NET MIGRATION
IN
SELECTED CENSUS TRACTS OF BOSTON, MASS.

by
Henry Sucher

Submitted in Partial Fulfillment
Of the Requirements for the Degree of
Master in City Planning
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Head of Department
Thesis Adviser
Author's Signature

Department of City and Regional Planning
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Cambridge, Massachusetts
May 16, 1952

Professor Frederick J. Adams
Department of City and Regional Planning
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Cambridge, Massachusetts

Dear Professor Adams:

I herewith submit a thesis entitled *Net Migration in Selected Census Tracts of Boston*, in partial fulfillment of the requirements for the degree of Master in City Planning.

Respectfully,

Henry Sucher
Acknowledgments

I should like to express my thanks and appreciation for their assistance and cooperation to the following:

Professor John T. Howard, M.I.T.

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Mr. Leon Pollard, without whose able cooperation the method for computing net migration could not have been evolved.

To my wife, Cobi, and to Mrs. John Geiger for their help in the final presentation.

Henry Sucher
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NET MIGRATION IN SELECTED CENSUS TRACTS OF BOSTON, MASS.

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Submitted for the degree of Master in City Planning in the Department of City and Regional Planning on May 16, 1952.

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Introduction:

The primary purpose of this thesis is to seek relationships between net migration and various other factors in neighborhood sized areas of large central cities, which will make more accurate population predictions for such areas possible. At present migration is usually the component of population change about which forecasters and planners are least certain.

Natural population change (i.e. the difference between number of births and number of deaths) which is the other factor in population change has fairly well known relationships to the progress of medical science, to cyclical economic fluctuations, and to the type of people inhabiting an area. Especially concerning death rates rather accurate predictions are possible nowadays, largely perhaps because of their significance for the life insurance business.

For cities as a whole rough predictions of net migration can be made from an examination of their economic base and outlook, as was done for New York, for example, by the Regional Plan Association¹. But the question still remains, how large a part of the labor force will live in the city itself.

This leads directly to the problem of decentralization. We know that we can expect much slower growth - if not actual decline - in the central areas as compared to the environs of large cities. We do not generally know, however, what areas of the central city lose most heavily, or why they do. It is hoped that some of the more important causal factors will be brought to light by this inquiry. But even if no actual causal relationship can be established, it is still desirable to find certain conditions whose presence or absence in a given area will stimulate or retard, as the case may be, decentralization activity. For the purpose of prediction, correlation rather than causation, is important.

The decade of 1930 to 1940, which was chosen as the period of study, was one of relatively slight decentralization activity, due to the great depression. The correlation coefficient obtained therefore tend to underemphasize rather than overstate the existing relationships.
I. General Description of the Study

A. The Need for Determining and Predicting Net Migration

Net migration\(^1\) for neighborhoods or other subdivisions of a city must be predicted in many different situations in order to make valid planning possible. For many of these purposes future age distribution of the population is also very important, so that a forecast by age groups is often needed. A sound program of school construction for instance is inconceivable if such estimates are not available; the same holds true for recreation facilities.

Any long range housing market analysis has to work with population forecasts, taking into account future family sizes and ages of individuals. Density standards, zoning and many other planning principles and tools must take population as one of their starting points.

The embarrassment which the task of predicting migration causes planners is illustrated by a statement in a recently published general plan of a large city. It says that since migration is not subject to direct forecast, this influence was not included in the calcula-

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\(^{1}\) Net migration is the difference between total in-migration into an area and total out-migration from it; net in-migration is positive (+), net out migration is negative (−).
tions of future population.

But even the ability to compute past net migration for small areas is an important asset. For it is possible to draw fairly sound conclusions from past experience about net migration in the future by taking into consideration

1) Wider (e.g. national, regional) trends in both the migration picture and the economic situation

2) Changes in local conditions which are likely to affect migration trends (this is one of the reasons why it is important to know what local factors actually show a correlation with net-migration).

B. Methodology

The general outline of the method used consists of four steps:

1) Net migration between 1930 and 1940 for twenty-eight selected census tracts in Boston was computed.

2) Factors to be examined for their relation to net migration were tabulated.

