are preferentially digested by deoxyribonuclease I. In contrast, treatment of red cell nuclei with staphylococcal nuclease results in no preferential digestion of active globin genes. When the 11*S* monomers obtained after staphylococcal nuclease digestion of nuclei are then digested with deoxyribonuclease I, the active globin genes are again preferentially digested. The results indicate that active genes are probably associated with histones in a subunit conformation in which the associated DNA is particularly sensitive to digestion by deoxyribonuclease I.

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City Size Effects, Trends, and Policies

The consequences as a city grows in population and recent patterns of U.S. urban growth are examined.

Irving Hoch

With increasing city size, there is an increase in wage rate for the same work, an increase that is explainable as compensation to city residents for increased costs with size. In this article I document that relation and then draw implications for prediction and policy. Rather than using the political jurisdiction as the unit of analysis, I use the economic city, which corresponds best to the census definition of urbanized area, but is measured well enough by the standard metropolitan statistical area (SMSA).

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The Wage-Cost Relationship

As a city grows in population, land values increase because more people want to locate in the city and hence bid up rents. With higher rents, land use becomes more intensive as inhabitants economize on the use of a more expensive resource. This is another way of saying that urban density will increase (*1*). With rents up, new migrants into an expanding city can be attracted only if they are paid enough to cover the now higher rents, which drives up wages. Higher rents also imply higher transportation costs, since there is a trade-off between locating near the center of town and paying higher money rents or locating at an increasing distance from the center and paying higher commuting costs (*2*). Higher rents or transport costs, or both, cause general increases in the cost of living. Food costs, for example, increase because grocery store rents are higher and because grocery store clerks receive higher wages to cover their higher residential rents. Increased size and

density generate congestion and pollution effects; it is often hypothesized that there will be other health and welfare effects that involve increased levels of social disorganization (delinquency, crime, insanity, and the like) (*3*). Some recent studies have cast doubt on the validity of the putative health and welfare effects (*4*). However, as a city grows larger, the value of its inhabitants' time increases with the city's increasing wage rate and cost of living, so that economizing on time becomes more urgent, and life becomes more hurried and harried (*5*).

Many of these increased costs appear in a conventional cost-of-living index; others do not but nevertheless affect the quality of life and ultimately should be reflected in wage rates, although they will be offset to some extent by the benefits of city size. With increased size, greater specialization and division of labor can and does occur, so that the inhabitants of larger places have greater variety and choice in consumption and better access to specialized services (*6*).

There is considerable evidence to support this reasoning. Drawing on my own research, I present some of that evidence; however, parallel studies by others have yielded similar results (*7*).

Money Compensation by City Size

The first set of results that I report was obtained by relating wage rates in individual occupations to city size (measured by the logarithm of SMSA population) and to location in the South, fitting equations by regression analysis (*8*). The Bureau of Labor Statistics publishes data on wage rates for well-defined and very specific occupations in a relatively large number of metropolitan areas (*9*). Because the work characteristics of each occupation are well defined, comparisons made on the basis of these data avoid the problem of lack of homogeneity of the labor forces being compared. Data on 25 occupations were developed in the form of standardized wage rates to make comparisons easier; all wage observations for each occupation were divided by the average wage rate for the occupation and then multiplied by 100 so that all results are on a base of 100 percent.

The effect of population size was always positive and was statistically significant in 24 of the 25 cases, while the effect of the South was always negative, and was statistically significant in 21 of the cases. Some sense of overall pattern can be obtained by averaging results. Wage rates, on average, increased by about 9 percent per order of magnitude of population; thus a place with 10 million people had a 9 percent higher wage rate than did a place of 1 million, which in turn had a 9 percent higher wage rate than did a place of 100,000 for the same work. The wage rate in the South, on average, was 7 percent less than that in the North for the same work. The fitted equation results, in terms of the overall average, and in averages for groupings of the occupations, are given in Table 1.

There was considerable variation in the results for the individual equations, but when the results were grouped by the categories of Table 1, cross classified by sex, and analyzed, some significant regularities appeared. The effect of population size on wages was significantly stronger for female than for male occupations and for union than for nonunion occupations. The negative wage differential for the South was stronger for blue-collar than for white-collar occupations and decreased as the average rate of pay increased. Wage rates in low-paid and, presumably, less-skilled occupations were relatively much lower in the South than in the North, while wage rates in well-paid, more highly skilled occupations were almost as high in the South as in the North. This suggests a much larger relative supply of less skilled than of highly skilled labor in the South than in the North and is probably the core of the explanation for the long-term migration of blacks from South to North and of whites from North to South. Money wages for skilled labor that are a few percentage points lower in the South than in the North are higher in the South in real terms. The cost-of-living differential between North and South is about 7 percent, approximately equal to the average differential for wages that is shown in Table 1 (*10*). From the variation in the wage differential by occupation, it can be inferred that much of the cost-of-living differential stems from the lower wages of unskilled labor rather than from such factors as climate differences (*11*).

Data on per capita income for SMSA's suggest that differences in wages and income with population size narrowed between 1929 and 1950, but have been remarkably stable since 1950 (*8, 12*). The evidence is somewhat weaker than that developed for the wage equations because income differences can reflect differences between SMSA's in labor quality and in the distribution of income between wage and nonwage components. I hypothesize that the quality and composition differences explain why the effect of population size for income is greater than that for wages. From 1929 to 1950, the income differential declined from 26 percent to roughly half that amount per order of magnitude of population. From 1950 through 1972 the income differential with size showed little fluctuation from a level of about 15 percent per order of magnitude of population. The narrowing of this differential between 1929 and 1950 is suggestive of movement to an equilibrium; the stability since then suggests that equilibrium between SMSA's of different sizes has been more or less attained and maintained, with the income differential interpreted as a compensatory payment for quality of life differences rather than as an indicator and source of needed population shifts. In contrast, the North-South differential showed contin-

Table 1. Average values of coefficients of wage relations for all occupations (*8, 9*). The value for the constant shows the estimated standardized wage for a population of 1000; the value for the log of population shows the percentage increase in wage rate for each order of magnitude of population; and the value for the South shows the decrease in wage rate that occurs with location in that region.

