ENVIRONMENTAL GOODS AND EARNINGS DIFFERENCES AMONG JAPANESE CITIES

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Personal incomes often vary across geographical regions of an economy. The existence of income disparities between developed and undeveloped regions, for example, is well known and has been the subject of much research. Differences in incomes also exist among cities within a single economy. Recently, it has been suggested that some systematic variations in earnings among urban centers can be explained by variations in amenities of location, or in other words, by availability of environmental goods. Several studies have found that incomes in U.S. cities are higher where the quality of environmental goods is lower. The purpose of this paper is to determine whether this is true in the case of the Japanese urban system as well.

The first section of the paper describes the concept of environmental goods and develops a model of the relation between availability of these goods and intercity income differences. The second section reviews several empirical studies of environmental goods in U.S. cities. The third section describes an application of the environmental goods hypothesis to Japanese cities. The final section of the paper offers comments about the value of this type of research.

I. *The Concept of Environmental Goods and the Wage Model*

The importance of location to firms has long been a basic assumption in models of urban agglomeration, but only relatively recently has location been considered in models of consumer behavior. While pleasant climate, polluted air, and other such attributes of location clearly affect individual well-being these factors differ from the goods that are normally considered in consumer analysis or in utility functions. There are two characteristics which distinguish these kinds of goods—which we will call "environmental goods"—from regular market goods.[1] First, while an individual's consumption of both regular goods and environmental goods affects his well-being, location determines the environmental goods he consumes. Second, unlike the consumption of regular goods, the consumption of environmental goods entails no direct market transaction or monetary cost to the individual. Regular goods are explicitly purchased at observable market prices, although these prices may not be the same in all locations. Environmental goods, on the other hand, are not explicitly purchased.

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[1] The term "environmental goods" is probably attributable to Izraeli. The definition given here is derived by synthesizing ideas of Izraeli [6, 7], Tolley [14], Rosen [12], Getz and Huang [2], Nordhaus and Tobin [10], and Polinsky and Shavell [11].

According to this distinction, then, the concept of environmental goods encompasses not only the obvious examples of climate and air quality, but also consumption opportunities, commuter travel time, risk to personal safety from fire or crime, and the quality or character of recreational, educational, and health facilities. Each of these "goods" involves an unpurchased level of consumption which is determined simultaneously with location.

Three further points should be made in order to clarify the nature of environmental goods. First, in some cases regular goods can serve as partial substitutes for environmental goods. For example, air conditioners may be purchased to alleviate an inhospitable climate or poor air quality, and security systems may be purchased to guard personal safety and property. Second, the fact that local taxes are collected to pay for locally provided services does not exclude consideration of these services as environmental goods. The payment of local taxes is not made in direct exchange for the specific services consumed, while the exchange is a direct one in the purchase of regular goods. Moreover, taxes, or even user charges, do not necessarily reflect the true value of the services to the consumer.[2] Third, the concept of environmental goods is different from the concept of local public goods, even though each concept refers to goods which are consumed both collectively and locally. It is usually assumed that local public goods are produced or are producible. For example, Tiebout says about public goods: "A definition alternative to Samuelson's [definition of public goods] might be simply that a public good is one which should be produced, but for which there is no feasible method of charging consumers." [13, p. 416] Implicit in this statement are the notions that public goods are producible and that they are produced to be consumed. Evironmental goods, however, include goods which exist whether or not they are produced or provided by any economic entity either in the private or in the public sector. Thus, the concept of local public goods does not encompass many location attributes which are important to well-being, but the concept of environmental goods does encompass Tiebout-style local public goods, and more.

Thus far, we have discussed environmental goods as attributes of locations in general, but the term "location" is open to specification. It may be taken to be something as large as a national or even global region, or something as small as a neighborhood. In this paper we specify that a location is a city and we go on to examine environmental goods which are distributed unevenly among cities. From this point of view we develop a model in which the fixed supply of environmental goods available in each city generates intercity wage differences.

The relationship between environmental goods and wages is derived from a model of utility maximization and the necessary condition for locational equilibrium. All consumers are assumed to have similar utility functions with environmental goods E and regular goods X as arguments. Consumers are also assumed to be freely mobile. From an individual consumer's point of view the supply of environmental goods to be consumed is fixed for each city. His utility level thus becomes dependent on his city of residence: $U_C = U(E_C, X)$. Since environmental goods have no explicit prices, total earnings W are spent on regular goods which have a market price P. The first-order utility maximization conditions specify demand for regular goods in terms of earnings and prices. Using this informa-

[2] This may be particularly true in Japan, where in 1970 only about 35% of the revenues of cities, towns, and villages came from local taxes or user charges. [7, p. 10]. A large part of local revenues comes from allocations from the central government.

tion we convert to the indirect utility function and express utility in terms of earnings, the prices of regular goods, and environmental goods: $U_C=V(W, P, E_C)$.