3) Coefficients of correlation were calculated between 1. and 2.

4) Some measure of interpretation of findings was attempted.
A somewhat more detailed discussion of the methods and procedures used will reveal many of the problems encountered in setting up the study.

The first step was to select the sample census tracts\(^1\). Since at first mainly social and housing conditions in general were thought of in relation to net migration, the tracts were chosen with the aim of getting a wide range of housing qualities for each type of social condition and vice versa. Wide geographic distribution within the city was desired, but a somewhat more intensive study of one larger area was thought potentially useful, and five contiguous tracts in East Boston were therefore included. The first difficulty appeared at this early stage: nearly all census tracts in West Roxbury and Hyde Park had been split into two or three between 1930 and 1940, making it practically impossible to use them because of the added statistical work this would have involved. The geographic distribution of the sample tracts is therefore far from satisfactory, and the outlying sections are rather poorly represented (see chart 7).

It may be of interest that no tracts were found

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\(^1\) It is realized that census tracts are by no means ideal neighborhood units, but they were the only units of the size wanted for which presumably accurate population data were available.
in which social conditions were relatively good while housing conditions were poor; the converse situation however was found in several cases.

Calculation of net migration in the sample tracts was part of a regular staff assignment at the Boston City Planning Board, and was done jointly by Mr. Leon Pollard and the writer. However, during the writing of this thesis certain changes were made in the method. For the 0 - 9 age group an entirely new and more practical as well as more accurate way of calculating migration was found. All net migration figures and correlations were revised accordingly. For a detailed description of the methods by which net migration was computed see Appendix.

The procedures and sources used in tabulating the factors which were correlated with net migration will be described in the sections dealing with each factor.

C. Limitations of the Study

Since this is essentially a pilot study, it is not easy to judge the extent to which the findings are typical in any general way. The empirical investigation is limited to one central city and one decade, neither of which may be an adequate sample to permit generalized conclusions. As a matter of fact, the decade between 1930 and 1940 was in some respects the least "normal" period in American History to that time. Also, Boston,
more than most other large cities, lacks large quantities of vacant land suitable for residential development, a fact which may influence the migration picture somewhat.

No adequate theoretical framework was available for a study of this type. Therefore, intuition had to be used to a considerable extent in deciding what factors should be examined for possible correlation with net migration. Some factors, such as transportation facilities or prestige value, could not be used because of their not readily quantifiable nature.

Because of the form in which the information was available, only a five point scale was used in tabulating some of the factors. This probably reduced their correlations in comparison to those for which a continuous range of figures was available (e.g. excess density versus average monthly rent).

Last, but not least, the entire study is based on net migration figures experimentally evolved for a specific purpose and a certain set of given data. This method is in some respects an improvement over those generally used in the past, but it also contains several minor shortcomings and inaccuracies, the importance of which cannot be gauged from this investigation. (These shortcomings are mentioned in the appendix).
CHART 1: NATURAL POPULATION CHANGE

$r = .63$
II. Correlation with Factors

A. Description and Discussion of Factors

1. Natural Change in Population

Coefficient of Correlation (r) = 0.63 (see Chart 4). This relatively good correlation of natural increase with net out-migration seems entirely reasonable: since there is very little land suitable for residential development available in most of the areas under examination, any increase in the population causes a spill-over into other parts of the city or the metropolitan area. Conversely, where the population is decreasing due to low birth rates, excess population from other areas can be attracted and absorbed.

Since most of the areas examined had an excess of births over deaths, the outward trend of migration was fairly general. Four of the five tracts with natural decrease showed inward migration, while twenty of the twenty-three areas with natural population increase lost population due to migration. On the average the loss in population due to out migration amounted to between one and one and one half times as much as the gain from natural causes. This ratio, if confirmed by further research could be used to predict not only net-migration, but total population change quantitatively.

1. The figures for natural population changes were obtained in the course of net migration calculations.
For Boston as a whole, natural population increase between 1930 and 1945 was 11.8%. Since total net out-migration in the sample tracts was about 10% for the decade of 1930 - 40, it can be assumed that the net out-migration from 1930 - 45 was between 12 and 18%, which corresponds to the ratio.

