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Urban economic growth and migration: their interaction

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Abstract. The objectives of this study are twofold. Firstly, a simultaneous-equations model that takes into account the interaction between various economic aspects of urban growth, and migration to and from urban areas is specified. Secondly, the model is estimated for the 100 largest Standard Metropolitan Statistical Areas in the United States. Among the jointly dependent variables utilized are civilian labor force outmigration, civilian labor force inmigration, income growth, employment growth, unemployment growth, and natural increase of the civilian labor force.

1 Introduction

The process of urban or regional growth is obviously extremely complex. Many diverse social and demographic factors, as well as more purely economic variables, influence the process of change in urban areas. One aspect of urban growth, however, stands out clearly. The tremendous urbanization that has characterized practically every country on the globe during the last quarter of a century could not have resulted alone from natural population increase in urban areas. Urban population growth, of the magnitude that has occurred, surely would not have been experienced in the absence of sizeable and persistent migration to cities. Hence, it is difficult to conceive of any reasonable model of urban growth that does not take migration into account.

No less than other aspects of urban growth, migration to and from urban areas is influenced by many diverse economic, social, and demographic factors, and these various factors are in turn influenced by the migration that occurs. This interaction between cause and effect suggests that it is appropriate to specify a model of urban growth which takes into account the interactions between the various interdependent factors involved in the growth process. The present study therefore specifies and tests a simultaneous-equations model of urban growth and migration.

While this study concentrates primarily on the interaction between migration and certain economic aspects of urban change, it should not be construed that economic factors are regarded to be the only factors of importance in the growth process. The selection of primarily economic variables for consideration is rather arbitrary, but this considerable simplification does have the advantage of leading to a manageable and empirically testable model of urban growth.

A number of previous studies that have attempted to explain migration by means of a single-equation multiple-regression model have found 'wrong' signs or insignificant coefficients on variables *a priori* thought to play a crucial role in the potential migrant's decision concerning his destination. Particularly troublesome have been variables relating to income levels, income growth, and unemployment rates. These single-equation models have typically been estimated by ordinary least squares. One possible explanation for the surprising results that have been obtained in such studies is that the parameter estimates possess a simultaneous-equations bias. This bias is likely to be particularly marked in those studies that employ some measure of cumulative life-time migration, since migration that has occurred over a long period of time is especially likely to have influenced the independent variables of the models.

An important consequence of employing a simultaneous-equations model of migration is improved model specification.

The present study is not the first attempt to specify and estimate a simultaneous-equations model of migration. Previous studies by Muth (1968, 1971), Okun (1968), Olvey (1970), and Persky and Kain (1970) have employed a simultaneous-equations approach. However, in the present study both the model employed and the data base differ considerably from those utilized in earlier comparable studies. Let us next turn to a more detailed discussion of the specification of the model employed in this study.

2 The specification of the model

2.1 *Data, equations, and definitions of variable*

The model that is hypothesized in this study has been estimated for the 100 largest Standard Metropolitan Statistical Areas (SMSA's) in the continental United States. Of 211 SMSA's in the continental United States in 1960, 100 had a population in excess of 250000 in that year. These 100 SMSA's are the only ones for which appropriate *census* migration data and other *census* data exist. In 1960 approximately 54% of the US population resided in these 100 SMSA's.

The model estimated for this study consists of seven equations in seven jointly dependent (endogenous) variables. Five of the equations are structural and two are identities. The endogenous variables include the number of civilian labor force (CLF) outmigrants (OM), the number of civilian labor force inmigrants (IM), income change (ΔINC), employment change (ΔEMP), unemployment change (ΔUNEMP), civilian labor force change (ΔCLF), and natural increase of the civilian labor force (NATINC). Each variable that relates to a change is defined as the logarithm of the ratio of the 1960 to the 1950 level of the variable. The model is of the following form:

$$\mathrm{OM} = f_1(\widehat{\mathrm{IM}}, \Delta\widehat{\mathrm{INC}}, \Delta\widehat{\mathrm{EMP}}, \Delta\widehat{\mathrm{UNEMP}}, \mathrm{INC50}, \mathrm{UNR50}, \mathrm{CLF50}, \mathrm{EDU50}, \mathrm{AGE60}, e_1)\,, \tag{1}$$

$$\mathrm{IM} = f_2(\widehat{\mathrm{OM}}, \Delta\widehat{\mathrm{INC}}, \Delta\widehat{\mathrm{EMP}}, \Delta\widehat{\mathrm{UNEMP}}, \mathrm{INC50}, \mathrm{UNR50}, \mathrm{CLF50}, e_2)\,, \tag{2}$$

$$\Delta\mathrm{INC} = f_3(\widehat{\mathrm{OM}}, \widehat{\mathrm{IM}}, \Delta\mathrm{EDU}, \Delta\mathrm{GOVT}, \mathrm{DEW}, \mathrm{DNS}, e_3)\,, \tag{3}$$

$$\Delta\mathrm{EMP} = f_4(\widehat{\mathrm{OM}}, \widehat{\mathrm{IM}}, \widehat{\mathrm{NATINC}}, \mathrm{INC50}, \Delta\mathrm{EDU}, \Delta\mathrm{GOVT}, \mathrm{DEW}, \mathrm{DNS}, e_4)\,, \tag{4}$$

$$\Delta\mathrm{UNEMP} = f_5(\widehat{\mathrm{OM}}, \widehat{\mathrm{IM}}, \widehat{\mathrm{NATINC}}, \mathrm{DEW}, \mathrm{DNS}, e_5)\,, \tag{5}$$

$$\Delta\mathrm{CLF} \equiv \Delta\mathrm{EMP} + \Delta\mathrm{UNEMP}, \text{ and} \tag{6}$$

$$\mathrm{NATINC} \equiv \Delta\mathrm{CLF} + \mathrm{OM} - \mathrm{IM}\,, \tag{7}$$

where each of the variables is defined below.

Endogenous variables

OM — is the outmigration; that is the logarithm of twice the number of individuals, classified as civilian labor force (CLF) members in 1960, who resided in the SMSA in question on April 1, 1955, but elsewhere on April 1, 1960. (Data source: US Bureau of the Census, 1963b, table 6.)

IM — is the inmigration; that is the logarithm of twice the number of individuals, classified as CLF members in 1960, who resided in the SMSA in question on April 1, 1960, but elsewhere on April 1, 1955. (US Bureau of the Census, 1963b, table 4.)

ΔINC — is the income change; that is the logarithm of the ratio of the 1959 to the 1949 median income of persons residing in the SMSA on April 1, 1960, and on April 1, 1950, respectively. (US Bureau of the Census, 1963a, table 133, and 1953, table 185.)

ΔEMP	is the employment change; that is the logarithm of the ratio of the 1960 to the 1950 level of employment of the SMSA, where both levels are measured on April 1. (US Bureau of the Census, 1963b, table 75, and 1952, table 35.)
ΔUNEMP	is the unemployment change; that is the logarithm of the ratio of the 1960 to the 1950 level of unemployment of the SMSA, where both levels are measured on April 1. (US Bureau of the Census, 1963a, tables 73 and 75, and 1952, table 35.)
ΔCLF	is the civilian labor force change.
NATINC	is the natural increase of the CLF; that is the excess of CLF entrants over exits (net of migration) measured between 1950 and 1960.