The necessary condition for locational equilibrium is that consumers be indifferent among cities. In other words, when the system is in equilibrium no individual can improve his well-being by moving to another city. This condition means, though, that the level of utility must be the same in all cities: $U_C=V(W, P, E_C)=U^*$. Thus, in a city with a given level of environmental goods, wages and prices must be such that they equalize residents' utility with the rest of the system. Cities with low quality environmental goods must have higher wages and/or lower prices, and cities with better environmental goods must have lower wages and/or higher prices.

The equilibrium condition which fixes the level of utility allows us to invert the indirect utility function and express earnings as a function of prices and environmental goods: $W=f(P, E)$. In other words, if environmental goods are important to well-being, differences in environmental goods generate differences in the supply of labor to cities. All other things equal, consumers will accept different wages in exchange for their labor services depending on the environmental goods which are available. This is the basic hypothesis which will be examined in this paper.

Economists have exhibited interest in this hypothesis because, among other reasons, it suggests a means to measure consumer preferences, or demand, for environmental goods. It is possible to show that the parameters of the relationship between environmental goods and wages are the marginal consumer valuations of environmental goods.[3] The estimated coefficients, then, may be used to evaluate the costs and benefits of changes in environmental goods. The implicit prices derived from this method of analysis might also be used to construct aggregate indexes of the quality of life.[4]

II. *U.S. Empirical Studies*

So far, we have defined environmental goods and developed a model which says that in equilibrium differences in earnings among cities should be related to the availability of environmental goods and to the prices of regular goods. In testing this hypothesis it is important to control for the possibility that observed wage differences are indications of disequilibrium and to control for earnings differences which reflect differences in human capital. A more basic problem is determining appropriate measures for environmental goods. In this section we review three studies which examine the relation between environ-

[3] This is true, strictly speaking, only if the set of locations, or the set of environmental goods choices, is continuous. Rosen's model [12] is based on such an assumption. Rosen also discusses other limitations in interpreting these coefficients as implicit prices.

[4] The pioneering work in this field was done by Nordhaus and Tobin [10]. These two researchers employed elasticity of income with respect to population size, population density, and urbanization to compute a GNP figure corrected to exclude welfare losses from urbanization. The Net National Welfare Measuring Committee constructed a similar overall welfare measure for Japan but followed a different approach in imputing losses to urbanization [1]. It estimated the losses by summing the cost of excess commuting time and the cost in lost life and personal injuries from traffic accidents. The framework discussed in our study incorporates features of both earlier approaches. It examines specific factors which contribute to the quality of life, as the NNW committee did, and it uses variations in earnings to impute values to these factors, as Nordhaus and Tobin did.

mental goods and earnings in U.S. cities. These studies, by Izraeli [6], Rosen [12], and Getz and Huang [2], indicate some of the ways the concept might be applied. This review will serve also to summarize the empirical status of the hypothesis.

TABLE 1. SOME RESULTS OF PAST STUDIES ON ENVIRONMENTAL GOODS AND EARNINGS IN U.S. CITIES

	Izraeli[a]		Rosen[b]		Getz &[c] Huang
	ln male wages		ln real male earnings		white male earnings
	money	real			
AIR & WATER QUALITY					
Sulfates	.07 (1.9)	.06 (1.9)			
Particulates			.0009*	.0006*	
Inversion days			.0102*		
Air pollution					.01 (0.7)
Water pollution			−.0009		
SAFETY					
Crime, fire & accident	.01 (0.1)	.04 (0.6)			
Crime rate			.00003*	$.93 \times 10^{-5}$	.05 (2.2)
CLIMATE					
January temp.	−.50 (7.3)	−.42 (6.7)			
Rainy days				.0030*	
Sunny days			−.0096*		
Days temp.>90°			.0024*		
Freezing days					.00 (0.1)
OTHER ENVIRONMENTAL GOODS					
Commute time					.17 (1.1)
Consumption opportunities					−.02 (0.9)
Health facilities					−.11 (1.8)
Teacher quality					−.09 (1.6)
Local expenditures	−.07 (0.8)	−.11 (1.3)			
Property tax rate	.14 (2.9)	.08 (1.8)			
Population	.10 (5.0)	.08 (4.6)		$.97 \times 10^{-8}$*	
Population density				$-.11 \times 10^{-4}$*	
Live in center city			−.0823*		
HUMAN CAPITAL					
Education					−.24 (1.7)
Age	.56 (2.1)	.39 (1.6)	b	b	−.81 (1.3)
CONTROLS					
Migration rate	.12 (5.1)	.10 (4.8)			.07 (0.2)
Unemployment rate	.02 (0.3)	−.01 (0.3)			
Females % males					−.60 (2.7)
% Mfg. empl.					1.77 (3.3)
R^2	.72	.66	NA	NA	.82

