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Author

Alonso, William

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THE SYSTEM OF INTERMETROPOLITAN POPULATION FLOWS

William Alonso

Institute of Urban and Regional Development
and
Department of City and Regional Planning
University of California
Berkeley, California

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The system of locations and population sizes of our metropolitan areas reflects the numbers and composition of our population, our economic activity, the distribution of our resources, including those regarded as amenities, our technology, our beliefs, our laws, direct and implicit policies at all levels of government, and our history. At any one time, such as the present, this system may be thought of as a pattern of elements, varying in size and composition, distributed in space. Over time this system evolves through the flows of people, ideas, capital and authority, adjusting to new forces and developments. But it is not a system in instantaneous equilibrium, as in the usual economic models of the market. It is a viscous system, infused with history, where the various adaptive flows proceed at different rates, some at the pace of molasses, some at that of lightning. The result is in a system in a rolling equilibrium, always in some sort of balance, but never balanced.

There are too many variables, most of them poorly defined, and too many relations, too few of which are known, to be able to construct an image of this system as a whole by piecing together its microcomponents. Rather, we must search for macro-relations, for systematic regularities at a higher level of abstraction. These higher-order relations might allow us a graspable picture of the whole, even if it is only a simplified diagrammatic one, much as Boyle's Law described regularities in the behavior of gases without reference to the mechanics of Brownian motion among the particles.

The pages that follow will present some preliminary findings about the dynamics of the system of metropolitan areas in the United States

based on empirical regularities and on some behavioral interpretation of these regularities. In addition some observations on policy for such an urban system will be offered.

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The Rising Importance of Intermetropolitan Migration

The evolution of the demographic structure of the American metropolitan system has been the result of three forces: (1) migration into the system from non-metropolitan areas and from abroad; (2) natural increase in each of the metropolitan areas; and (3) migrations among the metropolitan areas. As the first two decline in importance, the third comes to dominate.

Migration from non-metropolitan areas and from abroad plays a shrinking role in metropolitan growth. The rate of migration to all metropolitan areas has declined from 21 per 1000 inhabitants per year in the first decade of the century to less than 5 in 1960-1965.¹ Migration's share of total metropolitan growth declined over this same period from 70% to less than 30%, and it is now apparently about 20%. In other words, the intermetropolitan population system has become more closed, and changes in the structure will accordingly respond more to its internal dynamics and less to external forces.

The second source of population change is also on the decline. The annual national rate of natural increase has dropped from 1.5% in 1955 to about 0.8% currently. And, although the coming of age of those born in the baby boom which followed World War II may push the birth

¹W. Alonso and E. Medrich, "Spontaneous Growth Centers in Twentieth Century American Urbanization," Working Paper No. 113, Institute of Urban and Regional Development, University of California, Berkeley, January 1970, p. 8. It appeared from preliminary 1970 Census reports that the present rate is less than 4 per 1000 inhabitants per year.

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rate slightly upward for the next several years, those rates which are adjusted for population composition continue to decline. Thus, while it is a risky business to predict the child-bearing habits of Americans, it is clear they have been having babies at a lessened rate and the prospects are that the rate will decline yet further.

Since the turn of the century each metropolitan area has been able to count on a decennial population increase of between 20 and 30% from migration from outside the metropolitan system and from natural increase. Migration among metropolitan areas made for marginal adjustments in the rate of growth of diverse metropolitan areas, but the substantial cushion of natural increase and migration from outside the metropolitan system made rates of population growth relatively similar, with few exceptions, throughout the metropolitan system. But now, with the cushion provided by the traditional forces shrinking rapidly, intermetropolitan flows become all important to the growth or decline of population in diverse metropolitan areas.