This ratio between natural and migratory population change will vary in all probability according to the city and the period under examination, but there is no reason why an average ratio cannot be found in each case by testing some areas in the community and then using the ratio for prediction. Changes in national and regional trends will have to be considered, and their effects estimated. If natural change in population actually is the most important influence causing decentralization, as seems to be indicated by this study, questions of great significance arise.

Is the trend towards disappearance of complete families with children from the central portions of metropolitan districts irreversible? Or could it be stemmed by redevelopment on a scale large enough to improve the environment in these areas thoroughly? If this is not possible, redevelopment for either non residential uses or efficiency and other small apartments will probably be indicated.

Experience to date seems to indicate that families with children can be attracted to large, centrally located redeveloped residential areas (e.g. in New York City) but the extreme housing shortage may have been responsible for this. Tentative plans currently being prepared by the Boston City Planning Board also take this trend into consideration and anticipate that approximately 2/3 of the families to be housed in Boston's cleared redeveloped areas will consist of one or two persons.1

There is a close connection between this correlation and the net migration picture by age groups. The people in their thirties have the largest numbers of children, and are also the heaviest out-migrants. The areas with few families in this group therefore show little decentralization as well as low birth rates.

1. Actual population in the 0-9 age group decreased by 10-30% in most sample tracts between 1930 and 1940.
CHART 2: AVERAGE RENT

$r = .63$
2. Average Monthly Rent\(^1\)

\[ r = .63 \] (High rent correlates with in-migration, low rent with out-migration)

This correlation, while equally high as the previous one, is somewhat more difficult to explain. Rent is a rough index of both quality of housing\(^2\) and economic status of the inhabitants. Seen in terms of housing quality, it is somewhat surprising that average rent shows a higher correlation with net migration than any of the other housing indices tested. The relation of rent to the economic status of tenants and to fluctuations in both general economic and specific real estate market conditions probably tends to make this a relatively less reliable indicator of net migration, especially over longer periods of time. For these reasons less reliance should be placed for the time being on this correlation than on the previous one.

By comparing 1934 rents with those of 1940 it was found that the few tracts which showed an appreciable rise in rent\(^3\) during that period also had a preponderance of inward migration during the decade. The other three


2. A study (not published to date) by J. E. Baril of the Boston City Planning Board shows a correlation of .81 between low rent and lack of private baths, and of .94 between low rent and lack of central heat.

tracts with net in migration showed no significant change in rent between 1934 and 1940, which was in line with the general pattern.

Percentage of change in average rent between 1934 and 1940 is listed for all sample tracts in table 1B.
CHART 3: EXCESS DENSITY FOR HOUSING TYPE

\( r = 0.55 \)
3. Excess Density for Housing Type
   \[ r = 0.55 \] (see Chart 3).

Five classifications of excess density were used:
1) Not below desirable density standards.
2) Exceeding desirable density by not more than 50%.
3) Exceeding desirable density by 50 - 100%.
4) Exceeding desirable density by 100 - 200%.
5) Exceeding desirable density by more than 200%.

This relatively good correlation confirms the belief that the search for less crowded conditions is an important motivating factor in the decentralization movement. It indicates too, that while people have different preferences concerning the type of housing they like to live in, they are also able to distinguish decent conditions from overcongested ones. The high percentage of out-migration in the 0 - 9 age group from the most densely built up areas indicates that many families are primarily concerned with providing a good environment for their children. The availability of recreation areas, both active and passive, which is closely related to this factor was not tested, as it is not easily quantifiable.

1. Figures for this factor were obtained by inspection from a map of the Boston City Planning Board, showing by what percentage the density in each block exceeds those given as desirable by A.P.H.A. for various housing types. The blocks in each tract were visually averaged for purposes of this study.
CHART 4: CROWDED DWELLINGS

r = .54
4. **Room Crowding**

\[ r = 0.54 \] (see Chart 4)

This factor is rather closely related to natural change in population as well as to excess density. It would appear that this yardstick would measure the unfavorable results of overcrowding on the individual family more accurately than excess density for housing types. Therefore, it could be argued, the correlation with out-migration ought to be higher. On the other hand it is possible that each family, primarily due to its particular socio-cultural background, develops a certain "crowding tolerance" (that of the Italian immigrant families in Boston's North End being rather high, for instance). When the size of the household increases beyond that tolerance due to natural increase, the family, or at least parts of it, finally move out. In any case, the fact that both measures of congestion show a significant correlation with out-migration, confirms beyond doubt the importance of this motive for decentralization.