Notes: a) Independent variables are in logs.
b) Full regression includes set of personal and human capital variables.
c) Full regression includes 4 regional dummy variables.
t statistics are in parentheses
* *t*-value greater than 2

According to the model developed in the previous section, wages vary in relation to both environmental goods and prices. Izraeli's study emphasizes the simultaneous nature of price and wage determination in cities. He argues that while price variations contribute to wage variations, price differences are themselves determined in part by wage differences. In other words, because labor is one component of the cost of production, differences in wages among cities create differences in prices, and these price differences are in turn reflected in wage differences. Izraeli's argument seems to apply most clearly to differences in the prices of goods which are not traded among cities. With the exception of food, there are in practice relatively small differences in the prices of goods which are traded widely throughout an economy, but there are often large differences in the costs of housing and other market goods which are produced and consumed within one urban market area. One reason why the prices of these non-traded goods might vary, then, is differences in city wage levels.

Izraeli shows that estimating a simple regression between wages and environmental goods, without controlling for price differences among cities, produces coefficients which are equivalent to the reduced-form parameters of a structural equation which explains wage differences in terms of both environmental goods and prices. He also shows that the "pure" effect of differences in environmental goods can be judged by examining differences in money wages net of the price-induced component. Izraeli tests his model on data for 67 U.S. cities. Shown in the first two columns of table 1 are his estimates from regressing male wages on several measures of environmental goods. Because the dependent variable in the first column is the log of average money wages, the coefficients express the combined effects of environmental goods and prices on wages. In the second column the dependent variable is the log of money wages minus the log of the consumer price index, and the coefficients express the pure effects of environmental goods.[5]

Table 1 shows that poorer air quality and greater risk to personal safety from crime, fire, or traffic accidents are associated with higher money and real wages, while a more favorable climate and better local public services are associated with lower wages. These are the effects predicted by the theory. The safety and local services measures are not statistically significant, however.[6] In addition, Izraeli finds that population size is positively associated with wages. He contends that this relation should not be interpreted to mean that workers demand compensation for greater city size itself. It reflects, he says, compensation for the lower quality of other, excluded environmental goods (most notably commuting time) that accompany larger population.

Izraeli's results thus provide some support for the environmental goods hypothesis, and Rosen's work adds further evidence. Rosen makes use of a newly available source of data on annual wage and salary earnings for almost 9000 individual male workers in 19 U.S. cities. Because of the nature of the earnings data and the extremely large sample size, he is able to include in his regressions variables to measure individual differences in human capital and earnings capacity. His study differs from other research because in working with this data he makes use of multiple measures for several of five classes of environmental

[5] Izraeli found that 100% of price differences are reflected in money wage differences. He concluded therefore that the appropriate way to deflate money wages was by the full amount of the CPI.

[6] Izraeli expected that the coefficient on the property tax rate would be zero in these wage equations. (It was included here simply to be consistent with the price equations which he also estimated.) He explains the positive coefficient by the fact that the property tax is closely related to property value, and that property values and income are themselves closely related.

goods: climate, air and water quality, safety, and what he calls "crowding." Rosen relates these measures to real wages (the log of money wages deflated by the local cost of living index). He reports more than 30 regressions in order to demonstrate the robustness of the different measures under alternative specifications. Two of these regressions are reproduced in columns 3 and 4 of table 1.

A more general way to summarize Rosen's results is to look at the effects of the "best" measures for each of the environmental goods he examines. In his study, the effect of particulates and rain days on earnings is consistently positive. Furthermore, the coefficients on these variables are statistically significant in almost every regression specification. Thus, both Izraeli's research and Rosen's research show that climate and air quality are closely tied to wage differences. Rosen's single measure of safety (his crime variable) does not show a consistent sign. However, when the coefficient is significant, it is most often positive, and this is as the theory suggests it should be.

The most interesting aspect of Rosen's study is his discussion of the results for the measures of the environmental good crowding. These measures are population and population density. The population variable is consistently positive and significant, as it was in Izraeli's work. Rosen reasons that the population variable measures both specific omitted environmental goods which deteriorate with city size and a more general "distaste" for the impersonality of city living. (But he also reasons that if size detrimentally affects utility, it must at the same time generate productivity gains for firms in order to enable employers to buy off workers' distaste for living in larger cities. Otherwise, it would not be possible to explain the viability of larger cities.) In addition, Rosen finds that while population size itself is positively related with real wages, population density is negatively related with real wages. The greater population density, the lower are real earnings. The coefficient on population density is also always statistically significant. Rosen suggests that one advantage of greater population density for which workers are willing to accept lower real wages might be support of a broader range of consumption activities. These represent, he says, greater utility of consumption and a truly higher standard of living. Rosen's finding of a negative relation between population density and wages conflicts with the results of the Nordhaus and Tobin study of the welfare losses of urbanization. Those researchers imputed welfare losses from both greater population size and greater population density.