The rising importance of intermetropolitan migration will increase certain long-term trends which have been in operation since the turn of the century. Between 1960 and 1965, 60 metropolitan areas, which accounted for 25.1% of all metropolitan population, drew immigrants at at least twice the rate of the metropolitan system as a whole, and accounted for 48.6% of all metropolitan growth. They also accounted for 109% of total migration into the metropolitan system, which is to say that the remaining 152 metropolitan areas lost migrants in the net. Although 34% of the 101 metropolitan areas below 250,000 population were fast growing by this definition, they captured only 10.7% of all metropolitan

growth, with the lion's share of metropolitan growth being taken by larger fast growing areas. But historically the proportion of small metropolitan areas which have attracted migrants at twice the overall metropolitan rate has been increasing, as has the proportion of overall metropolitan growth captured by all the fast growing metropolitan areas. Turning to the other side of the ledger, whereas only 18 of the 212 metropolitan areas as defined in 1960 had net outmigration during 1900 to 1910, 82 of them did in 1960-65.²

The per cent of metropolitan areas which lost population through outmigration in 1960-65 was about 45%, both for those below 250,000 as for those above that figure; and it even holds for the 20 largest metropolitan areas, 9 of which had net outmigration. Thus, although 91% of all metropolitan areas have grown in population in the last decade, it does not take much imagination to see that the drying up of immigration into metropolitan areas as a whole will increase the number of net migratory losers and the extent of the net loss; and that this, together with the decline in the rate of natural increase, might result in some 60 to 80 metropolitan areas (not central cities) actually losing population by 1980, with many others achieving stationary populations. Viewed another way, national population stability will result in considerable instability among the metropolitan elements.

The Pattern of Intermetropolitan Flows

In the context of the preceding discussion, I will present some preliminary findings of ongoing research into the patterns of intermetropolitan migratory flows. The data is based on a 25% sample of

² Figures from Alonso and Medrich, op. cit.

the United States population in the 1960 Census, whereby the 1955 residence of people was established. The Census reported³ the gross flows only among the largest 100 metropolitan areas, but indications are that the findings presented below apply throughout the metropolitan spectrum. Considering that the populations of metropolitan areas vary by 3 orders of magnitude, and that gross migration flows vary by 4 orders of magnitude, our coefficient of multiple determination (R^2) at .82 is quite satisfactory. Examination of residuals of various sorts indicates that our findings are unbiased in terms of the variables considered. Further information on the statistical aspects is offered in the Statistical Appendix. In the following pages is a summary of some of our findings, but the reader is reminded that not only are they preliminary, but that "findings" in this type of research are reasonable numerical answers obtained by reasonable methods to what appeared to be reasonable questions. They are not directly observed facts, but rather complicated inductions.

The basic approach was to compute a logarithmic multiple regression in which the migratory flow from one metropolitan area to another was related to local conditions in the metropolitan area of origin, to local conditions in the metropolitan area of destination, to the distance between them, to an aggregate measure of all the opportunities in other metropolitan areas available to a migrant from the metropolitan area of origin, and to a measure of the competition he might find from other migrants at the metropolitan area of destination. Local conditions at

³U.S. Census of Population, 1960, Final Report, PC(2)-2C, Mobility for Metropolitan Areas.

origin and destination correspond to the classic push and pull forces of migration, while the other two variables (alternative opportunities and competition) are systemic variables.

Perhaps our most surprising finding was that local conditions at the origin did not affect the rate of outmigration, counter to general expectations. In other words, there was no push. Aside from population, of which more will be said below, the variables considered at the origin were mean per capita income, weather (in degree days), and growth in the previous decade. We had expected that high income would retard migration and low income accelerate it. But income at origin was not a statistically significant force. Even more, our findings consistently show a slight positive association between income and outmigration, which is the reverse of a low-income push. From discussions in the literature, we knew that the national population has been moving towards temperate climates, and thus we expected that a cold climate at the origin might be associated with a high rate of outmigration. But climate at origin failed to appear as a significant factor, which signals that people do not seem to be fleeing cold weather (although it will be noted below that those migrating seem to be attracted to warm weather). Finally, from the literature, we knew that places that had been growing would have a high proportion of recent migrants, who are typically young and therefore still in an age of high mobility, and of chronic movers, regardless of age.⁴ We have found that growth

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P.A. Morrison, "Population Movements and the Shape of Urban Growth: Implications for Public Policy," Working Note-7497-CPU, The Rand Corporation, Santa Monica, Calif., June 1971. Prepared for the National Commission on Population Growth and the American Future. This also provides a useful survey of detailed studies of migration.

in the previous period is positively associated with the rate of out-migration. That is to say, that fast-growing areas have a higher rate of out-migration than slow growing ones, because they have larger pools of potential migrants. Similarly, in a regression equation which is a slight variant from that on which we are generally reporting, we found a clear and strong association between the rate of out-migration and the proportion of young people 15 to 29 years old. But this is not, of course, a push in the sense that poverty or harsh climate would have been.

