of air for life support and amenity decreases as the contents of pollutants in the air increases. One of the important questions that should be asked here is: how is the existing pattern of air pollution distributed among different socio-economic groups? This first question also includes a second question: how are the gains from environmental policy distributed. In general, the burdens of air pollution can be distinguished according to effects which are known with reasonable certainty and those which are not. The effects on health, for example, belong to the latter category. The effects on health caused by the exposure to air pollution, are indicated in morbidity and mortality rates [6]. However, to a large extent these effects may not be perceived since in many cases neither the affected individual is capable to recognize fully the relationship between air pollution and his deteriorated health conditions nor are those links in all cases satisfactorily established scientifically. The other kind of burden is the disutility in form of amenity losses and physical damages to property, etc. To the extent that the individuals are aware of the potential damages of air pollution, they will tend to avoid them. Since the level of air pollution differs quite substantially within a given economic region, individuals will tend to move to areas with a lower level of air pollution. Since the supply of land sites with lower levels of air pollution is limited, the unit land value will increase, other things being equal. Individuals with higher incomes, possess higher willingness to pay and will therefore tend to occupy the land in areas with lower levels of air pollution.[3] Since the level of air pollution is generally higher in the core of the city than in its surrounding suburbs, one could expect that persons within the lower income brackets will have their residence in areas with higher air pollution. In other words, since the economic conditions of low

[3] For details about the relationship between property values and air quality see the debate which took place for the last seven years in the Review of Economics and Statistics [7].

Table 1. Spearman Rank Correlation Coefficients for Air Quality and Income in Montreal 1971-72

Air quality indicators	*% of population < $2,999*	*% of population $3,000-$6,999*	*% of population $7,000-$14,999*	*% of population > $15,000*
M.A.Q.I.	+0.411[b]	+0.268[d]	-0.329[c]	-0.065[d]
E.V.I.	+0.3467[c]	+0.257[d]	-0.443[b]	-0.004[d]
E.C.C.I.	+0.509[a]	+0.2996[d]	-0.8287[a]	-0.104[d]

Incomes are based on household data source: Census Tract Bulletin, 1971 Census of Canada, Oct. 1974, Series B.

[a] Significant at 1 per cent level.
[b] Significant at 5 per cent level.
[c] Significant at 10 per cent level.
[d] Not significant.

income recipients restrict their mobility, it seems that poorer people tend to bear an absolutely greater share of the burden of air pollution.

To support the theoretical reasoning an attempt is made to examine the relationship between air quality and income in Montreal during the years 1971-1973. On the basis of available, usable data only two pollutants—SO_2 and suspended particulates—were selected since only they have been continuously measured by twenty-three Montreal monitoring stations.[4] These air pollution data were then used to construct the "Extreme Value Index" (E.V.I.) and the "Mitre Air Quality Index" (M.A.Q.I.) and the Economic Council of Canada indicators (E.C.C.I.) [9, pp. 36-44, 10]. The results of the analysis show that there exists a clear inverse condition between various levels of air quality and income levels for the Montreal region. To examine the variation between income and air quality Spearman rank correlation coefficients were computed for each of the three indicators (E.V.I., M.A.Q.I., E.C.C.I.) versus four income classes, which are derived from Census Tract data. Four income groupings were made: per cent of population with less than $3000 income; per cent of population between $3000 and $6999; per cent of population between $7000 and $14,999; and per cent of population with an income greater than $15,000. The results are shown in Table 1. For the first income class the correlation coefficients of all three indicators are positive and statistically significant indicating that

[4] The availability of only two pollutants does not undermine the results of our study. This is because the concentration of SO_2 and suspended particulates are highly and positively associated with other pollutants such as CO and HC [8, pp. 101-112]. See further the article by Müller for details about air pollution in Montreal [17].

the higher the proportion of low income recipients below $3000 in a given area, the higher the level of air pollution. The results for the second higher income group are not statistically significant, although the signs of the correlation coefficients are all positive. The results for the income class between $7000 and $14,999 suggest that there is an inverse relation. All three indicators are both negative and statistically significant, i.e., the higher the proportion of middle to higher income households in a given area, the lower will be the level of air pollution. The results of the coefficients for the highest income class are not statistically significant, although the negative signs for each of these indicators were expected. The data of Table 1 indicate that better air quality tends to be distributed toward higher income groups.[5] Although the Spearman correlation coefficients are useful to examine the air quality—income hypothesis, it does not provide us with a means to show how many households or each income class are exposed to a particular level of air quality. This context can be shown in a Lorenz-curve type chart, in which air quality is shown for each income class. The per cent of population exposed to successively higher concentration of air quality, measured in terms of the MAQI-indicator. Figure 1 shows over a substantial range of the curve that the lower income households are exposed to a higher pollution level than the low middle income households.