The third and final study which we include in this brief survey is Getz and Huang's attempt to improve on the work of the previous researchers. They fault earlier studies for neglecting demand-side factors influencing wage determination and for failing to include variables representative of a sufficiently wide range of environmental goods.

Unlike Rosen or Izraeli, Getz and Huang model the production activities of cities in conjunction with their model of consumer choices. They make use of information from the production side in order to identify the price and environmental goods estimates as the parameters of a labor supply function. Specifically, they estimate an instrumental price variable which controls for intercity variations in prices due to productivity differences.

Getz and Huang expand the set of measures of environmental goods in two directions. First, they remove the uncertainty associated with the population variable. They say that city size is unlikely to be directly important to consumers. A better approach, they claim, is to examine explicitly the environmental goods likely to be associated with city size—consumption opportunities, air quality, commuter travel time, and crime. Thus, unlike Izraeli and Rosen, they directly account for commuting time and the availability of such consumption opportunities as museums, concerts, recreation areas, and fine restaurants. At the same time they improve on measures of environmental goods not clearly linked to city size by including specific measures for the quality of health and educational services. (Getz and Huang employ principal components analysis to develop variables representative of air quality, health facilities, and consumption opportunities in a city. They use this technique in order to reduce multicollinearity problems.)

Getz and Huang examine the relation of these environmental goods measures with median annual money earnings of white males in 39 U.S. cities. Their results are shown in the far-right column of table 1. As was the case in the previous two studies, all of the environmental goods measures have the signs predicted by the theory, but only a few of these coefficients are statistically significant. While greater commuting time, violent crime, air pollution, and numbers of freezing days exert a positive influence on earnings, only the threat to personal safety (measured by the crime rate) is statistically significant. On the other hand, among those environmental goods measures negatively associated with earnings, health and educational facilities are statistically significant but consumption opportunities is not.

Together, these three studies (and others [5, 8, 9]) provide convincing evidence that in the United States differences in environmental goods among cities are associated with differences in wages among cities. But, while the qualitative effects of environmental goods are supported by this research, much more work needs to be done before the estimated magnitudes of any specific effect can be accepted with confidence. Any single environmental good can be measured in numerous ways, and it can't be said which is the most appropriate. Moreover, the set of all environmental goods which might be relevant to consumers' location choices has not been exhaustively examined. Finally, in underlying theoretical models as well as in empirical applications, more attention should be paid to accounting for other factors contributing to wage differences. Particular attention must be given to factors associated with population size and density, because these compete with environmental goods as relevant factors explaining inter-city wage differences.

III. *Environmental Goods and Earnings Differences among Japanese Cities*

We have examined empirically the relation between earnings and several environmental goods measures in a set of 49 Japanese cities. Included in this set are the nation's six largest cities, around which the bulk of population and economic activity is concentrated, as well as cities which lie at the periphery of the system (Tottori, Saga, and Yamagata, for example). The cities studied are the seats of government of the 47 prefectures plus Kawasaki and Kitakyūshū, the two cities in Japan with over one million population that are not prefectural capitals. These 49 cities were selected because data necessary to the study were readily available for them. Because their functions as centers of government administration make them different from other cities, they do not comprise an entirely typical cross-section of the Japanese urban system. This limits our ability to generalize to all Japanese cities from the results of this study.

The earnings measure used in this study is the twelve-month average of regular wages and salaries plus bonus income of male workers in the 49 cities. It was decided to include bonus income because it is in fact a regular contractural payment similar to regular income except in the frequency of payment. Moreover, the size of the bonus payment may be one means by which employers attract workers to otherwise unattractive locations. The data are for the year 1975 and are obtained from the Family Income and Expenditure Survey (FIES). Average monthly worker earnings in our sample range from a high of ¥234,948 in Nara to a low of ¥172,335 in Osaka. Tokyo ranks eighth from the top with a figure of ¥207,916.

We have examined measures for five specific environmental goods—climate, air quality, commuting time, local public facilities, and local basic infrastructure. Sources and derivations for all of the variables used in this analysis are given in the appendix. Included under the climate category are variables measuring average annual city temperature and average annual city precipitation. It is expected that these climate measures will each be positively related to earnings. Air quality is represented by an index composed of the levels of sulfur dioxide, nitrogen oxide, and particulates. The air quality index and the measure of average commuting time are also expected to be positively associated with earnings, since higher values of these variables represent lower quality environmental goods. The amount of local public expenditures per capita is used to measure the quality of local services. This variable and the infrastructure index are expected to be negatively related to earnings because higher values represent greater unpurchased consumption of local attributes. The infrastructure index has three components: the number of telephones per 100 people, the percentage of city population served by public water supplies, and the population per square meter of large retail store space. This index is intended to measure the widely disparate levels of urban development which exist among these Japanese cities. Since our theory predicts the signs on these environmental goods measures, it is appropriate to use a one-tailed *t*-test to judge the significance of their estimated effect on earnings.