Category	No. of cases	Average hourly wage ($)	Average of coefficients		
			Constant	Log SMSA population ($\times 10^3$)	South
All occupations*	25	2.71	75.08	9.41	−7.39
Nonunion building trades†	3	2.91	82.01	6.73	−5.86
Union building trades‡	3	3.87	64.87	12.72	−7.55
Low-paid blue collar§	4	2.20	79.80	8.96	−17.49
High-paid blue collar‖	2	3.04	69.76	11.52	−8.47
Low-paid white collar¶	5	1.80	70.25	11.09	−5.72
High-paid white collar#	8	2.95	78.31	7.84	−3.64

*The sample size ranged from 50 to 86, with each sample drawn for a particular year in the period 1966 to 1970. †Nonunion carpenter, electrician, and painter. ‡Union carpenter, electrician, and painter. §Janitor, laborer, shipping clerk, trucker, forklift operator (hourly wage < $2.50). ‖Auto mechanic, machinist (wage > $2.50). ¶Office boy and these female occupations: key punch operator B, stenographer-general, switchboard-receptionist, typist B; A, B, and C refer to skill classifications, with A highest, C lowest. #Accounting clerk A (female), computer operator B, draftsman A, draftsman B, draftsman C, accounting clerk A (male), registered nurse (female).

uous narrowing over time, declining from roughly 27 percent in 1929 to around 10 percent in 1972, which is suggestive of a long-term disequilibrium in process of slow elimination. Both size and regional effects were highly significant statistically.

The results thus far are based on the relation of a money measure to population size and to the South. It seemed possible that other variables, correlated with but not intrinsically connected to population size, might explain some of the effect attributed to size. When brought into the equation, such variables might be statistically significant and, concomitantly, might reduce the measured effect of population size on monetary rewards. In practice, when the equations used in Table 1 were extended by introducing climate measures (summer temperature, winter temperature, precipitation, and wind velocity) and racial composition (percent black population), the effect of population size dropped, on average, from about 9 percent to around 6 percent per order of magnitude of population (*11*). The latter value can be interpreted as the city size differential for white workers only; there is some outside evidence that the effect of size is stronger for blacks than for whites (*13*), perhaps explaining the pattern of black migration by size of place. Hence, we can take 6 percent as a lower bound and 9 percent as an upper bound in estimating the effect of size.

Some additional evidence that is also relevant to the impact of labor quality and income composition was obtained by using data on 1970 per capita income by congressional district (*14*) (Table 2). Income was first related to population size and the South, and the estimated effect for income was 18 percent per order of magnitude of population, a result that agrees fairly well with the 15 percent effect obtained with the use of SMSA data. Income was then related to population size, a finer regional breakdown, and a number of other putative explanatory variables. The final formulation contained only variables that were statistically significant, as measured by t ratios greater than 1.96. (Statistical significance here means that there is only one chance in 20 that the variable really has no effect.) With this equation, the percentage effect for population size was 6.3 percent, essentially the same as the lower bound obtained for the wage relation (*15*). The utilization of different data sources has led to consistent results, and the city size differential therefore can be bracketed as falling between 6 and 9 percent per order of magnitude of population.

Table 2. Regression equations relating 1970 per capita income in congressional districts to explanatory variables.

Independent variable*	Coefficient	t Ratio	Average value of variable†
Equation 1			
Constant	1580.314	11.168	
Log "metro" population (in thousands)	564.539	12.307	2.861
South	−369.126	5.822	0.309‡
$\bar{R}^2$ = .371			
Equation 2			
Constant	778.035	1.509	
Log "metro" population (in thousands)	195.267	6.112	2.861
Percent urban	9.900	10.272	73.210
College educated per household	7455.198	20.275	0.183
Percent black	−19.418	4.674	10.798
(High school educated per household) (percent black)	19.215	2.559	7.798
Percent white-collar	−23.525	6.207	39.583
Persons per household	−222.144	2.814	3.225
Aged 25+ per district population	2618.195	4.813	0.540
Great Lakes region	198.929	5.362	0.194‡
Plains region	−105.446	2.073	0.081‡
Southeast region	−99.175	2.289	0.217‡
Southwest region	−300.958	5.844	0.083‡
Rocky Mountain region	−304.133	3.709	0.028‡
$\bar{R}^2$ = .872			

*Some information on definitions of variables follows. (i) "Metro" population is population of largest metropolitan area (SMSA) at all coincident with congressional district. If the district did not contain an SMSA, then the county population for the largest city was used. This definition corresponds to the standard SMSA definition. (ii) College educated refers to the number of persons aged 25 or older who have completed 4 years of college. (iii) High school educated refers to the number of persons aged 25 or older who have graduated from high school, including college attendees who have not graduated from college. (iv) (High school educated per household) (percent black) is the product of the two variables and serves as an interaction term. (v) In equation 1, South is defined by Bureau of Census classification. (vi) In Equation 2, the regional classification is that of the Bureau of Economic Analysis, Department of Commerce. See (*39*) for states in each region. Regions not in equation 2 because of the absence of statistical significance are: New England, Mideast, and Far West. See data source for additional detail on definitions of other variables (*14*). †Average value of per capita income = $3081.561. ‡Average for variable = fraction of cases in sample, since variable takes on values of 0 or 1 only.