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1. Percentages of dwelling units with more than one occupant per room were taken from the *Boston Real Property Inventory, 1934, Vol. II.*
CHART 5: HOUSING PENALTY SCORE

% of net mig.

r = .53
Combined Housing Penalty Score

\[ r = 0.53 \] (see Chart 5)

Three items, all equally weighted, are contained in this housing score: median monthly rent, physical condition of dwelling structures, and percentage of structures built before 1900. A score of one indicates very good conditions, a score of five indicates poor conditions on all three counts. The relatively encouraging results of this correlation led to the breakdown into individual housing factors almost identical with those comprising the combined index, in order to determine the relative significance of specific housing factors.

There are many more factors which determine the over-all quality of housing, which could not be tested here. The A.P.H.A. method for determining the adequacy of housing, for instance, would be a more satisfactory index, and might show a better correlation with net migration.

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1. The figures were taken, with some further condensation, from Mr. Leon Pollard's B.C.P. Thesis, M.I.T., 1950.
CHART 6: COMBINED SOCIAL INDEX

\( r = 0.46 \)
6. Social Factors Ranking

\[ r = 0.46 \text{ (see Chart 6)} \]

The figures used to indicate social "quality" of the various tracts are purely relative, having been obtained by dividing the city in five fifths according to their ranking. These rankings were compiled by "neighborhoods", each of which coincides fairly well with an average of two or three census tracts. The tracts in the best fifth were assigned the score of one, and so on. Sixteen different factors were taken into consideration in compiling the rankings, all with equal weight:

Crowding, density, median rent, advanced schooling, median year of school completed, percentage of foreign born population, juvenile court appearances, cases of the Mass. Society for Prevention of Cruelty to Children, Dependent Aid cases, Old Age Assistance cases, Aid to Dependent Children cases, unemployment, infant mortality, new T.B. cases, T.B. deaths, age adjusted death rates (all are rates rather than absolute figures, where applicable).

There is a certain amount of duplication with factors which were separately correlated with net migration (especially involving housing factors); some of the factors also are not strictly of a social nature, although admittedly they may have social implications. Since the original figures for individual indices were not available the entire group was used as described above.

1. Figures from records of United Community Services.
7. **Need for Major Repairs.**\(^1\)

\[ r = 0.34 \]

The figures listed in the data sheet (Table I) for this factor represent percentages of structures either in need of structural repairs or unfit for habitation. This is first correlation coefficient which is not statistically significant, i.e. it could be accidental.

The depression may be partly responsible for this low correlation, by forcing people to move into or stay in slum areas where many structures were in poor condition. This same line of reasoning may apply to many of the other housing and environmental factors.

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1. Figures taken from *Boston Real Property Inventory*, 1934.
8. **Average Duration of Occupancy of Rental Units**

\[ r = 0.20 \]

The Real Property Inventory lists duration of occupancy of the occupied rental dwelling units as of 1934; those durations were assumed typical for the entire decade, and the duration in months was computed in the following manner:

<table>
<thead>
<tr>
<th>Duration of Occupancy (R.P.I.)</th>
<th>Average Duration Assumed</th>
<th>Number of Rental D.U.</th>
<th>Units x Dur.</th>
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<tbody>
<tr>
<td>0-5 mos.</td>
<td>3 mos.</td>
<td>58</td>
<td>58</td>
</tr>
<tr>
<td>6-11 &quot;</td>
<td>9 &quot;</td>
<td>81</td>
<td>243</td>
</tr>
<tr>
<td>1 yr. (to 2 yrs)</td>
<td>18 &quot;</td>
<td>171</td>
<td>1027</td>
</tr>
<tr>
<td>2 yrs. &quot;</td>
<td>30 &quot;</td>
<td>144</td>
<td>1440</td>
</tr>
<tr>
<td>3-4 &quot;</td>
<td>48 &quot;</td>
<td>145</td>
<td>2322</td>
</tr>
<tr>
<td>5-9 &quot;</td>
<td>90 &quot;</td>
<td>151</td>
<td>4530</td>
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<tr>
<td>10 &quot;</td>
<td>180 &quot;</td>
<td>98</td>
<td>5880</td>
</tr>
<tr>
<td>unknown</td>
<td>disregarded</td>
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Total rental d.u. 901