Exogenous variables

INC50	is the (logarithm of the) median 1949 income of persons residing in the SMSA in 1950. (US Bureau of the Census, 1953, table 185.)
UNR50	is the (logarithm of the) rate of unemployment prevailing in the SMSA on April 1, 1950. (US Bureau of the Census, 1952, table 35.)
CLF50	is the (logarithm of the) CLF of the SMSA in 1950. (US Bureau of the Census, 1952, table 35.)
EDU50	is the (logarithm of the) median number of years of school completed by persons 25 years old and over in 1950. (US Bureau of the Census, 1953, table 86.)
AGE60	is the (logarithm of the) median age of the population of the SMSA in 1960. (US Bureau of the Census, 1964, table 287.)
ΔEDU	is the education change; that is the logarithm of the ratio of the 1960 to the 1950 median number of years of school completed by persons 25 years old and over. (US Bureau of the Census, 1964, table 141, and 1953, table 86.)
ΔGOVT	is the local government expenditure change; that is the logarithm of the ratio of the 1962 to the 1957 level of local government expenditures of the SMSA. (US Bureau of the Census, 1967, table 3, and 1959, table 3.)
DEW	is the East–West dummy variable, where SMSA's of the Mountain and Pacific Census Regions equal one and all other SMSA's equal zero.
DNS	is the North–South dummy variable, where each SMSA south of a line drawn across the northern borders of North Carolina, Tennessee, Arkansas, Oklahoma, etc. equals one and all other SMSA's equal zero.

Others

e_i	represents random errors.

Note that the migration data employed in this study refer to civilian labor force movements that occurred over the 1955–1960 period. Data relating to the other endogenous variables, and to each exogenous variable that involves a change, refer to changes that occurred over the 1950–1960 period. Hence two alternatives regarding the definition of variables are available. The first is to assume that the migration that occurred over the 1950–1955 period was identical to the migration that occurred over the 1955–1960 period. In this case each migration flow would be multiplied by 2·0 [see footnote (1) over]. Such a multiplication would not result in changes in the parameter estimates of the explanatory variables of the model. One shortcoming of this first option is that an unknown degree of bias may be inherent in the empirical results if the migration of civilian labor force members differed in magnitude during the 1950–1955 and 1955–1960 periods. Unfortunately the only appropriate available data relate to the migration that occurred over the 1955–1960 period, and hence the actual difference in the migration flows for the two periods is unknown. It is likely, however, that some, and perhaps considerable, differences existed between the two five-year periods, since during the first half of the 1950 decade the Korean War was a dominant factor in the economy, while during the second half of the decade general sluggishness characterized the economy. Though migratory movements are somewhat sensitive to the cyclical behavior of the economy, they generally appear to be dominated by longer-run phenomena. Hence the migration that occurred over the 1955–1960 period may not have differed drastically from that which occurred over the 1950–1955 period.

The second available option involves defining other endogenous and exogenous variables, when possible, in a manner consistent with the migration variables. Since the appropriate *census* data exist for only 1950 and 1960, the second option requires the assumption that the changes that took place occurred at a constant average annual rate over the decade. The 1955 level of each variable could then be interpolated and the 1955–1960 change estimated. Because the second alternative requires the assumption that the 1950–1955 behavior of each variable except migration was identical to that variable's 1955–1960 behavior, the second alternative is less desirable than the first. Given the simultaneous nature of the model, it is not reasonable to suppose that migration differed over the two periods while the variables that influence and are influenced by migration behaved identically. Perhaps a more serious point is that under the second option the exogenous variables must be defined for 1955 from 1950 and 1960 data. Thus both exogenous and endogenous variables would be sensitive to 1960 levels and therefore sensitive to the differential impact that migration may have had during the two five-year intervals. Though neither option is without obvious shortcomings the first option appears to be preferable to the second.

Each variable that relates to a change is expressed as the logarithm of the ratio of the 1960 to the 1950 level of the variable. Hence a measure of absolute change is employed in this study. Each of the other variables of the model except the dummies (DEW, DNS) is expressed as the logarithm of a beginning-of-the-period value.

(1) To the extent that 1950–1955 inmigrants had, between 1955 and 1960, either left the labor force (through retirement or death) or moved elsewhere, inmigration flows should be multiplied by a factor of less than 2·0. More generally since the stock of inmigrants measured at any given point in time, or the flows of both out- and inmigration measured over any given period, tend to include higher percentages of more recent migrants, the latter tend in our migration measures to carry heavier weights than less recent migrants. Moreover, to the extent that 1955–1960 migrants returned to their 1950 residence, the flows should not be counted at all in either out- or inmigration. Note, however, that if in fact migration flows had been sufficiently greater in the 1950–1955 period compared with those of the 1955–1960 period, then surviving 1950–1955 migrants, as measured in 1960, would outnumber 1955–1960 migrants, as measured in 1960, and the flows should actually be multiplied by a factor greater than 2·0. This possibility, of course, violates the assumption that migratory behavior was identical over the two five-year periods. Any systematic tendencies for the actual weights (as opposed to the assigned weights of 1·0) for the two periods to differ between SMSA's may impart an unknown degree of bias to the estimated coefficients.

Apart from the problems associated with measuring gross out- and gross inmigration for the decade from data for half of the decade, certain related problems arise in attempts to measure the effects of the migration. For example, to the extent that the effects of migration are lagged, previous inmigrants who have retired, died, returned to their original locality, or moved to some other destination may still influence the behavior of certain variables of the system. A question also arises as to whether departure from the labor force through retirement or death should be treated any differently than outmigration. While previous residents of a locality who enter the labor force of that locality have effects that are similar to the effects of inmigrants, by no means are the effects identical. Although the variable for natural civilian labor force change is meant to account for some of the differences in the effects of natural civilian labor force change and civilian labor force change due to migration, this variable is not entirely adequate for its intended task.

Clearly, exogenous variables so defined are not subject to the influence of the endogenous variables of the model. Each migration variable is expressed as the logarithm of an absolute 1955–1960 migration flow. Migration flows are, however, normalized, since the 1950 civilian labor force (CLF50) appears on the right-hand side of each migration equation. Note that the migration flows refer to the migration of persons classified as civilian labor force members in 1960.

The use of two migration variables, one relating to outmigration and one to inmigration, is in contrast to the possible use of a single variable relating to net migration. The impact that migration has on both the sending and receiving localities depends significantly upon the characteristics of the movers themselves. The characteristics of the out- and inmigrants for any given locality are not likely to be identical and in some instances may not even be similar. Moreover the importance of certain variables in explaining outmigration is likely to be different from the importance of these same variables in explaining inmigration, and some variables that are relevant to explaining outmigration are not relevant to explaining inmigration. This latter group of variables includes those that relate to the characteristics of the population from which the migrants are drawn. Hence the use of two gross-migration variables does allow for differences in the determinants and consequences of out- and inmigration. The use of a net-migration variable would involve a substantial loss of information and this variable possesses no apparent advantages that cannot also be achieved by regarding the effect of net migration as the sum of the effects of gross out- and gross inmigration. Bowman and Myers (1967) and Sjaastad (1962) present related arguments for using gross-migration concepts.