In addition to these six variables which represent differences in specific environmental goods, we have also used population size and gross population density as explanatory variables in some of the regressions. These variables represent unmeasured quantities of environmental goods which are associated with size and density. But without specifying exactly what they represent we can have no a priori expectation about the signs on these variables. Therefore, a two-tailed *t*-test is applied to judge the significance of the coefficients on these variables.

Four other variables have been included in all regressions in order to control for other influences on average city earnings. Average age of the workers in each city is entered to control for human capital factors. It should be positively correlated with earnings. Where the labor market is in disequilibrium, we expect workers to move to areas offering higher wages. Therefore, the rate of net prefectural in-migration should be positively associated with earnings. Many writers have noted the dual structure of the Japanese economy and the existence of wage differentials by enterprise scale. Without attempting to analyze why plants of different sizes are not distributed evenly among cities, we have included the average number of workers per plant in our analysis to control for the effect of plant size on wages. In addition, the percent of city employment in secondary industries is included to control for the effect of differences in industrial structure on average city wages. A cursory look at FIES earnings data by size of enterprise and by industry group suggests that average earnings will be higher in cities with larger average plant size and lower in cities with a greater percentage of employment in the secondary sector.

TABLE 2. REGRESSIONS ON NOMINAL EARNINGS OF MALE WORKERS

	Expected Sign	(1)	(2)	(3)
Age	+	2095.8*	1157.0	627.4
		(1.37)	(0.76)	(0.45)
Migration rate	+	1078.1**	66.7	−177.9
		(2.91)	(0.12)	(−0.43)
Average plant size	+	594.6**	536.8**	538.0**
		(2.08)	(1.88)	(1.97)
% secondary employment	−	−44194.6	−36207.0	−36236.3
		(−1.27)	(−1.03)	(−1.05)
Population	?	6.5**	3.0	
		(2.44)	(1.04)	
Population density	?	−1.9	−1.3	
		(−1.53)	(−0.87)	
Local expenditures	−		−1.7**	−2.0**
			(−2.06)	(−2.58)
Commute time	+		755.7**	853.1**
			(2.32)	(3.15)
Infrastructure index	−		−7703.0	−8589.9*
			(−1.22)	(−1.42)
Pollution index	+		946.1	235.8
			(0.31)	(0.09)
Temperature	+		1073.3	893.1
			(1.04)	(0.91)
Precipitation	+		−0.5	−0.3
			(−0.10)	(−0.07)
Constant		112842.8	140056.9	166295.1
		(1.79)	(2.06)	(2.78)
R^2		.41	.59	.57
$\bar{R}^2$		.29	.39	.41

t statistics are shown in parentheses
** significant at 5% level
* significant at 10% level

Our regression results are summarized in tables 2 and 3. The dependent variable for the regressions reported in table 2 is nominal earnings and in table 3 it is real earnings (nominal earnings deflated by the consumer price index for each city).[7] Three regressions are reported for each dependent variable. The explanatory variables in the first column include simply population and density and the control variables. The regression in the second

[7] We also ran regressions on nominal earnings which included the consumer price index among the independent variables. Contrary to expectation, the coefficient on the CPI was negative, but not statistically different from zero. There is in this sample a tendency for wages to be higher where the CPI is lower. Some of the cities with the lowest consumer prices have among the highest wages (e.g., Tottori, Oita, Saga, and Miyazaki). Probably the CPI is low because of low food prices; these cities are all located in agricultural regions. At the same time these cities tend to have larger average plant sizes than the other cities. It appears that they have a few enterprises employing large numbers of workers and that the plant-scale effect accounts for the higher earnings.

TABLE 3. REGRESSIONS ON REAL EARNINGS OF MALE WORKERS

	Expected Sign	(1)	(2)	(3)
Age	+	1874.3	923.1	675.0
		(1.16)	(0.56)	(0.45)
Migration	+	755.8**	28.4	−4.5
		(1.93)	(0.05)	(−0.01)
Average plant size	+	785.3**	811.2**	830.1**
		(2.60)	(2.63)	(2.86)
% secondary employment	−	−65904.6**	−51195.1	−52211.9*
		(−1.79)	(−1.34)	(−1.42)
Population	?	4.4	1.2	
		(1.54)	(0.38)	
Population density	−	−1.9	−0.8	
		(−1.39)	(−0.49)	
Local expenditures	−		−2.0**	−2.1**
			(−2.18)	(−2.55)
Commute time	+		554.9*	553.5**
			(1.57)	(1.92)
Infrastructure index	−		−9980.1*	−10604.4*
			(−1.47)	(−1.65)
Pollution index	+		1062.0	381.5
			(0.32)	(0.13)
Temperature	+		987.5	861.7
			(0.88)	(0.82)
Precipitation	+		0.5	0.6
			(0.08)	(0.11)
Constant		128774.0	168473.6	184275.2
		(1.92)	(2.29)	(2.89)
R^2		.39	.56	.56
$\bar{R}^2$		.27	.35	.39