The low middle income households are in turn exposed to higher pollution levels than the upper middle income households, which apparently reside under the best available air quality.

In order to avoid a cluttered appearance the curve for the highest income group is omitted in this Figure 1. However the curve for the highest income households would indicate that they are exposed to lower levels of air pollution than either of the two lower income household groupings, but that they are residing under a lower level of air quality than the upper middle income households. A possible explanation of this result is that the highest income households may prefer a downtown residence in an air-conditioned luxury apartment, because of the immediate accessibility of the city's conveniences. This downtown residence may substitute for suburban residence with high level of air quality.

The results seem to indicate that different residential location has, at least to a certain degree, facilitated individuals to buy different levels of environmental quality according to the differences in their incomes. However, low and high income

[5] Similar results were derived by Zupan [11] for the New York region and by Freeman [4, p. 264] for Kansas City, St. Louis, and Washington, D.C.

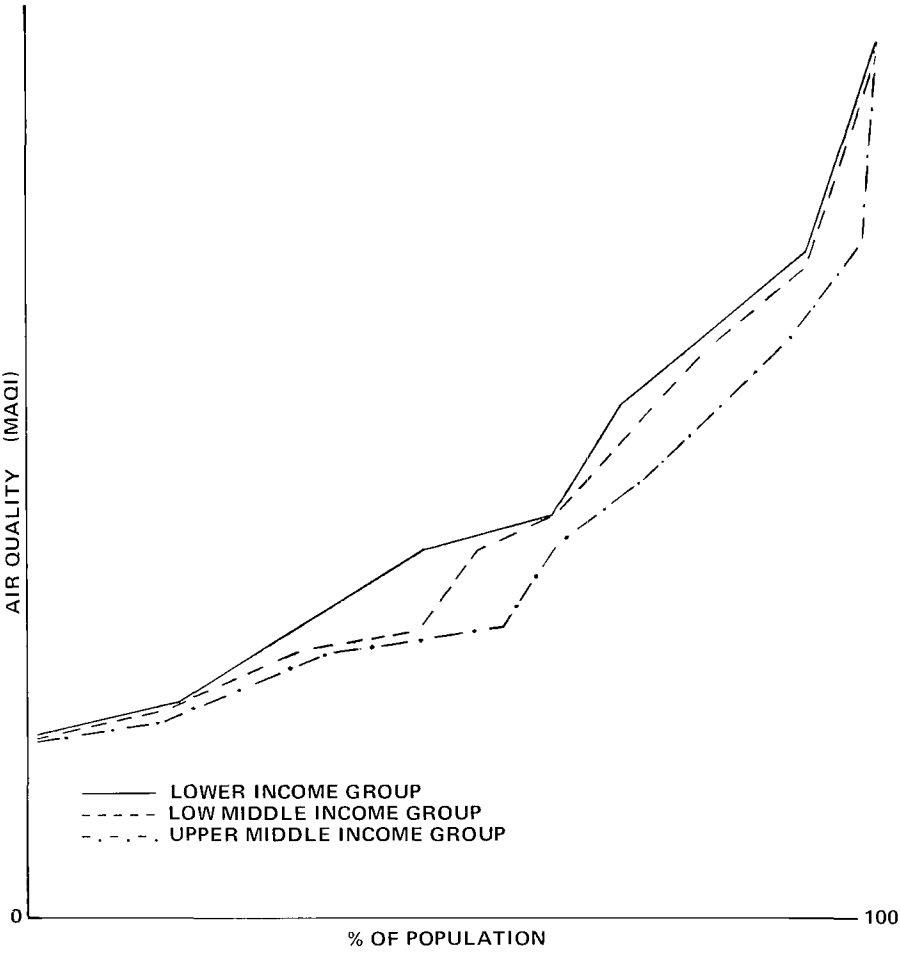

Figure 1. Population and decreasing level of air quality.

households cannot afford to reside too far apart, since the former provide the services for the high income households and the latter generate the jobs for the low income households. Substantial geographical separation of their residences would levy significant commuting costs on either of these income households. Therefore, if the air is polluted, neither of them could avoid completely the effects of it. Consequently, any improvement of air quality would effect simultaneously all neighborhoods directly, since most anti-air pollution programs contain a substantial element of publicness.