Note that two identities are employed to close the system. The first, given by equation (6), suggests that any change that occurs in the size of the civilian labor force between points in time must necessarily be made up of component changes in employment and unemployment. Thus we obtain the expression

$$\Delta \mathrm{CLF} \equiv \Delta \mathrm{EMP} + \Delta \mathrm{UNEMP} \,.$$

The second, given by equation (7), suggests that the natural increase (actually the natural change) of the civilian labor force must be equal to the actual change in civilian labor force plus the civilian labor force outmigration minus the civilian labor force inmigration. Since the natural increase variable refers to the actual civilian labor force change net of civilian labor force migration, the variable NATINC is defined in terms of other endogenous variables and therefore must itself be treated as endogenous. Let us next turn to a detailed discussion of each of the structural equations of the model.

2.2 *The migration equations*

Though they are not completely symmetrical, the gross out- and gross inmigration concepts are somewhat symmetrical. The following presentation is thus facilitated by treating both the out- and inmigration equations in the same context. In this study gross out- and gross inmigration are related to a number of aggregate proxy variables.

If migrants are responsive to income differentials, then migration should be away from relatively low-income cities and towards relatively high-income cities. Hence, other things being equal, the higher the level of income of an SMSA, the smaller its expected outmigration and the larger its expected inmigration. Localities experiencing sizeable income growth may be attractive for migrants, because such income growth may cause potential migrants to be optimistic about future income prospects in the area. Both his current expected income level and his expected future levels enter into the potential migrant's income calculation, since the relevant income measure for him to consider is the present discounted value of his stream of expected future returns.

Given his current expected income, then the greater his expected future increase in income is, for which his current actual increase may be a good proxy, the poorer is the potential migrant's current expected level as a proxy for the discounted value of the stream of expected future returns. Migrants may thus be expected to move not only to areas with relatively high income levels, but also to areas with relatively rapidly growing income levels because, other things being equal (including income level), the greater the expected increase in future income the greater is the present discounted value of the stream of expected future returns. Localities experiencing sizeable income growth are thus expected to have both smaller outmigration and greater inmigration, other things being equal.

Localities with larger labor markets are likely to prove more attractive to potential migrants, since absolutely more job opportunities are likely to exist in such places. Absolute civilian labor force size has therefore been employed as an exogenous variable in the inmigration equation. The larger the locality, the greater is the number of persons who are likely to have any given reason to migrate from it, and so the civilian labor force size is also expected to have a positive sign in the outmigration equation.

It is generally expected that outmigration will be lower and inmigration will be higher the greater is the employment growth that occurs in a region, other things being equal. The growth of employment is here considered to be a proxy for the expansion of job opportunities in an area and is expected to reflect growing labor demand.

Areas that are experiencing rapid increases in excess labor supply (that is, unemployment) are likely to experience heavy outmigration and light inmigration. Moreover areas having higher unemployment rates are also expected to experience both larger outmigration and smaller inmigration. Localities in which the pool of unemployment is increasing rapidly or in which the unemployment rate is high offer the potential migrant rather poor prospects for quick reemployment, because jobs are either already difficult to find or are becoming more difficult to find. Furthermore, to the extent that the migrant must spend more time searching for work where such conditions prevail, his opportunity costs of entering such labor markets will be greater. Since the opportunity costs of migration are lower for unemployed civilian labor force members, outmigration is expected to increase more with increased unemployment growth and with increased rates of unemployment.

Several personal characteristics are likely to exert important influences on the individual's decision to migrate. Among these characteristics are his age and his level of education. The probability that a labor-force member will migrate is likely to decrease as his age increases, since older persons have a shorter expected working life over which to realize the advantages of migrating, which makes the rate of return on migration lower for them. Moreover, as Becker (1964) points out, individuals for whom migration is profitable find it more profitable to move immediately, rather than postpone their move, because to postpone moving involves the loss during early years of returns that are discounted least. As Gallaway (1969) points out, job security and family ties are also likely to be more important for older persons than for younger ones, and these will further discourage older persons from migrating. Outmigration is thus expected to be lower the higher the median age (AGE60) of the SMSA, other things being equal[(2)].

[(2)] Note that 1960 age has been employed in this study, rather than 1950 age. The reason for this is that the appropriate comparable age data do not exist for all of the SMSA's in the sample. Since the 1960 and 1950 age measures are likely to be very highly correlated, and because it is neither desirable to drop observations nor employ noncomparable data, the 1960 age data have been preferred.

Employment information and job opportunities are both expected to increase with increased education. Each factor should in turn tend to increase the likelihood that an individual will migrate. Education may also reduce the importance of tradition and family ties and increase an individual's awareness of other localities, with the consequence that the forces that hold him to his present locality are weakened. Thus the higher the level of education of the SMSA the greater is the expected outmigration.

A number of previous studies indicate that where inmigration tends to be great, so does outmigration. In the present study a simple correlation coefficient of 0·871 between OM and IM tends to confirm this finding. A number of explanations have been offered for this phenomenon[(3)]. Miller (1967) suggests that areas which experience much inmigration also experience much outmigration, because such areas possess substantial segments of their populations that are 'migration prone'. Since migration is selective of that portion of the population that is highly mobile, those who have moved at least once are more likely to migrate than those who have not moved at all. Eldridge (1965) estimates that 17% of the 1955–1960 interstate migrants were return migrants, which suggests that a significant fraction of outmigrants (and hence inmigrants somewhere else) is likely to be disenchanted inmigrants from an earlier period who return home. Hence for those migration variables that appear in migration equations a positive sign is expected.

Certain previous studies, among which Blanco (1963), Lowry (1966), and Mazek (1969) are prominent, have related (net) migration to 'prospective unemployment', which is the amount of unemployment that would exist in a region in the absence of migration. In the context of a simultaneous-equations model of migration it seems clear that prospective unemployment would grossly exaggerate the actual amount of unemployment that would exist in the absence of migration. The lack of migration would tend to aggrevate unemployment and to produce significant downward pressure on wage rates. Other things being equal, such conditions would result in an increase in the quantity of labor demanded (and hence employment) and a decrease in the quantity of labor supplied. The net result would be to reduce unemployment below what it would be in the absence of migration. Thus at least some of those who would have been counted as 'prospective' unemployed would not actually have been unemployed if no migration occurred.

It might occur to some readers that natural civilian labor force increase should be employed in the migration equations, particularly in the equation for outmigration. However, the view taken in this study is that natural increase does not influence migration directly, but rather through its effects upon labor market conditions in the locality. Natural increase thus encourages outmigration through its effects on increased civilian labor force size, where this increased size is reflected in employment and unemployment growth. To employ natural increase along with employment and unemployment change as explanatory variables in the migration equations would thus involve 'double counting' natural increase on the right-hand side of these equations.

2.3 *The income-change equation*

Several previous studies concerned with the effects of factor supply adjustments have shown that factor mobility will lead to wage equalization between regions. (Even in the absence of factor mobility, wage equalization might occur if commodity trade takes place.) Traditional labor mobility theory has a certain factor supply orientation, since the labor mobility that occurs is generally taken to influence labor supplies in sending and receiving localities, while labor demand in each region is unaffected.

(3) For a summary of these arguments, see Stone (1971).

Hence, as homogeneous units of labor migrate from low- to high-wage regions, increased labor supply in the high-wage region places downward pressure on wage rates there, while decreased labor supply in the low-wage region places upward pressure on its wage rates[(4)]. While this presentation greatly simplifies what is a rather sophisticated argument, it can be seen that interregional factor mobility tends to result in regional wage equalization.