Table 3. Estimated per capita income and all federal taxes, fiscal year 1972, by SMSA population size. Index 1 is an index of personal income, while index 2 is an index of income minus taxes, with base for both the respective value for the 0 to less than 250 class (*17*).

SMSA population ($\times 10^3$)*	Personal income ($)	Federal taxes ($)	Income minus taxes ($)	Index 1	Index 2	Ratio of index 2 to index 1
0 to < 250	3758	758	3000	100	100	1.000
250 to < 500	4104	889	3215	109	107	.982
500 to < 1000	4424	981	3443	118	115	.975
1000 to < 2500	4619	1045	3574	123	119	.969
2500 to < 9000	5272	1205	4067	140	136	.967
9000 or more	5860	1388	4472	156	149	.956

*The number of SMSA's in the six classes were respectively 5, 50, 35, 26, 7, and 1, running from smallest to largest populations, and totaling 124 cases.

Cost by City Size

The question of what factors are behind the city size differential can now be raised. The cost of living increases by 4.5 percent per order of magnitude of population (*10*), thus explaining from one-half to three-quarters of the wage differential with size. It seems evident that the remainder can be explained as the net effect of nonmarket benefits and costs that vary with city size. Because one-quarter to one-half of the wage differential is to be explained, it follows that the costs must outweigh the benefits. The nonmarket costs include the value of time spent in the journey to work, the value of risks not covered by insurance, and the cost of air pollution, among other items. The benefits include access to specialized activities and services—such as ballet, museums, major league sports, and specialized medical facilities—which become economic at a large enough scale of operation. Specific factors that affect the wage differential with size, including taxes, environmental quality, and crime, are discussed in more detail below.

Taxes. There is no provision in tax

law, of course, for such niceties as an accounting for income differentials that compensate for unpleasant or costly environments. A progressive income tax implies an augmentation of the wage differential at equilibrium. Thus, if a worker needs 10 percent more in disposable income to make place A comparable to the national average, and if he pays a 20 percent tax rate on additions to his income, then he will need to be paid 12.5 percent more in wages in place A, with 2.5 percent for taxes and 10 percent retained as disposable income. Bureau of Labor Statistics cost-of-living data support this argument (*10*). Taxes, which cover social security and all income taxes, account for about 10 percent of the money wage differential with size for low-income families, about 12 percent for middle-income families, and about 15 percent for upper-income families. Some progression occurs with population size, which can reflect both higher money income with uniform tax rates (the federal taxes) and, perhaps, higher tax rates for every income class (state and local income taxes). Additional evidence is utilized in Table 3, which shows indexes of per capita income and per capita income minus all federal taxes for six population size classes, and is useful in establishing the regularity of the size relationship. It seems clear that taxes increase faster with population size than does income (*16, 17*).

Environmental quality. There is considerable evidence that environmental quality tends to deteriorate as population size and density increase (*18*). This implies either lower environmental quality as a negative component of the quality of life, or higher abatement costs that are reflected in the cost of living. Some indicators of environmental quality, as of the late 1960's, are shown in Table 4.

Crime. Raw crime rates show marked increases with city size, and this is often interpreted to mean that increased city size is a cause, or at least a catalyst, in the commission of crime. However, statistical analysis shows that increases in raw crime rates overstate the risks attributable to size and density (*19*). Other factors, incidentally correlated with but not intrinsically connected to size and density, account for much of their raw data effect. This conclusion is based on regression equations in which crime rates were related to population size, density, and a number of other factors that turned out to be statistically significant. Those other factors included ethnicity [percent black, American Indian, Japanese, foreign-born, and ethnic (with parent or parents foreign-born)], region, July temperature, and a number of demographic and economic characteristics, such as unemployment, crowded housing, and percent primary individuals (persons who live alone or with nonrelatives, only). When those other factors were brought into the relation, the combined effect of size and density on crime rates showed marked decline. Somewhat surprisingly, the effect of density was negative (*20*), and this accounted for part of the reduction; however, the positive effect of size was also reduced after the other factors were introduced. Table 5 shows indexes of crime rates by SMSA population class in terms of observed (actual) rates, and then in terms of size and density effects alone after effects attributable to the other variables have been removed. A statistically significant interaction between percent black and city size occurred in the case of assault and robbery but had important consequences only in the case of robbery, thereby accounting for a substantial portion of the effect of size on that crime. Some evidence (*21*) indicates that the robbery results reflect a well-developed heroin market, which, in turn, appears to be a function of city size, an instance of the benefits (?) of specialization with size. Blacks have much higher heroin addiction rates than whites, addicts are likely to engage in property crime to help pay for their habit, and robbery is the most direct criminal method for obtaining cash. Although crime rates with size and density are considerably reduced by the introduction of other explanatory factors, some residual crime effect may well be intrinsic to city size, beyond any putative effects attributable to stresses inherent in size. In property crimes, at least, a higher cost of living may cause criminals to engage in more crime even though returns per individual crime are probably higher.

Table 4. Indicators of environmental quality as of late 1960's. Level for 100,000 population set at 1.0 for all cases (*18*).

SMSA population ($\times 10^3$)	Air pollutants			Solid waste disposal: relative cost per ton	Probability of major water pollution problem
	Particulates	SO_2	NO_2		
100	1.0	1.0	1.0	1.0	1.0
2000	1.4	2.5	1.3	1.6	1.7
10000	1.6	3.3	1.5	1.8	1.9

A Theory of City Size

The proposition that money wage rates increase with city size can be placed in broader perspective within a theory of city size. The wage relation can be interpreted as corresponding to a long-run supply of labor that faces the individual city. When we make the simplifying, but empirically plausible assumption that the ratio of labor force to population is stable with city size, any population has a corresponding labor force. Obviously, other factors affect the supply relation; high risk of natural hazard or a poor climate should shift the supply function so that workers are paid more for any given population size. Even after some of these factors are taken into account, the effect of size is of primary importance (*11*). Hence, for simplicity, the other factors can be disregarded by subsuming them under the heading of "other things equal."