Of course, our surprise at the absence of push factors was not complete. Lowry had obtained equivalent results on the same body of migration data using, instead of income, wages and unemployment as measures of local conditions,⁵ although not including either previous growth (or population composition) or climatic variables. In our own work, when unemployment at origin is included, it fails to relate to the rate of out-migration; we have already reported that income at origin has, if any, a slight positive association with out-migration. Similarly, Lansing and Mueller, working with other bodies of non-metropolitan data, had found that the rate of out-migration from economically distressed areas did not differ from those of other areas, even after taking into account such variables as age and education.⁶ Thus our findings are in accord with recent empirical research.

⁵I. S. Lowry, Migration and Metropolitan Growth: Two Analytical Models, Chandler Publishing Co.: San Francisco, 1966.

⁶John B. Lansing and Eva Mueller, The Geographic Mobility of Labor, Ann Arbor, Survey Research Center, Institute for Social Research, 1967, pp. 292-294.

Yet two grounds for doubt must remain before rejecting push factors. In the first place, not only common sense but a great deal of detailed data suggests that individual migrants are to a large degree responding to their economic conditions, and that therefore unfavorable local conditions accelerate out-migration. For instance, the interstate annual mobility of males who have been fully employed in the previous year is 3.1%, while that of those who did not work is 13.1%.⁷ One would therefore expect that areas of high unemployment would have higher out-migration; yet our findings and those of others are to the contrary. Similarly the mobility rates differ sharply among whites and blacks, white and blue collar workers, and so forth. Such micro-data is hard to reconcile with these macro findings.

The other reason to doubt the finding that push factors play no role is its very importance. National policy in this country and in others has been based on population-maintenance programs for depressed areas and smaller settlements. Their implicit theory has been that people are being forced to leave areas of reduced economic opportunities, and that programs of local economic stimulation can halt this outflow. If the no-push finding is correct, these population-maintenance programs will not slow the outflow. Even if they are successful, they will maintain population levels by drawing new migrants to these areas, while the original inhabitants continue to leave. Obviously, this may keep the numbers from going down, but it is quite a different matter from enabling

⁷U.S. Bureau of the Census, Current Population Report, Series P-20, No. 210, January 15, 1971.

the original population to remain, since, in effect, it would amount to drawing additional population to labor surplus areas. It might still be argued that this policy would be justified because those leaving the area are the younger, the more energetic, and the better educated, and that the incoming migrants would replace this yeast. But it appears that this is not so: migrants into distressed areas resemble those who stay (older, less educated) rather than those who leave.⁸

Should this no-push finding be correct, therefore, it would turn on its head most of our policies dealing with distressed areas and profoundly affect more general population distribution strategies. The very importance of these consequences and the apparent counter evidence of detailed surveys suggest that policy must be circumspect on this issue and that research must be urgently focused on this question.

Before abandoning this most important issue, it is necessary to report that our findings appear to deny one counter-argument to a no-push finding. It has been argued recently⁹ that, while the rate of in-migration into an area will respond to its economic well being, the rate of out-migration depends on at least two factors: 1) the level of local ill-being, so that the rate of out-migration should correlate negatively with local income and positively with unemployment, and 2) the size of the pool of potential out-migrants, so that the

⁸Lansing and Mueller, op. cit., p. 319.

⁹C. L. Beale, "The Relation of Gross Outmigration Rates to Net Migration," Economic Research Service, U.S. Department of Agriculture, mimeo, undated.

rate of out-migration will be higher for those areas which have attracted a large pool of the young and the chronic movers. These two effects would run counter to each other and thus their joint effect might be U-shaped, with highest rates of out-migration for the poorest and the fastest-growing areas, and lower rates for intermediate ones.