<table>
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<tr>
<th>Units x Dur.</th>
<th>16 x 3 48 mos</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14,500 ÷ 901 = 16</td>
</tr>
</tbody>
</table>

Again the Back Bay tracts are the outstanding deviants from the expected pattern, thereby reducing the coefficient of correlation considerably.

---

1. Figures computed from *Boston Real Property Inventory, 1934*.
NET MIGRATION IN SAMPLE TRACTS

CHART 7

SCALE IN MILES

- BOSTON -
UNITED STATES CENSUS TRACTS
1940
9. **Distance from City Center**\(^1\)

No Correlation

Undoubtedly the lack of correlation is in part due to the almost complete absence of really outlying tracts among the sample. This, as mentioned earlier, could not be avoided, since most tracts in the southwestern part of the city were split between 1930 and 1940, so that census figures are not comparable. The very irregular shape of the city of Boston also is probably working against such a correlation, since it has distorted the growth pattern, which in cities with regular topography is, however imperfectly, concentric, at least in the early stages.

---

1. Figures in miles, obtained from Chart 7, with center arbitrarily assumed at Haymarket Square.
10. **Percentage of Dwelling Structures Forty or more Years of Age**

No Correlation

Conceivably forty years is too low an age to be regarded as critical in a city as old as Boston. It is also recognized that many other factors besides chronological age influence the obsolescence of a neighborhood. Nevertheless the complete absence of correlation was somewhat of a surprise. It certainly does not mean that this factor will in no case show any correlation with net migration.

In many centrally located areas there is a population increase about the time the district is converted to rooming house uses, which generally happens after it has been built up for a good many years. The fact that large parts of the Back Bay were at that stage of development during the thirties probably counteracted whatever correlation would have otherwise existed.

---

1. Figures from *Boston Real Property Inventory*, 1934.
11. Percentage of Owner-Occupied Dwelling Units\(^1\)

No Correlation

The fact that the highest percentage of ownership is only about 35% shows that no single family areas of better quality are included among the sample tracts. Since such areas could be expected to show the least decentralization, the lack of correlation is not too surprising. The Back Bay tracts also ran counter to the pattern here, showing very low percentages of owner occupancy and a definite in-migratory pattern.

\(^1\) Figures from Boston Real Property Inventory, 1934.
<table>
<thead>
<tr>
<th>CENSUS TRACT</th>
<th>NET MIGRATION</th>
<th>1934-40 CHANGE IN Nº OF D.U.</th>
<th>1934-40 CHANGE IN AVER. RENT</th>
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<tbody>
<tr>
<td>A 1</td>
<td>+134</td>
<td>+45</td>
<td>+20</td>
</tr>
<tr>
<td>A 2</td>
<td>-102</td>
<td>+11</td>
<td>-30</td>
</tr>
<tr>
<td>A 3</td>
<td>-200</td>
<td>+04</td>
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<td>A 4</td>
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</tr>
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<td>A 5</td>
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</tr>
<tr>
<td>C 3</td>
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<td>E 2</td>
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<td>+83</td>
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<td>H 1</td>
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<td>J 4</td>
<td>+30</td>
<td>+138</td>
<td>-112</td>
</tr>
<tr>
<td>J 5</td>
<td>+21</td>
<td>-25</td>
<td>-15</td>
</tr>
<tr>
<td>K 2</td>
<td>+40</td>
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B. General Discussion

1. Changes in the Number of Dwelling Units

Apart from tract K 3 where large scale conversion to smaller dwelling units and rooming houses took place, the count of dwelling units showed few significant changes between 1934 and 1940. In predicting net migration for any area, the expected change in the number and type of dwelling units should of course be considered. Where the change is only in number, the percent of net migration ought to be somewhat close to the percent of change in dwelling units. Where a change in type is involved too, this is not the case however. In tract K 3 for example the net in-migration amounted to 20%, while the number of dwelling units was more than doubled between 1934 and 1940. The 1930 census did not list dwelling units by tracts which is the reason why 1934 and 1940 figures were used. It is believed, though, that the changes between 1930 and 1934 were relatively unimportant. The percentage changes between 1934 and 1940 in the number of dwelling units for the sample tracts are listed in Table 1B.