t statistics are shown in parentheses
** significant at 5% level
* significant at 10% level

column includes both our specific measures of environmental goods and population size and density, and that in the third column omits population and density from the set of explanatory variables. (The regressions reported in these tables involve only 37 observations because some or all of the pollution measures were not available for 12 cities. When the equations which do not include the pollution index were run on all 49 cities, the results were not substantially different from those reported in tables 2 and 3.)

Looking first at column 1 of tables 2 and 3, it can be seen that the control variables all have the expected signs. An older labor force and greater in-migration are associated with higher nominal and real wages. Migration is more significantly related to real than to nominal wage differences. Average plant size significantly affects nominal and real wage differences among cities. The proportion of secondary employment is negatively associated with average earnings.

How do earnings vary with population size and density? The larger the city the higher are both nominal and real wages, though population size is significantly positive only in relation to real wage differences. On the other hand, greater concentration of population (as measured by gross population density) is associated with lower nominal and real earnings. However, this negative relationship is not statistically significant for either dependent variable. The pattern of a positive population coefficient and a negative density coefficient is the same as the pattern found by Rosen, the only one of the three U.S. researchers to include both variables. It appears that some environmental goods deteriorate with increasing city size while others improve with greater population density. We should pay attention to what happens to these coefficients when the specific measures of environmental goods are included in the regressions. Overall, this regression specification explains only about 40% of the variation in money earnings or in real earnings in this sample of Japanese cities.

Looking at the regression results presented in column 2 we see first of all that the variables representing various environmental goods have the expected signs, with the exception of precipitation in the real earnings equation. Higher local expenditures per capita are significantly associated with lower money earnings and real earnings. If this variable accurately reflects differences in the quality of local services, then it appears that Japanese consumers are willing to accept lower earnings in exchange for better public services. In addition, better local infrastructure shows a slightly weaker but still negative relation with money and real earnings. Longer commuting times, on the other hand, are associated with higher earnings.[8] The effect of commuting times is more highly significant in terms of nominal than real earnings. Such a result is to be expected because longer commuting times generally entail greater monetary expenditures and these expenditures are to some extent counted in the consumer price index.

The measures of the two environmental goods climate and air quality are not so clearly important in explaining differences in earnings among these cities. The estimated effects are not statistically significant. Nevertheless, these effects are generally in the direction predicted by the theory. It may be these factors are not particularly important to Japanese, but more likely these variables are not very good measures of the relevant differences in climate and air quality. Annual averages may mask the extremes of temperature which cause discomfort. Izraeli, Rosen, and Getz and Huang employed what are probably better measures of climactic differences—number of rainy days, number of days the temperature rose above or fell below some extreme value. Since there is considerable variation in air quality within a city, our city-average measures of pollution may not enable us to distinguish the effect of air quality differences. Better measures might include the number of days pollution indicators exceeded some official health standards.

Comparing the regression in column 2 with that in column 1 we see that adding measures of environmental goods increases the proportion of the variation in earnings which is accounted for. The R^2 moves from .41 to .59 in table 2 and from .39 to .59 in table 3. The relevance of these environmental goods measures to explaining earnings variations among cities is more clearly shown by the fact that the adjusted R^2 increases 8 points in the nominal equation and 10 points in the real earnings equation. When the six environmental goods measures are added, however, the significance levels on the population and density variables fall way off, although their signs remain unchanged. In addition, the migration variable also becomes statistically insignificant as a factor in explaining earnings differences.

Such changes might be the result of multicollinearity between the environmental goods

[8] Some positive correlation between the earnings measure and commuting time might be expected because some Japanese companies reimburse employees for their commuting expenses.

measures and the population, density, and migration variables. There is a general tendency for a stronger correlation of environmental goods with density than with population. Commuting time, air quality and the index of infrastructure are the environmental goods measures which move most closely with size and density. The strongest correlation (.72) is between the pollution index and population density, and multicollinearity between these variables may limit our ability to distinguish the effect of air quality on earnings. In addition, the fact that commuting time and the migration rate are fairly highly correlated (.62) may explain why the migration variable becomes insignificant when commuting time is added to the regressions. In this sample, cities with high rates of in-migration also have longer commuting times, both of which are associated with higher earnings.