According to this argument, Lowry's tests look exclusively for one type of effect (income and unemployment) but neglects the other (population composition¹⁰). Such a test might run a horizontal straight line as a best fit through a U-shaped distribution, and thus find no effect. But in our study we have included variables, however limited, for both effects, income and unemployment for local economic conditions, and previous growth and age composition for the pool of potential movers. Our negative findings somewhat strengthen the no-push conclusion, because both types of variables were given a chance.

The number of migrants leaving an area is slightly less than proportional to the local population. A metropolitan area twice the population of another will have only 89% more outmigrants. It is almost as if an urban area were a radioactive body, emitting particles at a steady rate regardless of such local conditions as heat or vibration. The number of particles is slightly less than proportional to the size of the body because, with increasing size, an increasing proportion of the particles is trapped within the body on their way out. Thus, the slight decline with size of the rate of out-migration might be interpreted as a reflection of a greater likelihood in larger cities that some of the pool of potential migrants find their opportunities at home.

¹⁰ Which is examined in detail in some of Lowry's other models.

The number of migrants arriving at the destination, neglecting for the moment the distance between origin and destination and the systemic variables, is almost proportional to the population size and to local conditions there. If we consider the population at the destination as a measure of the number of opportunities available to the migrant at that location, it might be expected that the flow of migrants might be proportional to the destination population. It is slightly less than proportional: a metropolitan area twice the size of another one will attract only 81% more migrants. This suggests that migrants may be somewhat put off by urban size, so that the range of opportunities is somewhat discounted against this negative preference. Conversely, had we found that flows of immigrants increased faster than population at destination, this would have supported a "bright lights" interpretation of pull forces on migrants.

Although we suggest different interpretations for the less than proportionality to population at origin and destination, it is worth noting that the near coincidence of these two rates means that, all other things being equal, the flow of migrants in either directions between a big and a small city would be nearly equal, and perhaps slightly in favor of the smaller area. In other words, the pattern of flows within the metropolitan system is neutral with respect to urban size per se, and there is no basic trend towards larger metropolitan areas.¹¹

¹¹The finding of less than proportionality to size at both origin and destination suggests that the total number of migrants would increase if more of our population were in smaller urban areas. This makes a rough sort of sense, in that smaller areas offer fewer job alternatives and career opportunities and are more prone to local cyclical effects, so that migration as an adaptation to normally changing circumstances should occur more frequently.

Contrary to the no-push finding, pull forces are very strong: local conditions at destination unequivocally affect flows. Using mean per capita income as a measure of economic attractiveness, we find that a 1% rise in income, all other things being equal, increases in-migration by 2.2%, although below we shall see that this increase is not fully realized. This finding is extremely important because, however aggregate and imperfect a measure, per capita income in a region is a variable which can be modified by public intervention, whether by direct taxes or subsidies or by the more accepted techniques of categorical aid programs, procurement preferences, etc. It is the handle by which in our later work we hope to examine alternative policies and objectives.

We also consider climate at destination, since many have argued that people and enterprises are becoming more footloose and seeking warmer climates. We have used degree days, which measures the amount of heating needed in a year for personal comfort. We might have included also, or instead, the number of hours of sunshine or the number of inches of rain, but even this roughly defined hedonistic quality-of-life variable enters quite strongly and confirms that Americans are seeking warmer climates. It is worth emphasizing, however, that the failure of this variable at the origin means that

they are not fleeing colder climates. Rather it argues that a person who is moving heads to a warm place in preference to a cold one.

Other things being equal, our model says that people head towards places that are growing fast. This variable was originally introduced into our model as an indicator of the pool of young people and chronic movers at the origin, in the expectation (confirmed) that previous growth at the origin would correlate positively with the total number of out-migrants. It was incorporated at the destination for reasons of symmetry, and scores positively there beyond reasonable doubt. Two interpretations, not mutually contradictory, suggest themselves. The first is that migrants regard not only the present population size of a place as indicating the number of opportunities available there but that they also look at the growth rate as an indicator of the number of opportunities being generated. The second interpretation is based on the effect of informal networks whereby early immigrants send the glad news back home and encourage their friends and relatives towards the same destinations. Both of these interpretations may be true, but in either case, this finding suggests that a policy of alternative growth centers might well consider a strategy of sequential encouragement of growth in a few centers at a time to achieve higher growth rates, by raising local incomes by whatever means, rather than a strategy of encouragement of growth in many centers, each of which would accordingly have a slower growth.