However, with regard to the impact of factor mobility on *income* change for a region as a whole, the traditional arguments appear to possess less validity. There is no strong *a priori* reason to suggest that the signs on the out- and inmigration variables in the income change equation should be positive, negative, or zero. Migration from or to a given area influences labor demand as well as labor supply in that area. The movement of persons from one locality to another causes labor supply to increase in the recipient locality and to decrease in the sending locality. In itself such a movement may be expected to place downward pressure on wage rates and income levels in the destination and upward pressure in the origin, if labor-demand functions are not infinitely elastic. However, if either the prices of locally produced goods and services or the marginal product of locally supplied labor is sensitive in a positive direction to inmigration and sensitive in a negative direction to outmigration, then the derived demand for labor will tend to increase in the receipient region and decline in the sending region. While the price level of the locality's exportable commodities may not be particularly sensitive to migration, the price level of those goods and services that are both produced and consumed locally is likely to be somewhat sensitive. This sensitivity may not be symmetrical between sending and receiving regions, since downward price rigidity may prevent price declines in sending localities. Moreover if inmigration induces increased investment and outmigration induces decreased investment in a locality, then labor's marginal product may be expected to increase in the receiving region and decrease in the sending region. Those adjustments that tend to result in outward shifts of the labor-demand function in the recipient region and in inward shifts in the sending region place upward pressure on wage rates and income levels at the destination and downward pressure at the origin. There appears to be no *a priori* reason to suppose that the labor demand shift associated with migration will dominate the labor-supply shift, that the supply shift will dominate over the demand shift, or that the shifts will not offset one another. The signs on the out- and inmigration variables are thus regarded as an empirical matter, and no *a priori* specification is made of the direction of the relationship between the out- and inmigration variables and the income change.

It is worth noting that Borts and Stein (1964) emphasize the impact that migration has on the wage and income levels of the indigenous population, as distinct from the migrant population. They argue that migration to an area tends to place downward pressure on the wage rates of the indigenous residents, but nevertheless upward pressure on their average income level. The argument is that the wage of the migrants is equal to their marginal product, while the income gain to the region is equal to the migrants' average product. The difference between the average and marginal products is a net gain that is potentially available to the indigenous population of the recipient region.

In figure 1, which is reproduced from Borts and Stein (1964, p.192), OL workers are initially employed at wage rate W_0. The locality then experiences inmigration of magnitude LM, which causes the wage rate to fall to W_1. While the migrants produce an addition to the region's total product of LW_0W_1M, the migrant wage bill is

(4) For a discussion of the manner in which interregional capital mobility can affect labor demand, see Borts (1960).

LBW_1M. The difference, which is the area in the cross-hatched triangle BW_0W_1, is potentially available to the indigenous residents. The average product of the indigenous residents could potentially rise from $(OCW_0L)/OL$ to $(OCW_1BL)/OL$. Presumably the opposite consequence is felt in the region or regions that lose the migrants.

It should be stressed that the Borts and Stein argument assumes that the migrant population is not able to capture the addition to producer surplus (BW_0W_1) that results from its migration, at least not in the short run, nor is the migrant population able to capture any of the original product. The migrant and indigenous populations are assumed to be recognizable groups that have different income levels. The migration is also assumed to be insufficient to change the position of the labor demand curve. However, if the demand for labor in the recipient region should increase due to migration, the Borts and Stein argument would be reinforced, since there would be further upward pressure on wage and income levels of both migrant and indigenous populations. Should the inmigration induce an increase in investment expenditures, there would occur a still further increase in labor demand and further upward pressure on income levels. While the Borts and Stein argument may have some validity in the short run, in the long run, when the distinction between the migrant and indigenous populations becomes blurred as the migrants are assimilated and when migrant entrepreneurs have had sufficient time to capture a portion of the producer surplus, the income level of the 'residents' must fall (from A_0 to A_1) unless there is an increase in labor demand.

It is clear that a high correlation exists between education and income levels, and a positive relationship is generally expected between changes in these variables. A problem arises in specifying the direction of this relationship, since it is as plausible that increased income results in increased education and that increased education results in increased income. Since attempting to explain education change is beyond the scope of this study, the relationship is specified as running from education change to income change. If increased education results in increased labor productivity, the consequence of the increased education will be increased labor demand. Given labor supply curves that are not perfectly elastic in the relevant ranges, increased labor demand will result in increased income growth.

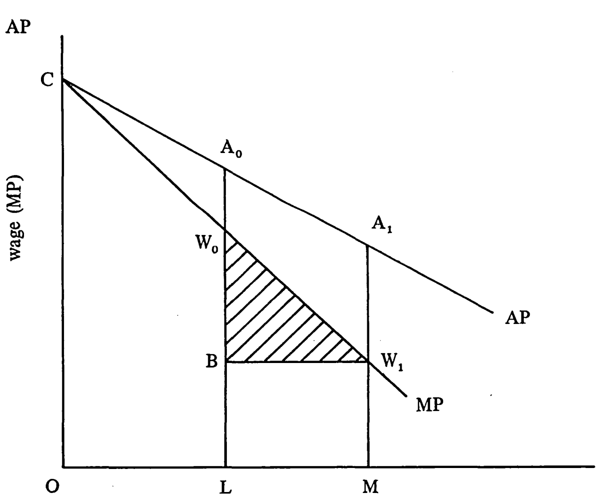

Figure 1.

Income is also expected to increase with increased government expenditures. Increased government expenditures are viewed as a factor causing increased labor demand. Unfortunately the only available data on government expenditures relate to the change in local government expenditures between 1957 and 1962. No information exists on changes in federal government expenditures in SMSA's, nor even on the level of federal government expenditures at an appropriate point in time. It is necessary to assume that the 1957–1962 change in local government expenditures is indicative of the 1955–1960 change, and hence the 1950–1960 change. To the extent that this assumption runs contrary to actual expenditure patterns of local governments, the measure employed here is deficient.

In order to test for significant differences in income growth between the East and the West, and between the North and the South, East–West (DEW) and North–South (DNS) dummy variables are included in the income-change equation. Differential capital growth and differential impacts of technical progress between regions are two factors that could contribute to differential income growth between regions. Unfortunately relevant data do not exist on the stock of physical capital by an SMSA at two different points in time, and it is therefore not possible to include this variable, or some variant of it, in the income-change equation. Several other factors could contribute to differential income growth between regions. These factors have been discussed at some length in the literature on the North–South (United States) income (or wage) differential, and they will not be further discussed here(5).

2.4 *The employment-change equation*

Earlier it was argued that there is no strong *a priori* reason to suppose that migration from or to a given region will result in an increase, a decrease, or no change at all in that region's wage level. This argument holds because migration is expected to result in offsetting shifts of labor supply and demand curves, and there is no strong reason to believe that the shift of one curve will dominate the shift of the other. The expected impact of out- and inmigration on the region's level of employment is, however, clearer. Since inmigration results in rightward shifts of both labor supply and demand curves, and outmigration results in leftward shifts of these curves, inmigration is expected to increase the region's level of employment, while outmigration is expected to reduce it.