To determine how changes in air quality (either due to yearly

Table 2. Changes in Air Quality by Income for Montreal,[a] 1971-1973

	MAQI-Reading			*% change by income groups*[b]			*Ratio of change per groups to yearly overall change*		
	Low	*Middle*	*High*	*Low*	*Middle*	*High*	*Low*	*Middle*	*High*
1971	4.42	4.56	4.03						
1972	7.49	5.53	4.98	-67.56	-21.27	-23.57	2.51	0.81	0.78
1973	2.44	3.95	2.66	67.42	28.54	46.58	1.68	0.71	1.13

[a] Income Division: Low: < $4,999; Middle: $5,000-$9,999; High: > $10,000.
[b] A negative sign indicates a deterioration in air quality.

changed meteorological conditions, or fluctuations in emission) have affected the different income groups each of the monitoring stations was categorized into low, middle, and high income areas, based on annual average income per station. An average MAQI—air quality value was then obtained per year for each of the three income groupings. The per cent change in air quality per income category divided by the overall average yearly per cent change in air quality determines the value which can be considered as the distributional effects of change in air quality for the Montreal region. Table 2 shows that the lowest income class was affected the most by change in air quality. In 1972, when the average change in air quality worsened by approximately 26 per cent, the air quality deteriorated for the lowest income class by about 67 per cent or 2.5 times the city average. Similarly, in 1973, when the average change in air quality improved by 49 per cent from the previous year, the lowest income class experienced 1.68 times the average improvement for the city. Both of the other two income classes fluctuate more or less close around the city average change.

While the results support the hypothesis of the inverse relationship between income and levels of air pollution, some warnings must be mentioned against a generalization. Firstly, the empirical analysis is only based on two kinds of pollutants. The scantiness of measurements of other pollutants such as hydrocarbons and nitrogen oxide prevented it from including them in the analysis. Secondly, the pollution indicators used do not take into account time spent exposed to air pollution away from residence, e.g., time spent at working place. Thirdly, this study examines only the data of distribution of air pollution and income in Montreal. The observed relation cannot be used as proof of cause and effect

because levels of air quality, housing conditions, income, race and education etc. are highly interrelated among census tracts. For example, a person with poor education may only find a low paying job and therefore he can only afford to live in a polluted neighborhood where the property values and the rents are low. Finally, the data in our study represent only physical measures of the deterioration of air quality; monetary values have not been attached.

If a stricter anti-pollution policy would be successful in improving the air quality in Montreal, what can then be said about the probable distribution of the benefits of this policy? If land values are correlated with levels of air pollution, improvements in air quality will then also be reflected by increased land values.[6] Due to properties of atmospheric dispersion of pollution, any anti-air pollution measure will have its more noticeable impact in these urban areas with the highest level of air pollution [12, pp. 15-37]. If residential land in the urban area is a perfect substitute for other land before the reduction of air pollution, then any improvement in air quality for a given area will induce households to move into this improved urban area. This increase in the demand for a given supply of residential land causes the property values to go up. From this we may generalize that, if the property values increase, the homeowner can enjoy his benefits either in the form of better air quality or in a realized capital gain by selling his property. In the case where the homes are rented, the division of the benefits between tenants and home-owners will depend upon the extent to which these benefits are reflected in increased property values, i.e., higher rents, or increased consumer surplus for the tenants.

Consequently, any reduction in air pollution will most benefit the lower income households regardless whether they are living in homes, which are owner-occupied, or for rent [4, pp. 267-269]. But, for property values to rise, a household must be willing to settle (again) in urban areas where now the air quality is improved. However, this residential mobility seems to be unlikely, since urban and suburban residential land sites are very imperfect substitutes with respect to characteristics other than the level of air quality, e.g., the characteristics of the neighborhood. Therefore one may tentatively conclude that to a larger extent the benefits of cleaner air will not be capitalized into land values and the lower income households will benefit most from improved air quality.

[6] In a multiple-regression study Ridker and Henning found that the property values for the metropolitan area of St. Louis showed a significant inverse relationship with the level of air pollution [13].

However, to ascertain the complete effects of the incidence pattern of environmental benefits of Canadian anti-pollution programs among different income groups would require a corresponding analysis of the distribution among income groups of the burden of financing environmental protection measures [14]. Such an analysis lies beyond the scope of the present study, but without it no conclusive statement can be made on the overall economic equity of environmental programs.[7]

Conclusions

The preceding study is by no means comprehensive, since only one city was examined and only one aspect of environmental policy was analyzed, namely, the association between income levels and the distribution of air quality. Other environmental programs which may be designed to improve the utilization of land-based rural and water-based recreation services may produce a different distributional pattern of benefits than a program to enhance air quality in metropolitan areas.

The information provided in this study could be useful in the formation of public policy regarding environmental quality planning. For instance, if Montreal were to allow greater sulphur content in fossil fuels on the wake of another energy crisis, according to this study we could expect households with the lowest income to be most affected. Since any public policy requires broad public support it seems that equity concern should be given an appropriate role in designing a comprehensive Canadian environmental protection policy.

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