The attractive pull of one metropolitan area on the people of another is attenuated by distance, so that more migrants may go from a given area to a nearby, small, relatively low income metropolis than to a large prosperous one which is more distant. Thus, although our data is exclusively for metropolitan areas, this finding supports the possibility of an alternative growth center strategy. But the parameters indicate that these centers must be of substantial size. To illustrate, a metropolis of 2,000,000 inhabitants 1,000 miles away will exert the same pull as a metropolis of 200,000 inhabitants 100 miles away, all other things being equal.

Thus far the discussion has stressed conditions at the origin or the destination and the distance between them, as if migration among each pair of cities depended on just these things. But it is necessary to consider overarching relations in the system of cities. A migrant about to depart has over 200 metropolitan areas from which to choose, and migrants from more than 200 origins compete for the opportunities at any destination. The last two variables on which we will report address these systemic questions.

The alternative opportunities available to a migrant are represented in our model by the total of the attractive pulls of each of the other 211 metropolitan areas, each attenuated by the intervening distance. The basic idea is that the flow from one place to another is proportional to the relative attraction of the destination.¹² This is indeed the case, with an important qualification.

¹²D. L. Huff, "A Probability Analysis of Shopping Center Trading Areas," Land Economics, February 1963.

Our findings show that the total number of migrants leaving an area is also directly related to the total opportunities available.¹³

This may be interpreted as a pull-out affect, whereby the rate of outmigration rises with the number of temptations open to a prospective migrant. This is confirmation of the adaptive and developmental nature of migratory flows. It may be noted that, according to this finding, a policy of alternative growth centers would not only redirect migration flows, but would also increase their overall volume by increasing the number of options available to those who now have few.

Whereas we have thus far considered the relative attraction of specific destinations and the general attractiveness of the system from the point of view of migrants from a metropolitan area, our last variable measures competition at the destination as a repulsive force. Competition constitutes a negative systemic feedback, which sets the pull of a destination against the total number of migrants from all sources that would head towards that destination if there were no competition. In behavioral terms, it supposes that a potential migrant has a prior sense of how many others will be seeking the same opportunities, and that he adjusts his behavior accordingly. An alternative or complementary interpretation is that, since the Census asked where people had been living five years earlier, in areas of great competition some of the people who arrived and were disappointed in their expectations have returned to their origin or moved on to other areas during the intervening years. No simple numerical value can be given for

¹³The evidence is that the exponent of total opportunities has an absolute value smaller than 1. For the simple Huff-type proportionality to hold the exponent would have to be -1.

the strength of this counterforce, but it indicates that a policy of too-rapid growth would run into sharply diminishing returns. This negative feedback, together with the positive advantage of growth mentioned earlier, argues that a policy of growth centers must be mindful of the interplay between size, rate of growth, level of inducements, and the number of centers. Too few centers brought along under hot-house conditions might be grossly inefficient; too many centers with lukewarm support might be ineffective.

We also have preliminary findings for two other equations that relate to the system of metropolitan areas. First results are encouraging concerning the distribution of non-metropolitan and foreign migration to metropolitan areas, based on an equation similar to the relative attraction portion of the inter-metropolitan migration. The main difficulty here is the poor quality of the data, which we have had to reconstruct through complex procedures which inevitably introduce substantial error. Our preliminary findings show high statistical significance but considerable predictive error.

The second associated relation is that between per capita income and urban size, based on a cross section of data, in which our preliminary findings are that a doubling of population is associated with a 8% increase in per capita income. This finding is highly significant statistically, but it must be noted that the relation accounts for only a fraction of variation in metropolitan incomes.¹⁴

¹⁴W. Alonso, "The Economics of Urban Size," Papers of the Regional Science Association, Vol. XXVI, 1970.

This is not surprising, given the broad variety of resources, conditions, histories, and a thousand other variables by which metropolitan areas differ from each other.