In order to see what effects multicollinearity has on tests of significance of the environmental goods variables, we ran a third set of regressions excluding the population and density variables. These results are shown in the third column of tables 2 and 3. Omitting population size and density raises the adjusted R^2 without changing the total amount of variation which is explained. Part of the opposing effects of the omitted variables (population and density) appears now to be borne by the migration variable whose sign becomes negative and not statistically different from zero. While the sizes of the coefficients on the environmental goods measures change somewhat, our conclusions about the direction of their effects are not altered. Omitting population did not improve the significance of the air quality measure. The statistical significance of commuting time on nominal earnings is greatly increased when population and density are left out of the regressions.

In summarizing these results we can say, first of all, that differences in the environmental goods available in Japanese cities appear to be one source of systematic variations in wages. The environmental goods measures behaved (with one exception) in the predicted way. The hypothesis is confirmed most strongly in the case of local public services and commuting time. In elasticity terms, the most important environmental goods appear to be commuting time and infrastructure. Finally, because including population size and density largely represents our failure to specify appropriate measures of environmental goods, the formulation in which these variables are excluded better conveys the extent to which the concept of environmental goods aids in understanding earnings differences among these cities.

The overall explanatory power of the regressions presented here is not, however, entirely satisfactory. There still remain several ways to proceed in order to understand better the role of environmental goods as factors in earnings differences across cities. First, additional and more accurate measures of environmental goods should be employed. Suggestions were made above for alternative measures of the goods climate and air quality. In addition, the effect of local services would be better represented by obtaining direct measures of quality differences in these services. Second, increasing the size of the sample would likely reduce the multicollinearity problems and improve ability to distinguish separate effects. It would also be instructive to examine a more representative sample of Japanese cities than prefectural capitals. Third, a data base defined not along political boundaries but by economic areas (like the system of SMSAs for the United States) would useful. The earnings measure employed here refers only to differences among workers residing within the boundaries of the cities in the sample. It does not refer to the entire labor market of each city. Last, it might be interesting as well as important to understanding the effects of environmental goods to obtain measures of earnings for more specific categories of workers. For example, Getz and Huang found different patterns in the estimated effects on earnings for professionals, for laborers, and for workers in several other occupations. Whether these steps would improve the overall explanatory power of the regressions remains to be seen. It should also be noted that we have not explicitly controlled for demand-side influences on wages, and thus cannot claim that our coefficients are true labor supply parameters. Nevertheless, it is clear that the theory that wages compensate for environmental goods differences applies not only in the United States but also in Japan.[9]

IV. *Concluding Comments*

In this paper we have described the concept of environmental goods and we have applied that concept to partially explain variations in earnings among some Japanese cities. Similar uses of the concept of environmental goods may eventually provide a means to measure how people evaluate various non-market influences on their well-being. As research moves in this direction, a central problem in the empirical work will be how to conceive of the relation between environmental goods and population size and density. This is more difficult than merely arriving at a proper specification of an empirical model. Is population size itself, or even population density, an "environmental good"? Many people intuitively believe that the quality of life necessarily deteriorates along a scale from rural towns to huge metropolises, but might not this presumed deterioration be better described by viewing the components—both market and non-market—of well-being.

The concept of environmental goods offers a practical antidote to the "big cities are bad" school of thought. The more people there are who choose to live in a particular city, the greater will be the degree of air pollution and the greater will be the congestion of schools, transportation, and other public facilities. But at the same time, increasing population or density brings residents positive external benefits by supporting the provision of public and private goods and services. It is not the "bigness" of cities that is bad, rather it is the uncontrolled deterioration in environmental goods which accompanies bigness that is bad.

It may be that some cities are indeed too big, as measured by some social welfare criteria. But in order to develop policies to deal effectively with the problem it is essential first to develop a perception of the relation between city size and the quality of life. Measurement of environmental goods is a step in this direction. The results of this study demonstrate that Japanese as well as Americans make location choices on the basis of environmental goods. Wider use of this concept could significantly improve our understanding both of how urban systems work and of how they can be made to serve people better.

[9] Despite the reservations listed in this paragraph, one tentative suggestion for urban policy seems to emerge from our results. In a study of the patterns of population changes in Japan between 1950 and 1970, Glickman [4] notes one special characteristic of Japanese cities: they are much more highly centralized in terms of employment than in terms of residence. Such a configuration gives rise to excessively long commuting times, and our results indicate that longer time spent commuting to work has a significant effect in reducing the well-being of Japanese workers. Thus, it appears that considerable benefits might be realized by finding ways to decentralize employment within existing Japanese cities.