It is reasonable to hypothesize that different locales vary in the ability to perform urban functions, which are manifested as differences in economic productivity between places. The variation between places can reflect differences in the quality of the natural resource base and in entrepreneurship. The natural resource base includes such natural goods as water supply and the ability of land to support structures, as well as characteristics of location, such as access to national and world trade centers. Entrepreneurship can include the services of both private and public managers—developers and landowners as well as local government officials. The productivity differences are manifested as differences in the demand for labor. Thus, each city has its own demand curve. The varying demand curves of individual cities intersect the supply curve at various points to show corresponding wage and labor force combinations. The distribution of labor forces implies a distribution of city sizes which parallels the distribution of city sizes that is observed empirically. This model essentially is a variation on the theory of the firm of economics, with cities viewed as analogs of firms.

An immediate implication of the model is that there is no one optimal size of city (*22*), but rather that each city has its own optimal size, which corresponds to the equilibrium of its demand with supply. The equilibrium may shift over time. In

some variations of the theory of the firm, with the use of plausible equations to express firm production relations, small differences in productivity can lead to very large differences in equilibrium size. Analogously (*23*), there really may be only minor urban productivity differences between countries with many cities of varied sizes and countries (usually developing countries) with one primate city. The pure primate city is good enough, in terms of productive efficiency, to prevent any rival from being established. Nonetheless, its relative efficiency may be only a little higher than that of the largest city in a country with many rival cities (*24*). A final aspect of the theory is that, after labor and other purchased services are paid for, income generated in urban production is divided between the "residual claimants"—land (covering the natural resource base) and entrepreneurship. The division may well be politically determined.

Population Growth by City Size

Despite higher wages with city size, there has been an inverse relation between city size and the rate of population growth since 1970. Smaller places are growing at a considerably faster rate than larger. The New York City metropolitan area declined in population in both 1973 relative to 1970, and in 1974 relative to 1973, and all of the next eight largest SMSA's except Washington, D.C., lost population between 1973 and 1974. Table 6 shows the inverse relation by presenting SMSA population data for 1970, 1973, and 1974. Table 7 shows the results of testing the inverse relation statistically by relating population, measured as a percentage of the population in a preceding year, to the 1970 population in the census region and to a number of variables, which include individual states, capital cities, three aerospace areas, and new SMSA's (places that have attained the designation since 1971). These variables were found to be statistically significant from among a number tested. Newly designated SMSA's were introduced to avoid a possible statistical pitfall. Such SMSA's are almost invariably small places that have become SMSA's because they have grown faster than other potential places for the SMSA designation. Because those other candidates are not included in the sample, we could overstate growth attributable to small places if the new SMSA variable were excluded. Similarly, regional variables help avoid the attribution to city size of any effects that are primarily regional but happen to be correlated with city size.

In Table 7, the addition of appropriate factors to the base change yield estimated percentages of base year population for specific groupings. Thus, an SMSA of 0.5 million population in Florida is also in the South; its 1974 size as a percentage of 1970 is estimated to be $102.072 - 0.777\ (0.5) + 2.512 + 15.800$, which equals 119.999; therefore, typical growth for that locale is 20 percent.

Table 7 shows that (i) new SMSA's did grow at a faster rate than average; (ii) there are a number of fast- or slow-growing regions; (iii) state capitals (and Washington, D.C.) grew faster than other places of their size, indicating that government is a growth industry; and (iv) aerospace areas (Cape Canaveral and the Seattle-Tacoma region) showed marked decline. When all of these effects were taken into account, the inverse relation with population size was statistically significant in both 1973 and 1974.

A number of hypotheses can be advanced to explain this inverse relation.

Table 5. Index numbers of 1970 crime rates, observed versus estimates as functions of city size and density only (*19*).

SMSA population ($\times 10^3$)	Homicide	Rape	Robbery*	Assault*	Burglary	Larceny	Auto theft
	Raw crime rates (observed indexes, sample average = 100)						
0 to < 250	85	74	62	85	80	89	61
250 to < 500	94	89	67	95	94	91	75
500 to < 1000	100	96	91	96	102	104	120
1000 to < 2500	118	134	152	112	116	115	128
2500 to < 9000	133	154	251	134	126	115	171
9000 or more	138	106	470	178	156	157	200
	Indexes as functions of size and density only						
0 to < 250	96	92	94	104	94	103	73
250 to < 500	96	96	96	97	97	98	86
500 to < 1000	99	98	104	99	105	108	117
1000 to < 2500	110	121	102	101	102	98	119
2500 to < 9000	107	66	117	102	103	80	119
9000 or more	98	65	137	126	136	118	108

*In body of table, percent black-size interactions are not included in indexes as functions of size and density only. When the interactions are included, the indexes are: assault—101, 96, 99, 104, 107, 134; robbery—80, 80, 97, 134, 168, 299. The indexes run from smallest to largest size classes.

Table 6. Population and change in population in U.S. metropolitan areas (SMSA's), 1970, 1973, and 1974 (*40*).