We may now sketch the complex effects of the policy of subsidy to a designated growth center where the subsidies have raised local per capita income by 1%. The effects and counter effects are:

- 1) The rise in income increases in migration by 2.2%;
- 2) The rise in immigration increases population size, so that the center increases in attractiveness (with population) in the subsequent period;
- 3) The increase in the rate of growth (as distinct from size) also increases the attractiveness in the subsequent period;
- 4) The increased growth rate increases the migratory pool and therefore the rate of out-migration;
- 5) The increase in population size reduces slightly the rate of out-migration;
- 6) The increase in population size raises income slightly, in turn increasing immigration;
- 7) The rate of migration from other places to other centers is reduced slightly, especially for nearby ones;
- 8) Overall rates of migration, however, are increased slightly, especially in nearby populations;
- 9) The potential increases of immigrants increase competition at the growth center and generate counter forces which reduce the overall effects.

The complexity of these effects and counter effects, especially the last three, make it appear unlikely at this time that simple analytical procedures can be established to estimate net effects. Rather, it is our hope to establish them numerically in our subsequent work for each metropolitan area and potential growth center. This involves in each case very large numbers of calculations to determine the systemic effects, and must await the completion of the elements of the model. However, within the correctness and accuracy of the model, it should yield information as to the magnitude of effort involved in alternative population policies and rough measures of cost-effectiveness for each potential growth center. The general strategy, then, is to simulate the set of metropolitan areas as a population system. The simulation may be run forward to, say, the end of the century without policy intervention to establish the outcome of laissez-faire, either as an exercise in prediction or to establish a base-line against which to evaluate policy. It is our intention also, however, to use it to test the consequences of proposed policies and, conversely, to search for effective policies for specified objectives. We will use as our policy or control variables changes in per capita income in each metropolitan area. These would stand in a highly aggregated way for changes in subsidies or taxes to those areas.

Since the worth of such an exercise depends on the accuracy of the simulation, a sense of its power and its limits is important. Our findings account for 82% in the variation in the migration flows among metropolises, which is a strong result. While the prediction of individual flows carries considerable error (one third of our predicted flows will be off by more than 50%), large and therefore

important flows are predicted much better. Further, when the more than 200 flows in each direction are aggregated for each metropolitan area, considerable cancelling of error may be expected, so that the prediction of total immigrants and outmigrants by metropolitan area will be much more accurate than the prediction of pair-wise flows. It must be stressed, however, that it is not our intention or our claim to provide a set of population projections for every American metropolis. Our model is too simplified a picture, and a myriad of factors which we do not consider will affect the development of particular areas. Rather our intent is to gain a sense of the future development of the system of metropolitan areas as a whole and to evaluate the consequences of alternative policies of population distribution at a very generalized level.

Summary

Summary of Policy Considerations

Several policy considerations were mentioned in the body of this paper. They are tentative because not only is our work incomplete at this time, but because any model of a very complex reality can present only a partial and highly generalized picture. Yet several conclusions emerge:

1) There is no fundamental pull toward larger urban areas, but there is a significant pull toward higher incomes. The flow toward larger cities is a response to their higher incomes. A national policy of alternative growth centers would be feasible through programs that transferred money (for investment or directly for incomes) to designated centers. However, generally speaking, a redistribution of population toward smaller centers would lower total national income to some degree. The model is silent, of course, as to the social, political, or ecological consequences of such a choice.

2) The centers whose growth is to be encouraged must be of some substantial size to affect flows significantly. Although the model does not offer a minimum threshold, it suggests that the commonly cited populations of 250,000 to 500,000 provide a plausible floor. Relatively more isolated locations require relatively larger sizes for comparable effects, while mild climates require relatively smaller sizes. The model does not suggest maximum sizes for centers where growth is to be induced. However, it throws light on the reasons for the high rates of growth of secondary centers within megapolitan agglomerations, and indicates that growth is there most easily induced.

3) Because of a complex web of positive and negative secondary effects, too slow or too fast a rate of induced growth will be either

ineffective or inefficient. Our work is not sufficiently advanced to specify efficient rates of induced growth, although these would vary with the size and other characteristics of the centers. It does appear that a policy which tried to induce growth in too many centers at once would be inefficient, as would one that put too many resources into too few centers. Our work suggests that, if a long-run national policy of alternative growth centers is to be pursued, sequential sustained concentration in a limited number of centers of substantial size would be most effective.