1. In tracts C 3 and R 1 the number of dwelling units fell by 28 and 24 percent respectively.
2. The Influence of Non-Residential Land Use

In six of the twenty eight sample tracts the predominant land use was non-residential.¹ These six tracts showed an average net out-migration of approximately 16%, as compared to 9.9% for all sample tracts. In most of these cases very little encroachment by other uses on residential land took place during the decade. This indicates that a relationship exists, although it does not reveal anything concerning its nature. No correlation was calculated between land use and migration, since exact data were not available.

¹ From Boston Income and Cost Survey, 1935.
3. **The Back Bay Tracts**¹

As mentioned earlier, the Back Bay area underwent a fundamental change in character during the early thirties. This confused the net migration picture in these tracts, since a conversion from a high grade single family area into a rooming house district not only changes the age distribution of the population thoroughly, but results in a decided net increase in total population. The shift in age composition consisted mainly of a sharp decrease in the number of children and a corresponding increase in the young adult and old age groups. Generally there are many contradictory and variable elements present in areas of this type, which make the prediction of net migration more difficult.

¹ Of the sample tracts, the following are located in what is known as the Back Bay: J 4, J 5, K 2 and K 3.
<table>
<thead>
<tr>
<th>CENSUS TRACT</th>
<th>NET MIGRATION</th>
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<tr>
<td></td>
<td>0 - 9</td>
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<tr>
<td>A1</td>
<td>+ 131</td>
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4. The Cycle of Migration; Migration by Age Groups

Sociological theory states that young adults from rural areas move into the city, often living at first in the rooming house areas. Later they move into more stable residential areas. After they are married and start a family they move out into the suburbs if they are successful enough economically to be able to afford it. (This particular phase explains the sharp outward trend among children under ten years of age). After the children marry and perhaps either husband or wife are widowed, he or she moves back to the central area. The average migration in the sample tracts by age groups (see chart 8) reflects this picture quite accurately.

Some residential areas of the city, such as the Back Bay, are predominantly "centralization areas", while most of the more stable residential districts are decentralization areas.

In the better areas from an environmental point of view there are generally people willing to move into the dwellings vacated by this process. In the poorer ones, where no replacements can be found, this movement shows up to its full extent as net-out-migration.

Cyclical variations blur this picture to some extent, but, judging from this study, not enough to make
it unrecognizable. It appears that both centralization and decentralization activity are increased during prosperous times and inhibited during depressed eras.

During recent decades the influx of rural population into the large cities has slowed down to a trickle. This probably explains in part the predominance of out-migration over in-migration, especially since decentralization still seems to be gaining momentum.

The migration pattern found in this study with respect to age group apparently continued with very little change through the following decade. A paper\(^1\) dealing with net migration in Boston during the forties, describes an age distribution of migrants very similar to that found for the sample tracts in this study.

"The decreases are in two specific groups:

1) The very young; i.e. boys and girls between the ages of 0 and 9.

2) The middle-aged group; i.e. men and women between the ages of 30 and 65."

"The increases may also be classified into two distinct categories:

CHART 8: AVERAGE NET MIGRATION BY AGE GROUPS

<table>
<thead>
<tr>
<th>Age</th>
<th>0-9</th>
<th>10-14</th>
<th>15-19</th>
<th>20-24</th>
<th>25-29</th>
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<th>35-39</th>
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1) Young people between the ages of 10 and 29, consisting primarily of young girls (men between 15 - 19 and 25 - 29 indicate slight losses).

2) Old men and women over 65 years of age."

The only differences between the above and the findings of this study are: the twenty-eight sample tracts showed slight out-migration in the 10 - 14 group. Also, the age groups were not broken down by sex in this calculation.