SMSA population ($\times 10^3$) (as of 1970)*	Total population in size class (in millions)			1974 as percent of 1970	1974 as percent of 1973	1973 as percent of 1970
	1970	1973	1974			
0 to < 250	17.650	18.570	18.798	106.5	101.2	105.2
250 to < 500	21.249	22.199	22.470	105.8	101.2	104.5
500 to < 1000	25.665	26.653	26.893	104.8	100.9	103.9
1000 to < 2500	39.579	40.960	41.330	104.4	100.9	103.5
2500 to < 9000	35.700	35.906	35.832	100.4	99.8	100.6
9000 or more	9.974	9.746	9.634	96.6	98.9	97.7

*Size classes are defined on the basis of 1970 population. Thus, an SMSA with population of 240,000 in 1970 and 260,000 in 1974 appears in the 0 to < 250 class in both years. The number of SMSA's in the six classes were respectively: 124, 63, 37, 26, 8, and 1, running from smallest to largest populations, and totaling 259 cases.

1) The general decline in U.S. population growth may have had its strongest impact in large cities. Births relative to population in the 1970 through 1974 period for the size classes of Table 5 were, respectively, .074, .072, .070, .067, .064, and .062, with size classes in ascending order. Historically, there has generally been an inverse association between size of place and birthrate. Economists explain this phenomenon as reflecting the increased costs of rearing children as city size increases (*25*). It is possible that the relation has strengthened in recent years because the use of birth control pills and legal abortion may have come sooner, with greater incidence, in larger cities. There are data that showed marked association between abortion and size of place (*26*). For 1973 and 1974, "the availability of abortion services remained highly concentrated . . . the 12 largest SMSA's provided three-fifths of all reported abortions in 1973" (*26*). Again, the availability of specialized services is a function of city size; and the situation may also support the hypothesis that new technology tends to be introduced first in the largest places and filters down to smaller places over time (*27*).

2) Since 1967, the general price level has risen to 167 percent of the 1967 base, with much of the rise occurring since 1970 (*28*). With substantial inflation, taxes probably increased faster in the North than in the South, and faster in the larger city, as a result of the progressivity built into tax rates (Table 3). Hence, it is plausible that the tax structure has had the effect of intensifying long-term population shifts under way in this country.

3) The construction and substantial completion of the interstate highway system may have made smaller places more accessible and more attractive. This hypothesis has been questioned because construction often succeeded growth (*29*). However, growth may sometimes have been predicated on anticipated construction, so that the relationship may hold despite the observation.

4) Concern about the environment and quality of life has increased in recent years and may well have affected decisions on where to locate. Increased sensitivity to pollution and congestion may have caused [more people] to vote with their feet and move from larger to smaller places.

5) Finally, in a number of large places, public officialdom and selected constituencies may have taken over some of the role of and benefits accruing to landowners and then overpriced the residual share of land rent which they collected. The long run consequence may well be a decline in city population. New York City seems to be an extreme case in point. Rent controls, a residual of World War II, are an obvious example of a transfer from landlords to the tenant constituency; in addition, wages and benefits of municipal workers and payments to welfare recipients, relative to other cities, appear to be above levels that should hold for New York City in view of the estimate of a 9 percent increase in wages per order of magnitude of population; the welfare payment differential is well above the actual New York City differential in the raw wage and income data (*30*). Some transfer of rents from landlords to other interest groups seems to be a general long-term trend in developed economies, although the transfer is sometimes obscured because it involves a shift of property rights, rather than rent. I suggest that in New York City the transfer was probably overdone in terms of the long-term interests of many of the transfer beneficiaries.

If these hypotheses are true, then some future increase in the relative growth rate of large places is plausible provided that there is full diffusion of birth control technology, a slowing down of inflation, the playing out of the impact of the interstate highway system, an improvement in environmental quality; and that the lesson of the New York City experience is heeded.

Policy Implications

Lack of recognition of a compensatory wage differential with city size often results in poor policy decisions and recommendations. Federal agencies have a uniform national pay scale, which can well imply a lower quality of service in the North than in the South and in large cities relative to small ones. Some evidence on postal service efficiency conforms to this suggestion (*31*). Official measurement of poverty distinguishes between farm and nonfarm location, but does not account for differences by city size in cost of living (*32*). Policy recommendations on poverty often seem to be flawed by their neglect of such differences. Moynihan's family assistance plan, for example, may well have come to grief because of the proposed uniform

Table 7. Regression equations explaining recent population changes in metropolitan areas (SMSA's) (*40*).

Independent variables*	1974 as percent of 1970	1974 as percent of 1973	1973 as percent of 1970	Migration as percent of 1970
	Coefficients			
Constant (base change)	102.072	100.139	101.932	−0.917
SMSA population, 1970 (in millions)	−0.771	−0.171	−0.594	−0.598
South	2.512	0.810	1.665	1.287
West	4.301	1.608	2.588	3.812
Sunny West†	8.242	0.908	7.102	6.911
Alaska	11.446	0.332	10.902	6.200
Florida	15.800	3.630	11.324	17.798
Texas	3.047	0.806	2.128	2.005
West Virginia	−5.541	−1.487	−3.971	−3.459
Capitals, including D.C.	2.900	0.466	2.389	2.640
Aerospace areas	−13.540	−2.184	−10.893	−13.769
New SMSA's	3.277	0.376	2.763	3.610
	t Ratios			
Constant (base change)	193.780	686.394	246.279	1.768
SMSA population, 1970 (in millions)	2.619	2.099	2.567	2.063
South	3.178	3.698	2.680	1.653
West	3.526	4.760	2.700	3.174
Sunny West†	5.294	2.106	5.805	4.509
Alaska	2.281	0.239	2.765	1.255
Florida	10.681	8.860	9.742	12.222
Texas	2.592	2.476	2.304	1.732
West Virginia	2.194	2.126	2.001	1.392
Capitals, including D.C.	3.231	1.876	3.387	2.988
Aerospace areas	4.573	2.663	4.682	4.724
New SMSA's	3.407	1.411	3.656	3.813
		$\bar{R}^2$'s		
Explained variance	0.554	0.435	0.552	0.545

*All variables except SMSA population are discrete variables with values of 1 (for appearance) or 0 (for nonappearance) in the relation. A particular SMSA can take on a value of 1 in a number of such variables, for example, Melbourne-Titusville-Cocoa is in the South, in Florida, in Aerospace areas and in new SMSA's. †Includes SMSA's in Arizona, Colorado, Nevada, New Mexico, Utah, Hawaii, and California, except San Francisco, Los Angeles, and SMSA's in the Central Valley.

payments that would give much greater real income to poor people in southern small towns than to the poor in large northern cities (*33*).