The effects mentioned above may be regarded as the relatively direct effects of migration on employment in the sending and receiving regions. Certain indirect, or induced, effects of migration on employment levels may also be of importance and may reinforce the direct effects. Borts and Stein (1964) argue that migration to a region is likely to induce investment in that region, which will in turn further increase the demand for labor, and thus, given positive supply elasticities, the level of employment. The opposite consequences are likely to be felt in regions that are losing migrants. Consequently, other things being equal, the greater the outmigration, the smaller is the expected employment growth, and the greater the inmigration, the greater is the expected employment growth.

Since the civilian labor force can increase due to an excess of labor-force entrants over exits (net of migration), labor supply, and hence employment, may rise due to natural factors. The sign expected on the natural civilian labor force increase variable is therefore positive.

Borts and Stein assert that, if capital is immobile among regions while labor is mobile, employment in high-wage regions should grow more rapidly than that in low-wage regions. Olvey (1970), on the other hand, argues that if high wages reflect a

(5) Gallaway (1963) and Scully (1969) contain discussions of the North–South wage differential and include associated bibliographies.

low return on investment, employment growth should tend to be higher, the lower the wage. Borts (1960) argues in a similar vein when he considers a one-product, two-factor, two-region economy in which capital is abundant relative to labor in one of the regions, and labor relative to capital in the other. Wage rates are high in the former region relative to the latter, and the rate of return to capital is high in the latter relative to the former. As a consequence of such conditions labor migrates to the high-wage region, where the rate of return on capital is low, and capital migrates to the low-wage region, where the rate of return on capital is high. Due to the inflow of capital in the low-wage region and the outflow in the high-wage region, the demand for labor grows more rapidly in the low-wage region, with the consequence that wages also grow more rapidly there. Moreover labor supply grows less rapidly in the low-wage region and more rapidly in the high-wage region, which tends to promote further wage equalization. However, since OM and IM should themselves pick up the effects of labor migration on employment growth, the income-level variable, which serves as a proxy for the wage level, should reflect the effects of differential capital growth and have a negative sign in the employment-change equation.

Since both the education-change and the government expenditures-change variables are intended to reflect factors influencing labor demand, both variables are expected to have positive signs in the employment-change equation.

A number of factors may have had different regional impacts on employment growth, and the regional dummy variables have been included in the employment-change equation to pick up their effects. Fuchs (1962) suggests that one such factor, important during the 1955–1960 period, was the rapid expansion of the aircraft industry in temperate climates. He further suggests that unionization discouraged, and the availability of space encouraged, the relocation of manufacturing industries. Each of these factors would lead us to expect positive signs on the dummy variables.

2.5 *The unemployment-change equation*

Borts and Stein, and also Muth (1971), take the labor-demand curve for a locality to be infinitely elastic. However, the existance of unemployment (in excess of frictional) is not consistent with perfectly elastic labor demand. That the SMSA's which serve as the data base had substantial unemployment over the 1950–1960 period is evident. The average rate of unemployment over this period was 4·9%. Hence unemployment-change is treated as an endogenous variable in this model. Moreover the use of unemployment-change as an endogenous variable is consistent with the use of employment-change as endogenous, and the use of the latter closes the system, since it must necessarily be true that

$$\Delta \mathrm{CLF} \equiv \Delta \mathrm{EMP} + \Delta \mathrm{UNEMP} .$$

Previously it was argued that, since migration affects labor demand as well as labor supply in both the sending and receiving areas, no *a priori* reason exists to suggest that the impact on income levels will be in one direction or the other. A similar argument holds with respect to the influence of migration on unemployment. If the leftward (rightward) demand shift associated with out- (in-) migration were to dominate the leftward (rightward) supply shift associated with out- (in-) migration, unemployment would tend to rise (fall), given the wage rate at its initial, higher than equilibrium, level. There appears to be no more reason to suppose that this dominance will occur than to suppose that supply shift will dominate demand shift, thus causing out- (in-) migration to place downward (upward) pressure on unemployment levels. A final possibility is that migration has no impact on unemployment. It should be recognized, however, that to the extent that the unemployed are overrepresented in migration streams, and to the extent that unemployed outmigrants from a locality tend to become unemployed inmigrants in some other locality, the supply shift associated with migration is likely to dominate the demand shift such that outmigration results in decreased unemployment while inmigration results in increased unemployment.

Natural increase of the civilian labor force will tend to result not only in increased labor supply, but in increased labor demand as well. (The reasoning here is similar to that employed in the discussion of migration's impact on income levels.) However, since unemployment rates among the young tend to be relatively high, natural increase may result in increased unemployment.

The regional dummy variables are included in the unemployment-change equation to pick up the regional incidence of unemployment. If migratory response to unemployment is lagged, as it is likely to be, then the incidence of unemployment change is likely to be greater in those regions of the country that have a relatively high proportion of their employment in declining, or relatively slowly growing, industries. No specification of the signs to be expected on the dummy variables is made.

Table 1. Three stage least squares estimates of urban growth model: logarithmic regression coefficients (b) and *t*-ratios (*t*).

Independent variables	Equation for				
	OM	IM	ΔINC	ΔEMP	ΔUNEMP
OM b:		0·318	−0·023	−0·224	−0·399
t:		(3·290)	(1·090)	(3·229)	(3·192)
IM	0·139		0·043	0·232	0·192
	(0·880)		(2·220)	(3·945)	(1·965)
ΔINC	−1·247	2·166			
	(1·614)	(2·147)			
ΔEMP	0·165	2·843			
	(0·303)	(7·491)			
ΔUNEMP	0·476	−0·598			
	(1·225)	(1·250)			
NATINC				−0·011	0·047
				(0·624)	(1·689)
INC50	−0·545	0·212		−0·065	
	(3·112)	(1·043)		(0·345)	
UNR50	0·339	−0·439			
	(1·876)	(1·983)			
CLF50	0·791	−0·546			
	(5·525)	(5·477)			
EDU50	1·288				
	(3·474)				
AGE60	−1·212				
	(5·201)				
ΔEDU			0·462	−0·715	
			(3·364)	(1·464)	
ΔGOVT			0·033	0·071	
			(0·834)	(0·588)	
DEW			0·045	0·129	−0·104
			(2·669)	(2·513)	(1·125)
DNS			−0·003	0·172	0·172
			(0·212)	(3·005)	(2·305)
Constant	6·431	−3·427	0·117	0·689	2·064
	(5·059)	(2·191)	(1·177)	(0·513)	(3·490)
OLS R^2	0·96	0·93	0·46	0·72	0·20

3 The estimation of the model

3.1 *Estimation technique*

The structural model discussed in the previous section was estimated by three-stage least squares. Several previous studies, dealing with the 'determinants' of migration, have employed single-equation, multiple-regression models to ascertain the impact that each of several variables has had on interregional migration. These studies have typically been estimated by ordinary least squares[6]. One of the assumptions underlying the use of ordinary least squares to estimate these models of migration is that the independent (explanatory) variables of the models influence migration, but in turn are not influenced by migration. If this assumption is invalid, as it is shown to be in the present study, then the estimated coefficients may possess a simultaneous-equations bias. This bias is likely to be particularly serious in studies that have employed some measure of cumulative life-time migration, since migration

Table 2. Predicted (p) and actual (a) signs on coefficients of urban growth model.