The percentages of migration in each tract by age group are listed in Table 1A, and the average migration by age groups for all sample tracts is shown graphically in chart 8.
5. The Role of Decentralization and Centralization

It is unfortunate that practically nothing is known about the origins and destinations of migrants. Such knowledge would indicate much more clearly what part of migration can be ascribed to decentralization and concentration. As this study is designed, there is no way, for instance of separating people who move into (or from) the suburbs from those making inter-state or inter-regional moves. Thus a variety of forces influencing migration could not be isolated, so that their quantitative effects were not measurable. The only thing which can be done under the circumstances is to assume that inward and outward movement of other types cancel each other, so that what remains is "concentrated" decentralization and centralization.
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III. Conclusions

A. Summary

Eleven correlations were performed between net migration and various housing, social, economic and environmental factors; the following coefficients of correlation were obtained:

1. Natural population change: .63
2. Average monthly rent .63
3. Excess density .55
4. Room crowding .54
5. Housing penalty score .53
6. Social factors ranking .46
7. Need for major repairs .34
8. Duration of occupancy .20
9. Distance from city center none
10. Age of structures none
11. Owner occupancy none

The first five of these correlation coefficients are significant at the 1% level\(^1\), the sixth one is significant only at the five percent level, and 7 through 11 are not statistically significant.

The Data Sheet, Table 1, may be referred to for a complete listing of all the figures used in the correlations.

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1. i.e. it can be stated with 99% certainty that the correlation found was not due to accident or faulty selection of the sample.
B. Methods Suggested in Applying Results of this Study

The correlation coefficients obtained in this study show that at least six factors have a definite relationship to net migration.

In order to predict net migration for a given area, it is therefore advisable to test these factors both for the degree of their presence or absence, and for their trend.

If net migration is wanted for just one area of a community, it will generally be more practical to work with trends. Working by incidence would require the study of other districts for purposes of comparison, in a way similar to the procedure followed here with the sample census tract, but will probably give more accurate results.

With either method past net migration should be computed first, and city and regional as well as national trends should be considered in determining what changes can be anticipated.

Changes in average rent which are out of line with the general pattern, changes in the number and kind of dwelling units, changing land use patterns, changing population are all factors which should be examined for their influence on the migration picture.
Comprehensive study of migration in a whole city will in most cases yield more accurate results, even for specific small areas, than isolated examination of such sub-areas, since the element of relativity and comparison can be utilized only over wider areas.

The method for calculating net migration will have to be varied from the one here described depending on the availability of better, poorer, or similar data, and the accuracy of the results will vary accordingly.
C. Evaluation

While the correlation coefficients here obtained are not high enough to permit accurate quantitative forecasts to be made on their basis alone, they should be quite helpful if used in conjunction with other information as outlined in the previous section (III B).

Even if the correlations were considerably higher, one single pilot study would not be reliable enough to permit general application of results without further research.

Among the factors which in this study showed no statistically significant correlation with net migration, some may very well have such a relationship in general, though it was obscured by special conditions in this particular case.

Further data are needed on the time dimension of migration trends, in order to determine whether conditions in one decade will permit prediction of migration during the succeeding decade.

The overall significance of this study lies more in the new approach it points to for population prediction and computation than in the specific information it conveys regarding the migration picture in Boston between 1930 and 1940.
D. Suggestions for further Research

It was stated earlier that the same or similar correlations would have to be performed for other cities and other periods in order to test the universality of the findings here obtained. Apart from this, several questions came up during this investigation, which for one reason or another, could not be adequately resolved, but which seem well worth investigating:

1. Are net migration trends in areas of various sizes of sufficient duration to base their prediction on conditions in an earlier period?

2. What influence do cultural and ethnic factors in the population exert, both on the net migration pattern, and on the sensitivity to certain correlated factors?

3. What influence do additional factors, such as changes in employment sources, ease of access, traffic conditions, social reputation of the area, changes in social or ethnic composition of the population etc. have on the migration pattern?