Many countries, including Britain, France, Italy, Holland, and Sweden, have implemented policies to limit the growth of large cities, policies that are often rationalized as reducing urban congestion, pollution, and general disamenity of size (*34*). Similar growth policies have been advocated for the United States. The argument neglects the existence of compensation in the form of higher money wages. In addition, redirection of population usually seems to involve inefficient use of resources and loss of freedom. For example, Great Britain put severe constraints on the construction of office buildings in London, thereby driving office rents to extremely high levels relative to other parts of the country. This disequilibrium must have caused losses in national income (*34*).

Redirection from large cities is often supported by a social cost argument, that is, in-migrants impose external costs on others that exceed the benefits to in-migrants. However, new consumers in any market raise prices, and new suppliers lower prices; a policy accounting for such changes by limiting entry can be shown to be equivalent to monopoly. A rationale for national immigration quotas and for support of birth control (which are other forms of limiting entry) may also apply to cities. If current occupants have minimum standards of health, education, and welfare, then entrants who do not pay their way in attaining those standards must have their way subsidized, imposing a financial burden on the current occupants. Those occupants may object, perhaps with justice. However, uniform national standards would make such an argument inapplicable to population distribution within a country.

The recognition that an externality (imposed by immigrants) exists and is a problem amounts to definition of legitimate property rights. However, if the body politic decides that current residents of cities do have legitimate property rights in things-as-they-are with attendant rights to limit entry, then economic efficiency will be improved if such rights can be bought and sold in a way that parallels the markets for tobacco acreage allotments and the right to drive taxicabs in New York City.

Pricing issues also arise as a result of underpricing, or even zero pricing, of scarce resources, as in the case of clean air or access to roads. Many economists have argued that such underpricing will make cities too large (*35*). However, underpricing in one sector causes waste and improper use of resources which reduces income for the system as a whole, which in turn causes some stunting of growth potential. Overuse that can occur with faulty pricing—as in overgrazing on the public domain, or overfishing of common property marine resources—reduces the size of the activity in the long run. Where are the buffalo herds of yesteryear?

There is much to be said for proper pricing of common property resources, particularly by the use of effluent charges. If the benefits of such charges outweigh the costs, then the likely effect is that large cities will grow larger. They will become more attractive, both in the sense of being more pleasant places in which to live, and in the sense of inducing an inflow of population. The costs imposed by the system of charges should cause some downward shift in the demand for labor; but the improvement in the quality of life will mean that compensatory payments will fall. This downward supply shift should exceed the demand shift when benefits exceed costs, which should result in increased city size (*36*).

Many decry the distribution of population that emerges through the free play of the market (*34*), but the evidence suggests that the market usually is an effective way of implementing location preferences, both between and within locales (*37*). Because the benefits of some forms of information cannot be fully captured by private developers of such information, a case can be made for public support of experiments in alternative urban forms and patterns if there is good feedback of information, particularly when the experiments fail. Growth policy in practice has been distinguished by an almost complete absence of such feedback (*34*). More generally, however, the problems of the cities tend to be conditions inherent to size and density that are offset by higher wages, or are common property malallocations best handled by effluent charges, or are problems of race, class, and poverty that are best addressed by "investment in human capital" (*38*), rather than by the ineffective or counterproductive "quick-fix" of population redistribution.

Summary

As cities increase in size, so do wage rates for the same work. There is evidence that the wage differential is persistent and stable over time, which suggests that the differential does not arise from a lack of adjustment that is in process of correction. Indeed, there is an inverse relation between size and growth rate. Large metropolitan areas with high wage rates have been losing population in recent years, which is hardly a sign that their higher wage rates are temporary inducements to workers to move into those cities. It is much more plausible that the differential is a more-or-less permanent money payment that compensates urban residents for costs they bear as population size increases. This argument does not deny that there are nonwage benefits as well as costs of city size, that city size effects may vary between individuals and groups, or that there may be scope for improved policy on population distribution. Nonetheless, the benefits of size seem to be outweighed by the costs; all types and groups of people generally can and do move about until alternative locations are less attractive than their current location; and solutions to population distribution problems will often emerge as by-products to the solutions of more basic problems.