Independent variables		Equation for				
		OM	IM	ΔINC	ΔEMP	ΔUNEMP
OM	p:		>0	?	<0	?
	a:		$>0^{**}$	<0	$<0^{**}$	$<0^{**}$
IM		>0		?	>0	?
		>0		$>0^{**}$	$>0^{**}$	$>0^{**}$
ΔINC		<0	>0			
		$<0^{*}$	$>0^{**}$			
ΔEMP		<0	>0			
		>0	$>0^{**}$			
ΔUNEMP		>0	<0			
		>0	<0			
NATINC					>0	?
					<0	$>0^{**}$
INC50		<0	>0		<0	
		$<0^{**}$	>0		<0	
UNR50		>0	<0			
		$>0^{**}$	$<0^{**}$			
CLF50		>0	>0			
		$>0^{**}$	$>0^{**}$			
EDU50		>0				
		$>0^{**}$				
AGE60		<0				
		$<0^{**}$				
ΔEDU				>0	>0	
				$>0^{**}$	$<0^{*}$	
ΔGOVT				>0	>0	
				>0	>0	
DEW				?	?	?
				$>0^{**}$	$>0^{**}$	<0
DNS				?	?	?
				<0	$>0^{**}$	$>0^{**}$

** Indicates that the estimated coefficient is significant at 5% or better ($t \geqslant 1 \cdot 66$).
* Indicates that the estimated coefficient is significant at 10% or better ($t \geqslant 1 \cdot 29$).

[6] For examples of such studies dealing with the United States, see Bowles (1970), Fabricant (1970), Gallaway (1967), Gallaway *et al.* (1967), Greenwood (1969a, 1970), Lowry (1966), Nelson (1959), and Sjaastad (1960). Others by Beals *et al.* (1967), Greenwood (1969b, 1971), Levy and Wadycki (1972), and Sahota (1968), which are similar in technique, have examined the determinants of interregional migration in less-developed countries.

that has occurred over long periods of time is particularly likely to have influenced certain of the explantory variables employed in the models.

Moreover ordinary least squares is an inappropriate estimating technique for simultaneous-equations models such as that presented here. Ordinary least squares lacks the consistency property that two- and three-stage least squares possess. Furthermore, since three-stage least squares has greater asymptotic efficiency when equations are overidentified, as those in the present model tend to be, and when the equation disturbances have a nondiagonal covariance matrix, three-stage least squares is preferable to two-stage least squares. (These points are further discussed in Christ, 1966, pp.592–626.)

3.2 *The findings summarized*

Three-stage least squares estimates of the model are presented in table 1. Table 2 shows the expected sign of each partial derivative of the model, as well as the actual sign on each three-stage least squares estimate of the corresponding coefficient. Of the thirty-five coefficients estimated in the structural equations, thirty-two have signs that are not unexpected (that is, either expected *a priori* or not specified). Of these thirty-two, twenty-one are significant at the 5% level or better, and one other is significant at better than 10%.[7] Two of the three coefficients that have unexpected signs (ΔEMP in the outmigration equation and NATINC in the employment-change equation) are insignificant, while the third (ΔEDU in the employment-change equation) is significant at better than 10%. The coefficients of multiple determination (R^2's) associated with the ordinary least squares estimates of the structural equations are reasonably high, ranging from 0·96 (outmigration equation) to 0·20 (unemployment-change equation)[8]. Let us next turn to a more detailed discussion of the results for each structural equation.

3.3 *The migration equations*

In the outmigration equation, ΔINC has the expected negative sign and is significant at better than 10%, while in the inmigration equation it has the expected positive sign and is significant at better than 5%.[9] While INC50 has the expected sign in both equations, it is significant only in the OM equation. These results suggest that income is indeed an important determinant of migration. Furthermore the magnitude of the coefficients of ΔINC relative to those of INC50 suggest that income expectations are important in the individual's decision to migrate, and thus that the appropriate income concept to employ in migration studies is the present discounted value of the expected stream of future returns. These findings lend support to the suggestions of Becker (1964) and Sjaastad (1962), and to the empirical work of Bowles (1970).

Employment growth obviously provides a significant inducement to inmigration. The coefficient associated with ΔEMP in the IM equation is easily the largest in the structural system, and suggests that a 1% increase in ΔEMP results in a 2·843% increase in inmigration. Though ΔEMP has a positive sign in the outmigration equation, which is contrary to expectations, its coefficient is not significant.

While the signs associated with ΔUNEMP are appropriate in both migration equations, in neither equation is the variable significant. Contrary to the findings of a number of earlier studies, UNR50 has the expected sign and is significant in both

(7) Since in simultaneous-equations models the ratios of the estimated coefficients to their standard errors (that is, *t*-ratios) are approximately normal, *t*-ratios give a rough indication of statistical significance (see Christ, 1966, p.598).

(8) Since the coefficient of multiple determination does not carry its usual meaning in equations estimated by three-stage least squares, the ordinary least squares R^2's are presented to give a rough indication of the percentage of explained variance.

(9) Hereafter, unless otherwise indicated, 'significant' refers to significant at 5% ($t = 1 \cdot 66$).

equations. The positive and significant coefficient on EDU50 in the outmigration equation and the negative and significant coefficient on AGE60 are both as expected and suggest that increased education levels encourage, while increased age levels discourage, outmigration.

The positive and significant coefficient on OM in the inmigration equation indicates that localities which experience relatively heavy outmigration also tend to experience relatively heavy inmigration. This result is interpreted as an indication where outmigration tends to be relatively heavy, so does return migration. Though IM has a positive sign in the outmigration equation, its coefficient is not significant(10).

3.4 *The remaining equations*

Previously it was argued that there is no strong *a priori* reason to suppose that the signs associated with the out- and inmigration variables in the income-change equation should be either positive, negative, or zero. However, the Borts and Stein hypothesis appears to predict a negative sign on OM and a positive sign on IM. These results are precisely those obtained, though the coefficient on OM is not significantly different from zero. The positive and significant coefficient on IM suggests that inmigration induces income growth, and thus that the demand shift resulting from inmigration dominates the supply shift resulting from inmigration.

While both ΔEDU and ΔGOVT have the appropriate positive signs in the income-change equation, only the former is significant. The previously mentioned shortcomings inherent in the measure of ΔGOVT may account for the weak relationship between this variable and income change. Finally, other things being equal, income growth was no greater in the South than in the North. However, the West does exhibit a tendency towards a greater income growth than that experienced in the East.

In the employment-change equation both OM and IM have the expected signs and are significant. A 1% increase in outmigration induces a 0·224% decrease in employment change, while the same percentage increase in inmigration induces a 0·232% increase in employment change. In his (two-equation) simultaneous-equations model of net migration and employment growth, Muth (1971) arrives at a conclusion similar to that obtained in the present study, namely that, while employment growth influences migration, migration in turn influences employment growth. The similarity of the coefficients on OM and IM suggests that localities experiencing zero net migration will experience no employment growth due to net migration. As long as out- and inmigrants have comparable characteristics, this is not a surprising result.

NATINC, while it is not statistically significant in the ΔEMP equation, has a negative rather than a positive sign. Although the reason for the negative sign is not obvious, the lack of significance suggests that little should be made of this point.