4) Although our data applies to existing cities, but if our parameters apply to the development of new ones, the model indicates that substantially more effort is needed to attract a given population to a new location than to direct it to an existing center.

It should be understood that, in drawing these conclusions concerning the best strategies to achieve a national policy of relative population dispersal to alternative growth centers, we are not thereby endorsing such a policy. We have noted that it would be likely to reduce national income, and its consequences with respect to equity among social groups, to quality of life, and to environmental aspects are at best poorly understood. Rather, our comments are instrumental should such a policy be adopted.

5) The drying up of the pool of potential urbanizing migrants and the sharp decline in the birth rate will result in an overall decline in the rate of population growth of the nation's urban areas. The migratory flows among urban areas promise that a decade or so from now about one third of the metropolitan areas (not just their central

cities) will be losing population in absolute numbers. Although we have had two centuries of experience of the problems of urban growth, we have very little of the problems of population decline in large urban areas. It is recommended that research funds and programs be directed to focus the attention of researchers and decision-makers to the issues of metropolitan population decline, so that early warnings, intelligent diagnosis, and clear-headed programs and policies replace rhetoric, confusion, and ad hoc actions for this future crisis which is clearly on the horizon.

6) A fundamental question of particular importance for national policy addressed to distressed areas remains unanswered and should be made an issue of first priority for research. The question is whether the rate of out-migration from an area is responsive to unfavorable economic conditions. Much research, including our own, suggests that it is not; other research and general opinion holds that it is. This issue underlies virtually all aspects of the discussion of a national distribution policy, and affects the diagnosis of the problems, the setting of the objectives, and the design and operation of programs amounting to billions of dollars. It should therefore not be treated casually as just one more question of intellectual interest. A positive and substantial program of research should be directed to finding the answer.

STATISTICAL APPENDIX

We are experimenting with a great many variations of the basic relations. Our crudest models and our most complex ones share the same coefficient of multiple determination ($R^2 = .82$), the choice among them being based on theoretically-based evaluation of critical coefficients, principally those of O_i and C_j under alternative definitions. The variant presented here is representative.

$$M_{ij} = \frac{e^{-9.1} P_i^{.89(25.6)} g_i^{.79(1.9)} P_j^{.81(15.6)} g_j^{3.1(7.5)} y_j^{2.2(4.9)} h_j^{-.26(3.4)}}{d_{ij}^{.87(26.6)} O_i^{.54(5.4)} C_j^{.91(8.8)}}$$

where,

$$O_i = \sum_j \frac{P_j^{.89} g_j^{3.1} y_j^{2.2} h_j^{-.26}}{d_{ij}^{.87}}$$

$$C_j = \sum_i \frac{P_i^{.89} g_i^{.79}}{d_{ij}^{.87}}$$

$$R^2 = 0.83 \quad \text{Standard error of estimate} = 0.77$$

Numbers in parentheses are t values; the smallest (that of g_i) is significant at the 0.03 level.

The variables are:

M_{ij} = gross flow of migrants from metropolis i to metropolis j between 1955 and 1960.

P_i, P_j = 1955 populations in i and j respectively.

g_i, g_j = ratio of 1955 to 1950 population in i and j respectively.

y_i, y_j = per capita income in 1955 at i and j respectively.

h_i, h_j = degree days at i and j respectively.

d_{ij} = great circle distance between i and j, in kilometers.

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11. The finding of less than proportionality to size at both origin and destination suggests that the total number of migrants would increase if more of our population were in smaller urban areas. This makes a rough sort of sense, in that smaller areas offer fewer job alternatives and career opportunities and are more prone to local cyclical effects, so that migration as an adaptation to normally changing circumstances should occur more frequently.
12. D. L. Huff, "A Probability Analysis of Shopping Center Trading Areas," Land Economics, February 1963.

13. The evidence is that the exponent of total opportunities has an absolute value smaller than 1. For the simple Huff-type proportionality to hold the exponent would have to be -1.
14. W. Alonso, "The Economics of Urban Size," Papers of the Regional Science Association, Vol. XXVI, 1970.