References and Notes

1. Density depends on form of transportation system as a causative factor, as well as on city size. However, there is a positive empirical relation between city size and density in every U.S. region, despite regional variations in reliance on the automobile [I. Hoch, "Income and city size," *Urban Stud.* **9**, 308 (1972)].
2. There is a considerable literature on the trade-off between rent and transportation. See, for example, R. Muth, *Cities and Housing* (Univ. of Chicago Press, Chicago, 1969); E. S. Mills, *Studies in the Structure of the Urban Economy* (Johns Hopkins Univ. Press for Resources for the Future, Baltimore, 1972).
3. Some studies purporting to find a negative effect of size or density on health and welfare include those of L. Levy and H. Visotsky [*Urban America: Goals and Problems*, Joint Economic Committee, 90th Congress, 1st session (1967), R. C. Schmitt [*J. Am. Inst. Planners* **32**, 38 (January 1966], H. H. Winsborough [in *Social Demography*, T. R. Ford and G. F. DeJong, Eds. (Prentice-Hall, Englewood Cliffs, N.J., 1970)], and O. R. Galle, W. R. Gove, and J. M. McPherson [*Science* **176**, 23 (1972)]. Many of the results in the last study showed no significant relation between pathology and density.
4. J. L. Freedman, *Crowding and Behavior* (Viking, New York, 1975), p. 177.
5. L. Srole, a sociologist, states: "Studies have shown a direct correlation between the size of cities and the tempo at which people live. The bigger a city . . . the faster the tempo. . . . People are more in a hurry. They don't like to wait" [*New York Times*, 25 June 1971, p. 3]. M. H. Bornstein and H. G. Bronstein found that pedestrians walk faster the larger the city, with pedestrian locomotion rate increasing with log of city size [*Nature (London)* **259**, 557 (1976)].
6. O. D. Duncan develops some empirical evidence in *Pap. Proc. Regional Sci. Assoc.* **5**, 105 (1959). The argument is extended by D. R. Cox [thesis, Stanford University, Stanford, Calif. (1969)].
7. Parallel studies include those by V. R. Fuchs [*Differentials in Hourly Earnings by Region and City Size, 1959* (Occas. Pap. 101, National Bureau of Economic Research, New York, 1967)], W. Alonso [*Regional Sci. Assoc. Pap.* **26**, 67 (1971)], W. D. Nordhaus and J. Tobin [*Economic Growth, Fiftieth Anniversary Colloquium V* (National Bureau of Economic Research, New York, 1972)], O. Izraeli, [thesis, University of Chicago, Chicago (1973)], and J. R. Meyer and R. A. Leone [paper presented at the Conference on Public Policy and the Quality of Life in Urban Areas, New Orleans, 2 to 7 January 1975].

8. I. Hoch, in paper presented at the conference on Public Policy and the Quality of Life in Urban Areas.
9. U.S. Bureau of Labor Statistics, *Area Wage Surveys*, individual metropolitan areas, annual, 1966, 1969, and 1970.
10. Calculated on the basis of regression equations fitted to cost-of-living data in U.S. Bureau of Labor Statistics, *Autumn 1971 Urban Family Budgets* (News Release USDL-72-240, 1972).
11. I. Hoch with J. Drake, *J. Environ. Econ. Manage.* **1**, 268 (1974).
12. Calculated on the basis of regression equations fitted to per capita income data in *Surv. Curr. Bus.* **49** (May 1969); *ibid.* **51** (May 1971); *ibid.* **54** (May 1974).
13. Calculated on the basis of data in U.S. Bureau of Economic Analysis, Regional Information System, "Migration matrix," 18 January 1973.
14. U.S. Bureau of the Census, *Congressional District Data Book, 93rd Congress* (U.S. Government Printing Office, Washington, D.C., 1973); *Congressional District Data, 94th Congress* (U.S. Government Printing Office, Washington, D.C., 1974), for California, New York, and Texas. Sample size: 434. Data are based on information in *1970 Census of Population*.
15. To obtain the percentage change in income per order of magnitude of population, divide the coefficient for log "metro" population in Table 2 by average income $3081.561.
16. Regression equations that relate indexes of per capita income and all federal taxes to SMSA population and to the South show that the tax index increases faster with population than does the income index. The U.S. average value = 100 for each index; data is for fiscal year 1972 (*17*).

Independent variable	Income index	Federal tax index
	Coefficients	
Constant	50.75	32.05
Log population	18.90	25.04
South	−8.53	−9.66
	t ratios	
Constant	7.48	3.28
Log population	8.09	7.45
South	4.81	3.79
	$\bar{R}^2$'s	
Explained variance	0.48	0.41