While ΔGOVT has the expected positive sign in the employment-change equation, its coefficient is not significant. However, the negative coefficient on ΔEDU is both unexpected and significant at 10%. One possible explanation for this unexpected sign is that the employment-change equation is reflecting product–market conditions as well as the factor–market conditions previously discussed. While greater growth in education may result in increased productivity in certain industries (that is, those industries that employ the educated workers more intensively), all industries need not be similarly affected by the increased education of the work force as a whole. If, at given income levels, increased education growth results in decreased final demand for the output of certain industries, then education growth could result in decreased

(10) Appendix A contains the three stage least squares estimates of a model identical to that presented in table 1 except that the migration variables are not included in the migration equations.

employment in those industries. Thus the education-growth variable may reflect counteracting tendencies in the employment-change equation.

Finally, the regional dummy variables indicate that, other things being equal, employment growth was greater in the West than in the East and greater in the South than in the North. These findings are consistent with the earlier findings of Fuchs (1962), who argues that temperate climates and lack of unionization were conducive to rapid employment growth.

In the unemployment-change equation OM has a negative sign, while IM and NATINC have positive signs. Each variable is significant. These results suggest that outmigration tends to relieve unemployment, while inmigration tends to aggravate it. As was pointed out previously, if the unemployed are over-represented in migration streams, and if unemployed outmigrants tend to remain unemployed at their destination, then out- and inmigration should tend to have the effects observed. The positive sign on NATINC reflects the tendency for (young) labor-force entrants to experience relatively heavy unemployment.

While there is no significant difference between unemployment change in the West and the East, the South appears to have experienced a greater increase in unemployment than did the North, since DNS is positive and significant. This latter finding may be somewhat surprising since there is some evidence that unemployment rates tended to be higher in the North than in the South in both 1950 and 1960.(11) However, given the heavy migration that did occur from the South during the 1950's, the negative sign on OM suggests that in the absence of outmigration unemployment growth would have been far greater in the South than it actually was. The relatively large concentration of unskilled workers in Southern cities, particularly of black workers but including white as well, in conjunction with the depressed state of the economy during the latter half of the decade, could help account for the significance of DNS.

3.5 *The derived reduced form*

The derived reduced form coefficients are of interest because, unlike the coefficients of the structural equations, the derived reduced form equations account for the feedbacks implicit in the simultaneous system. Perhaps a brief exposition of the meaning of the derived reduced form is in order. For the sake of simplicity suppose that the model consists of two structural equations whose estimates are given by

$$X = a_0 + a_1 Y + a_2 M \,, \tag{8}$$

and

$$Y = b_0 + b_1 X + b_2 N \,, \tag{9}$$

where X and Y are endogenous variables and M and N are exogenous. It is now possible to solve for each endogenous variable in terms of exogenous variables only. Substitution of the value of Y given by equation (9) into the equation for X, and substitution of the value of X given by equation (8) into the equation for Y, yields the following reduced form equations:

$$X = \frac{a_0 + a_1 b_0}{1 - a_1 b_1} + \frac{a_2}{1 - a_1 b_1} M + \frac{a_1 b_2}{1 - a_1 b_1} N \,, \tag{10}$$

$$Y = \frac{b_0 + a_0 b_1}{1 - a_1 b_1} + \frac{a_2 b_1}{1 - a_1 b_1} M + \frac{b_2}{1 - a_1 b_1} N \,. \tag{11}$$

(11) The simple correlation coefficients between UNR50 and DNS (−0·185) and between UNR60 and DNS (−0·118) tend to confirm such a finding. For a more detailed analysis of regional differences in unemployment rates, see Rapping (1966).

'Derived' reduced form suggests that the coefficients of the reduced form equations have been calculated, given the estimates of the coefficients of the structural equations.

Table 3 presents the derived reduced form coefficients that correspond to the three-stage least squares estimates of the model. Let us consider in turn each of the equations of the derived reduced form. Because each coefficient of the reduced form is influenced by a complex set of interactions, it is difficult to attribute any direct causal relationship to the coefficients. However, it is interesting that the net impacts of the various exogenous variables are generally in the expected directions.

Consider for example the migration equations. The fact that INC50 has a negative coefficient in the outmigration equation and a positive coefficient in the inmigration equation suggests that the net effects of higher income levels are to discourage outmigration and encourage inmigration. Higher unemployment rates also behave as expected by encouraging outmigration and discouraging inmigration.

Note that if net (in) migration (NM) were defined as $NM \equiv IM - OM$, the effect of higher income levels on net migration would be given by $0{\cdot}290-(-0{\cdot}419) = 0{\cdot}709$. Similarly the effect of higher unemployment rates on net migration would be $-1{\cdot}422$. In other words, a 1% increase in the rate of unemployment results in a 1·422% decrease in net inmigration. CLF50, EDU50, ΔGOVT, DEW, and DNS all have larger coefficients in the inmigration equation than in the outmigration equation, which suggests that net migration tends to be in the direction of larger cities, localities with higher education levels and with greater increases in government expenditures, and towards urban areas of the West and the South.

The highest derived reduced form coefficient in the income-change equation is that on EDU50. However, while cities with higher levels of education experienced greater income growth, those with greater growth in education experienced smaller income growth. Greater growth of government expenditures resulted in greater income growth, and income growth in the West tended to be greater than in the East.

It is interesting that the higher a locality's unemployment rate, the smaller was both its growth in employment and unemployment. Furthermore, although larger localities experienced net inmigration, the natural increase in civilian labor force was smaller to such a degree that they experienced an overall smaller civilian labor force growth. That larger localities grew less rapidly than smaller ones is an important finding, because it suggests that the system is stable in the sense that city size will tend to converge over time. The net effect of increased government expenditures was increased employment growth, and employment grew most rapidly in the West and in the South.

Table 3. Derived reduced form coefficients of urban growth model.

Exogenous variables	Equation for						
	OM	IM	ΔINC	ΔEMP	ΔUNEMP	ΔCLF	NATINC
INC50	−0·419	0·290	0·022	0·100	0·204	0·304	−0·405
UNR50	0·052	−1·370	−0·060	−0·339	−0·244	−0·583	0·839
CLF50	0·880	1·263	0·034	0·101	−0·128	−0·027	−0·411
EDU50	1·037	2·583	0·549	0·380	0·028	0·408	−1·137
AGE60	−0·943	0·441	0·040	0·321	0·431	0·752	−0·633
ΔEDU	−1·064	−5·599	−0·216	−1·801	−0·547	−2·348	2·187
ΔGOVT	0·109	0·774	0·063	0·231	0·089	0·320	−0·346
DEW	0·189	1·522	0·106	0·449	0·075	0·524	−0·810
DNS	0·265	0·796	−0·001	0·298	0·218	0·516	−0·015
Constant	4·524	−10·14	−0·421	−2·798	−1·186	−3·984	10·68

Finally, certain of the reduced-form coefficients in the equation for natural civilian labor force increase are of interest. Localities with higher levels of both income and education experienced smaller natural civilian labor force increase. Localities with older populations also had smaller natural increase. Each of these results is as one might expect.

4 Summary and conclusions

After an exhaustive examination of population-income relationships in various regions of the United States, Perloff *et al.* (1960, p.589) conclude that "large numbers and high rates of population growth have quite different effects under different economic circumstances. Where job opportunities are expanding rapidly, population growth can itself be a force for growth in *per capita* income; but where job opportunities are not expanding at all or expanding only slowly, it may well have an opposite effect". The present study shows that inmigration of civilian labor force members not only causes greater employment growth in urban areas, but also induces greater income growth in these areas. Indeed inmigration is a concomitant of urban growth. Since the migratory behavior of civilian labor force members is significantly influenced by the growth of economic opportunities, the process of economic growth in urban areas tends to be self-reinforcing.