APPENDIX

Sources of Data and Measurement of Variables

Name of Variable	*Measurement*	*Source*
Earnings	12-month average of wage and salary plus bonus income of head, workers' households, 1975.	Sōrifu Tōkei Kyoku, *Kakei Chōsa Nempō 1975* Table 11 & Ref. Table 1
Consumer Price Index	Regional Difference Index of Consumer Prices, 1975	Sōrifu Tōkei Kyoku, *Shōhisha Bukka Shisū Nempō* 1976 Table 16.
Age	Median age of household heads sampled in each city	Sōrifu Tokei Kyoku, *Kakei Chōsa Nempō 1975* Table 11 & Ref. Table 1.
Migration Rate	Net prefectural in-migration as percent of prefectural population, 1975.	Sōrifu Tōkei Kyoku, *Jūmin Kihon Daichō Jinkō Idō Hōkoku Shikuchōson Hen* Table 1 and Tōyō Keizai *Chiiki Keizai Sōran 1976* Toshichosōn betsu shihyō Table 1.
Percent Secondary Employment	Percent of city employment in secondary industry 1975	Keizai Kikaku Chō, *Chiiki Keizai Yōran 1978* Table 201
Average Plant Size	Factory employment divided by number of factories, 1975	Tōyō Keizai, *Chiiki Keizai Sōran 1977*, Toshichōson betsu shihyō Table 2.
Population	Number of inhabitants in thousands, 1975 census	Keizai Kikaku Chō, *Chiiki Keizai Yōran 1978*, Table 201
Population Density	Number of residents per square kilometer 1975	*Ibid.*
Local Expenditures	Amount of regular fixed budget expenditures, 1975, converted to per capita monthly amount	*Ibid.*
Commuting Time	Minutes per day spent commuting by males with a job, 1975	Sōrifu Tōkei Kyoku, *Shakai Seikatsu Kihon Chōsa Hōkoku 1976* Chiiki I-(1), Kōdō Jikan Hen.
Infrastructure[1] Index	Number of telephones per 100 residents, % of population with public water supply	Keizai Kikaku Chō, *Chiiki Keizai Yōran 1977* Table 201
	population per m^2 of large retail store space, 1975	Tōyō Keizai, *Chiiki Keizai Sōran 1977*, pp. 30–57.

[1] Indexes are computed as $I=\sum(X_{in}/\bar{X}_n)$, where X_{in} is vector of three variables in city i and $\bar{X}_n$ is the mean of n^{th} variable in all cities.

Air Pollution[1] Index	Annual average SO_2 and NO_X in ppm, suspended particulates in mg/m^3, 1975.	Kankyō Chō, *Nihon no Taiki Osen Jittai* 1976.
Temperature	Average annual temperature in degrees centigrade, 1941–1971	Nihon Chisō Kenkyū Kai, *Nihon Chisō*
Precipitation	Average annual precipitation In mm, 1941–1971	*Ibid.*

REFERENCES

[1] Economic Council of Japan, *Measuring Net National Welfare of Japan: Report of the NNW Measurement Committee*, Tokyo: Ministry of Finance, 1974.

[2] Getz, M. and Y. Huang, "Consumer Revealed Preferences for Environmental Goods," *Review of Economics and Statistics* 60 (1978): 449–58.

[3] Glickman, N., "Financing the Japanese Urban System" Research Memorandum RM-77-48. International Institute for Applied Systems Analysis. October 1977 (Mimeographed).

[4] ________, "On the Japanese Urban System," *Journal of Regional Science* 16 (1976): 317–36.

[5] Hoch, I. and J. Drake, "Wages, Climate, and the Quality of Life," *Journal of Environmental Economics and Management* 1 (1974): 268–95.

[6] Izraeli, O., "Differentials in Nominal Wages and Prices Between Cities," *Urban Studies* 14 (1977): 275–90.

[7] ________, "Money Wages, Price of Nontradable Goods, and the Environmental Goods," *Journal of Envrionmental Economics and Management* 4 (1977): 265–70.

[8] Kelley, K.C., "Urban Disamenities and the Measure of Economic Welfare," *Journal of Urban Economics* 4 (1977): 379–88.

[9] Meyer, J. and R. Leone, "The Urban Disamenity Revisited," in L. Wingo and A. Evans eds. *Public Economics and the Quality of Life*, Baltimore: Resources for the Future and Johns Hopkins Press, 1977.

[10] Nordhaus, W. and J. Tobin, "Is Growth Obsolete?" in F. Juster ed. *Economic Growth: Fiftieth Anniversary Colloquium V.* New York: National Bureau of Economic Research, 1972.

[11] Polinsky, A.M. and S. Shavell, "Amenities and Property Values in a Model of an Urban Area," *Journal of Public Economics* 5 (1976): 119–29.

[12] Rosen, S., "Waged-based Indexes of Urban Quality of Life," University of Chicago and National Bureau of Economic Research, July 1977 (Mimeographed).

[13] Tiebout, C.M., "A Pure Theory of Local Expenditures," *Journal of Political Economy* (1956): 416–24.

[14] Tolley, G.S., "The Welfare Economics of City Bigness," *Journal of Urban Economics* 1 (1974): 324–45.