17. Calculations were made on the basis of data in *Federal Tax Burdens in States and Metropolitan Areas* (Tax Foundation, Inc., New York, 1974), tables 13 and 15, pp. 18–30, 32–34. Per capita income figure for the United States was set at $4325, on the basis of data in *Surv. Curr. Bus.* **53**, 25 (May 1973); *ibid.* **54**, 6 (May 1974).
18. I. Hoch, in *Population, Resources and the Environment*, R. Ridker, Ed. (Commission on Population Growth and the American Future, 1972), Research Reports, vol. 3; in *Transport and the Urban Environment*, J. G. Rothenberg and I. G. Heggie, Eds. (Macmillan, London, 1974).
19. I. Hoch, *J. Urban Econ.* **1**, 184 (1974).
20. Similar results for population size and density were obtained for the probability of urban riots in the 1960's [R. F. McNown and L. D. Singell, *Ann. Regional Sci.* **8**, 1 (1974)].
21. E. T. Fujii [*J. Urban Econ.* **2**, 181 (1975)] states that "addict crime has risen to the point that in major urban centers police attribute half or more of all property crime to addicts." See also D. J. Mulvihill and M. M. Tumin, *Crimes of Violence*, (Staff Report, National Commission on Causes and Prevention of Violence, U.S. Government Printing Office, Washington, D.C., 1969), vol. 2; R. L. DuPont and M. H. Green, *Science* **181**, 716 (1973); G. F. Brown, Jr., and L. P. Silverman, *J. Am. Stat. Assoc.* **69**, 595 (1974); L. G. Hunt, *Am. J. Public Health Suppl.* **64**, 16 (1974); Executive Office of the President, *Special Action Office Monograph 5* (19 October 1974).
22. A review of positions taken on the question of a magic number for city size appears in P. Goodman [in *Urban America: Goals and Problems*, Joint Economic Committee, 90th Congress, 1st session (1967)]. A. Downs notes that there is considerable agreement among urban experts favoring a metropolitan area size of about 250,000 to 300,000, adding that this is "not a scientific conclusion but a strictly sentimental opinion" [testimony before Commission on Population Growth and the American Future, (13 July 1971), p. 9]; A. Spilhaus [*Science* **159**, 710 (1968); *Daedalus* **96**, 1129 (Fall 1967)] advocates an optimum city size of around 250,000.
23. I. Hoch, in *Urban Problems and Public Policy Choices*, J. Bergsman and H. L. Wiener, Eds., (Praeger, New York 1975).
24. For discussion of primate cities, see *International Encyclopedia of the Social Sciences* (Macmillan, New York, 1968), vol. 12, pp. 373–374. Montevideo is an example of the class; see E. Griffin [*Geogr. Rev.* **63**, 500 (197→ C. A. Vapnarsky [*Econ. Dev. Cultural Change* **17**, 584 (1969)] discusses primacy versus the "rank-size rule."
25. M. Friedman, *Price Theory* (Aldine, Chicago, 1962), p. 210.
26. The Alan Guttmacher Institute, *Family Plann. Perspect.* 7, 224 (1975).
27. A. R. Pred [*The Spatial Dynamics of U.S. Urban-Industrial Growth, 1800–1914* (MIT Press, Cambridge, Mass., 1966)] argues that innovation and invention are positively related to both city size and growth rate. The diffusion by size argument appears in W. R. Thompson [in *Issues in Urban Economics*, H. S. Perloff and L. Wingo, Eds. (Johns Hopkins Univ. Press for Resources for the Future, Baltimore, 1968)].
28. *Mon. Labor Rev.* **98**, 101 (1975).
29. G. V. Fuguitt and C. L. Beale, *Population Change in Nonmetropolitan Cities and Towns* (Agricultural Economics Report 323, U.S. Department of Agriculture, Washington, D.C., 1976).
30. In 1969, average public assistance income in New York City relative to the average of 97 SMSA's was 1.88, while relative income per capita was 1.25; (*8*). In 1972, M. Friedman argued that "because so large a part of the voting population already consists of city employees and welfare recipients," New York City would not cure its "city disease," which he identified as local government spending [*Newsweek* **79**, 96 (20 March 1972)].
31. For a 5-week period in late 1972 and early 1973, the percentage of next day delivery of mail was as follows: national, 80 percent; South, 89 percent; New York City, 69 percent [P. Kihss, *New York Times*, 18 February 1973, p. 1].
32. The poverty level is defined by the Social Security Administration poverty thresholds adjusted for changes in price levels; the poverty level for farm families is set at 85 percent of that for nonfarm families. H. Kahne, *J. Econ. Lit.* **13**, 1271 (1975).
33. D. P. Moynihan, *The Politics of a Guaranteed Income* (Random House, New York, 1973), pp. 352–356; review of Moynihan [P. Passell and L. Ross, *New York Times Book Review Section*, 14 January 1973, p. 16].
34. J. L. Sundquist, *Dispersing Population* (Brookings Institution, Washington, D.C., 1975).
35. G. M. Neutze, *Economic Policy and the Size of Cities* (Australian National Univ. Press, Canberra, 1965); J. Spengler, *Natl. Resources J.* **7**, 367 (1967); J. M. Buchanan, *Am. J. Agric. Econ.* **51**, 1033 (1969); G. S. Tolley, *J. Urban Econ.* **1**, 324 (1974); G. S. Tolley and J. Gardner, paper presented at AAAS meeting, Boston, 18 to 24 February 1976.
36. My argument disregards distributional questions that can affect political feasibility of proper pricing. (i) The interests of current residents may not coincide with the interests of the people who would reside in the city if the change were implemented. (ii) The relatively poor might bear more costs and obtain fewer benefits than the relatively rich. Initially, this could limit population growth or even reduce it, even though the city increased its spending for labor. But ultimately, multiplier effects of the increased spending would probably increase population. Both factors may explain why effluent charges and urban toll roads have had limited application in practice.
37. E. S. Mills and F. M. Peterson present the case for the market in the context of urban sprawl [*Am. Econ. Rev.* **65**, 267 (1975)].
38. See the seminal works of T. W. Schultz on investment in human capital.
39. U.S. Department of Commerce, *Surv. Curr. Bus.* **51** (May 1971).
40. Source of data: U.S. Bureau of the Census, *Current Population Reports, Series P-25, No. 618* (January 1976).
41. I thank J. Drake, who served as research assistant.

NEWS AND COMMENT

Kronid Lyubarsky: The Soviet State Tries to Unmake a Scientist

While one Viking analyzes the surface soil of Mars and another circles the planet in search of a landing site, a man who more than most would love to follow the spacecrafts' progress is unable to do so.

He is Kronid Lyubarsky, an astrophysicist and astrobiologist who has made a special study of Mars and contributed to the Soviet attempts to explore the planet.

Lyubarsky is in prison, where he is serving a 5-year sentence for having helped distribute the journal of the Russian civil rights movement and other self-published literature. His case is of particular interest because of the tenacity with which he has tried to continue his scientific work while in prison, and because of the state's efforts to deny him the right to call himself a scientist.

The state's latest move is an expedient that even Orwell never thought of, a proposal to revoke Lyubarsky's scientific degree. It is not known whether VAK, the Highest Certifying Commission, has acted on the proposal, which came before it a year ago, but at least three other scientists are reported to have had their degrees revoked. "VAK, apparently, does not understand," Lybuarsky noted in a statement which was written from prison on 1 October last year and has just now become available, "that a scientist can indeed be demoted from the ranks of his peers, but it is not within its power to do so, fortunately."

Lyubarsky's trial, held from 26 to 30 October 1972, took place behind closed doors after those who wished to attend had been evicted from the courthouse.