The findings of this study do not suggest that outmigration encourages greater income growth such that regional income differentials are narrowed through interregional migration. Rather, to the extent that it does influence income growth, outmigration appears to depress such growth, as well as to depress employment growth. Outmigration does, however, tend to relieve unemployment in sending localities.

Lowry (1966), in his study of inter-metropolitan migration, concludes that the characteristics of an origin locality make little difference to an individual who is contemplating a move to another metropolitan area. Destination characteristics, on the other hand, do help determine the locality to which the migrant will move. The results of the present study clearly show that, at least for total out- and inmigration for large metropolitan areas, both origin and destination characteristics are important in the potential migrant's decision to move.

In the introduction it was argued that improved model specification is one advantage of employing a simultaneous-equations approach to the analysis of migration. The results concerning ΔUNEMP and UNR50 in the migration equations of the model are of particular interest in this respect, since certain previous studies have found that migrants are either not influenced by unemployment rates or are influenced in a direction opposite to that expected[(12)]. Other researchers have suggested that such results may in part have been caused by a simultaneous-equations bias inherent in the parameter estimates obtained in single-equation, multiple-regression models. The results of the present study indicate that these suggestions may possess some validity, and that less-than-adequate model specification could have caused such 'surprising' results as were found.

Moreover the present results are in contrast to those of Sjaastad (1960), who found that a more rapid income growth significantly affects migration in a direction opposite to that expected. Sjaastad points out that one reason for his perverse results may have been inappropriate model specification, since migration may itself have influenced income growth. Present findings also lend support to Sjaastad's suggestion.

(12) See, for example, Gallaway *et al.* (1967), Lowry (1966), Rogers (1967), and Sjaastad (1960).

Table 4 presents ordinary least squares estimates that can be compared with the three-stage least squares estimates of table 1. For the two sets of results only three sign switches are evident. In the outmigration equation, ΔEMP switches from being positive and insignificant in its three-stage least squares form to being negative and significant in its ordinary least squares form. In the income-change equation, ΔGOVT switches from being positive and insignificant to being negative and insignificant, and in the employment-change equation, NATINC changes from being negative and insignificant to being positive and significant. Hence comparison of signs suggests little difference between the three-stage least squares results and the ordinary least squares results.

Among those coefficients whose signs do not change, five switch from insignificant to significant at 5%, and one other switches from significance in three-stage least squares form to insignificance in ordinary least squares form. Three of the changes that occur are in the outmigration equation (IM, ΔINC, and ΔUNEMP), with one each in the inmigration equation (ΔUNEMP), the income-change equation (OM), and the unemployment-change equation (NATINC).

Actually, among that group of variables that has proven troublesome in past studies, the ordinary least squares estimates provide stronger evidence of the expected

Table 4. Ordinary least squares estimates of urban growth model: logarithmic regression coefficients (b) and *t*-ratios (*t*).

Independent variables		Equation for				
		OM	IM	ΔINC	ΔEMP	ΔUNEMP
OM	b:		0·649	−0·092	−0·384	−0·269
	t:		(6·905)	(4·821)	(7·740)	(2·761)
IM		0·330		0·107	0·367	0·178
		(4·107)		(6·409)	(8·725)	(2·153)
ΔINC		−0·797	1·395			
		(2·919)	(3·585)			
ΔEMP		−0·306	1·768			
		(1·706)	(10·34)			
ΔUNEMP		0·385	−0·326			
		(4·870)	(2·696)			
NATINC					0·007	0·009
					(1·786)	(1·016)
INC50		−0·502	0·067		−0·004	
		(3·574)	(0·367)		(0·029)	
UNR50		0·313	−0·282			
		(5·514)	(3·229)			
CLF50		0·603	0·293			
		(8·295)	(3·393)			
EDU50		1·149				
		(4·436)				
AGE60		−1·107				
		(5·786)				
ΔEDU				0·427	−0·528	
				(3·195)	(1·568)	
ΔGOVT				−0·205	0·094	
				(0·529)	(0·978)	
DEW				0·035	0·093	−0·106
				(2·100)	(2·240)	(1·235)
DNS				−0·017	0·158	0·194
				(1·294)	(3·555)	(2·789)
Constant		6·128	−1·885	0·202	0·301	1·162
		(6·265)	(1·420)	(2·098)	(0·299)	(2·446)
R^2		0·96	0·93	0·46	0·72	0·20

results than is provided by the three-stage least squares estimates. In the outmigration equation the three-stage least squares estimates of ΔINC and ΔUNEMP fail significance at 5%, but the ordinary least squares estimates of these variables are highly significant. The *t*-value on UNR50 increases in its ordinary least squares form, but it is significant in its original form. In the inmigration equation ΔUNEMP changes from insignificance in three-stage least squares form to significance in ordinary least squares form, and the *t*-values on ΔINC and UNR50 both rise, though the variables are significant in their original form. While results that are stronger in the expected directions do not justify the use of ordinary least squares estimators as compared to three-stage least squares estimators, these results do suggest that the cause of the unexpected findings of earlier migration studies is somewhat deeper than the techniques used to estimate the models.

Several of the studies that have uncovered surprising results have attempted to explain the migration that occurred over a given period of time by means of origin and destination characteristics defined for the end of the period. Certainly exogenous variables defined for the end of the period could be influenced by the migration that has occurred over the period. The results of the present study clearly indicate that migration influences income, employment, and unemployment growth, and hence migration influences end-of-period income, employment, and unemployment levels. In the present study the exogenous variables have been defined for the beginning of the period and are therefore not subject to the influence of whatever migration occurs over the period. As distinct from model specification, the selection of appropriate definitions of variables could prove helpful in future migration studies.

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APPENDIX A

Table A1. Three-stage least squares estimates of variant of urban growth model: logarithmic regression coefficients (b) and *t*-ratios (*t*).

Independent variables	Equation for				
	OM	IM	ΔINC	ΔEMP	ΔUNEMP
OM b:			−0·0002	−0·124	−0·401
t:			(0·010)	(1·956)	(3·209)
IM			0·024	0·153	0·192
			(1·290)	(2·848)	(1·969)
ΔINC	−1·077	2·026			
	(1·465)	(1·807)			
ΔEMP	0·685	3·310			
	(1·838)	(8·433)			
ΔUNEMP	0·377	−0·467			
	(0·967)	(0·882)			
NATINC				−0·012	0·047
				(0·704)	(1·726)
INC50	−0·493	0·215		−0·102	
	(2·814)	(0·944)		(0·536)	
UNR50	0·271	−0·401			
	(1·509)	(1·632)			
CLF50	0·909	0·820			
	(24·29)	(13·42)			
EDU50	1·164				
	(3·386)				
AGE60	−1·200				
	(5·694)				
ΔEDU			0·458	−0·784	
			(3·324)	(1·601)	
ΔGOVT			0·049	0·130	
			(0·013)	(1·067)	
DEW			0·050	0·153	−0·103
			(2·966)	(3·018)	(1·110)
DNS			0·002	0·183	0·171
			(0·139)	(3·195)	(2·284)
Constant	6·001	−3·269	0·071	0·737	2·072
	(4·692)	(1·875)	(0·721)	(0·547)	(3·504)
OLS R^2	0·90	0·91	0·46	0·72	0·20