4. To what extent do city, state or nationwide migration trends correlate with and influence local trends?

5. What effect do cyclical economic fluctua-
tions exert on migration trend in areas of various types?

6. What influence do planning measures and controls of various types have on the migration pattern?

7. Can adequate explanations be found for the deviation of some areas from the normal pattern of correlation?

8. What can be learned from correlation of migration in specific age groups with other factors?

9. How are additional deaths distributed among age groups and sexes in areas which have higher death rates than the city as a whole?

10. Can normative ratios be set up between natural increase and out-migration for specific communities and specific periods?

11. Would the change or trend in the factors which were correlated with net migration perhaps be more significant than their incidence?
E. Specific Conclusions

1. The net-migration picture in the sample tracts was dominated by decentralization and centralization according to age groups.

2. The city was divided into decentralization areas with net out migration, and centralization areas with net in-migration.

3. Family growth was the most important factor in out-migration. This conclusion is supported by the good correlation with factor 1 and by the higher fertility rate of out-migrants.

4. Families with growing children were leaving the central city area if they were able to afford it. The question remains whether this trend can be stopped by redevelopment.

5. Poor living conditions cause decentralization probably to a greater extent than high taxes and similar considerations.
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<th>1940 census population</th>
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<th>10 yr. city surv. rates</th>
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**TABLE 2: SAMPLE CALCULATION**

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**Note:** The calculations for net migration are not fully described in the table provided.
Appendix:
Computation of Net Migration

This was by far the most time consuming and troublesome part of the investigation, primarily because no satisfactory method was available. The procedure finally adopted was corrected and modified several times during the process of its evolution, and, as described here, should be regarded as an initial effort rather than a finished product.

The objective was to calculate, as accurately as possible, net migration by census tract and age groups, from the following given data:

- Population in 1930 by age group;
- Population in 1940 by age group;
- Actual number of births for each year of the decade;
- Actual number of deaths for most years of the decade (but not broken down by age group);
- City wide fertility rates;
- City wide survival rates.

The following method finally appeared to be most satisfactory for this purpose: (see sample calculation, Table II.)

a) 1930 census population
b) 1940 census population
c) 1935 (average) population
d) Five year (1935-1939) city wide survival rates

e) Five year hypothetical cumulative deaths (1935-39) in tract: d) applied to c)

f) Ratio between actual deaths ($\Sigma D_a$) and hypothetical deaths in tract ($\Sigma D_h$) established, to be used in calculating 1940 survivors in the tract.

g) Ten year city survival rates.

h) Tract deaths during decade, if city and tract rates the same.

i) Tract deaths during decade (where tract rate different): city rate times ratio of actual to hypothetical deaths applied to 1930 population.

j) 1940 survivors in tract above ten years of age (a-i, carried forward by ten years)

k) Difference between actual births in tract during decade and census count for 0-9 age group doubled, giving net migration in that age group.

m) Net migration for other age groups equals

\[ j - b. \]

---

1. All survival and fertility rates taken from population study of Boston City Planning Board, with adjustment where necessary for differences in time period covered.

2. Hypothetical, as used here, means according to city wide rates.

3. Death rate = 1000 - survival rate.
Step k requires some explanation: it is based on the assumption that migrants have half their babies in the tract, half of them outside; since both out-migration and birth rates were generally higher during the first half of that decade, the inaccuracy introduced by this assumption should be quite small in most cases.

By comparing the net migration figures obtained by the above method with those arrived at by a method involving the assumption that migrants had the same fertility rates as non-migrants, it was discovered that such an assumption would have introduced an important error. The fertility rates of out-migrants were in most cases considerably higher than those of non-migrants in the same tract. This confirms the close correlation found between natural population change and net migration.

One point to be kept in mind when interpreting the net migration figures by age groups is this: The actual age of the migrant is up to ten years lower than appears from the tables, since they show the age at the end of the decade, while migration took place at any point during the decade.

Generally the assumption that births, deaths and migration are evenly distributed throughout the period is implied in the method used here for computing net migration, although in this particular case the inaccuracy is reduced as explained in connection with step k above.
Finally, it should be noted that all percentages of net migration are based on the average natural population for the decade i.e. the average between 1930 census population and 1940 expected survivors.
Bibliography


Income and Cost Survey of the City of Boston, Boston City Planning Board, 1935.


