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THE ROLE OF LABOR IN REGIONAL MULTISECTORAL GROWTH MODELS

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PREFACE

This report is the fourth working paper in a series that have as their common concern the development of multisectoral models for the analysis of regional demographic and economic growth. The present paper outlines the general form of an integrated regional demographic and economic model and examines in detail the role of the labor force in such a model.

This work is being conducted under the sponsorship of a grant from the Economic Development Administration of the U.S. Department of Commerce. A complete listing of the Working Papers under this grant appears on the back page of this paper. They deal with regional patterns, development, and policies.

Andrei Rogers
Center for Planning and
Development Research
University of California, Berkeley
June 15, 1969

Working Papers on Multisectoral Models of Regional Growth

- #66 Andrei Rogers, "The Aggregation Problem in Demography," October, 1967.
- #81 Andrei Rogers and Susan McDougall, "An Analysis of Population Growth and Change in Slovenia and the Rest of Yugoslavia," June, 1968.
- #92 Andrei Rogers and Susan McDougall Choy, "Multisectoral Models of Regional Demographic and Economic Growth," February, 1969.
- #99 Susan Choy, "The Role of Labor in Regional Multisectoral Growth Models," June, 1969.

INTRODUCTION

This paper represents an effort to examine further the integration of demographic and economic models of regional growth. In a previous report¹ we identified the cohort-survival and input-output models as suitable for regional analysis. We discussed their characteristics and also various extensions that either contribute to the realism of the models or facilitate their linkage.

The first part of this paper is devoted to outlining the general form of an integrated demographic and economic growth model that uses the cohort-survival and input-output models as a base. Concentration is on the relationships among the various aspects of the economy and population and the assumptions necessary for a workable model. The second part is a detailed examination of the role of the labor force, and the third part presents some empirical findings on the response of the various sources of labor supply to changes in demand for labor.

¹Rogers and Choy (1969)

II. OUTLINE OF A REGIONAL GROWTH MODEL

Figure 1 is a diagrammatic representation of an outline of a regional growth model. No original basic methods of analysis are introduced, but rather an attempt has been made to modify and integrate existing techniques to provide a description of the major components of the regional demographic and economic system. Concentration in this section is on the form of the linkages between various parts of the model and the implications of the assumptions that are necessary to make the links possible.

The basic cohort-survival model summarizes the components of population change (births, deaths, and migration) in matrix form, allowing different rates for each subgroup. For an integrated regional model, the migration component is removed from the operator matrix and migration becomes jointly determined by the demand for labor and the characteristics of the existing population. The manner in which this is done will be described later.

The basic input-output model can be either closed, in which case it provides a complete description of all production, consumption, and investment activity, or it can be open, in which case only interindustry relationships are described. For this model we have chosen a partly closed model in which local investment is determined endogenously and consumption and exogenous investment are determined using other techniques.

There are two links between the models: consumption and labor. The population supplies labor in response to the demand of the economy and at the same time demands the economy to produce a certain output for its consumption. Construction of a workable, integrated, demographic and economic model, then, requires the identification of the response and demand mechanisms and development of models to represent them.

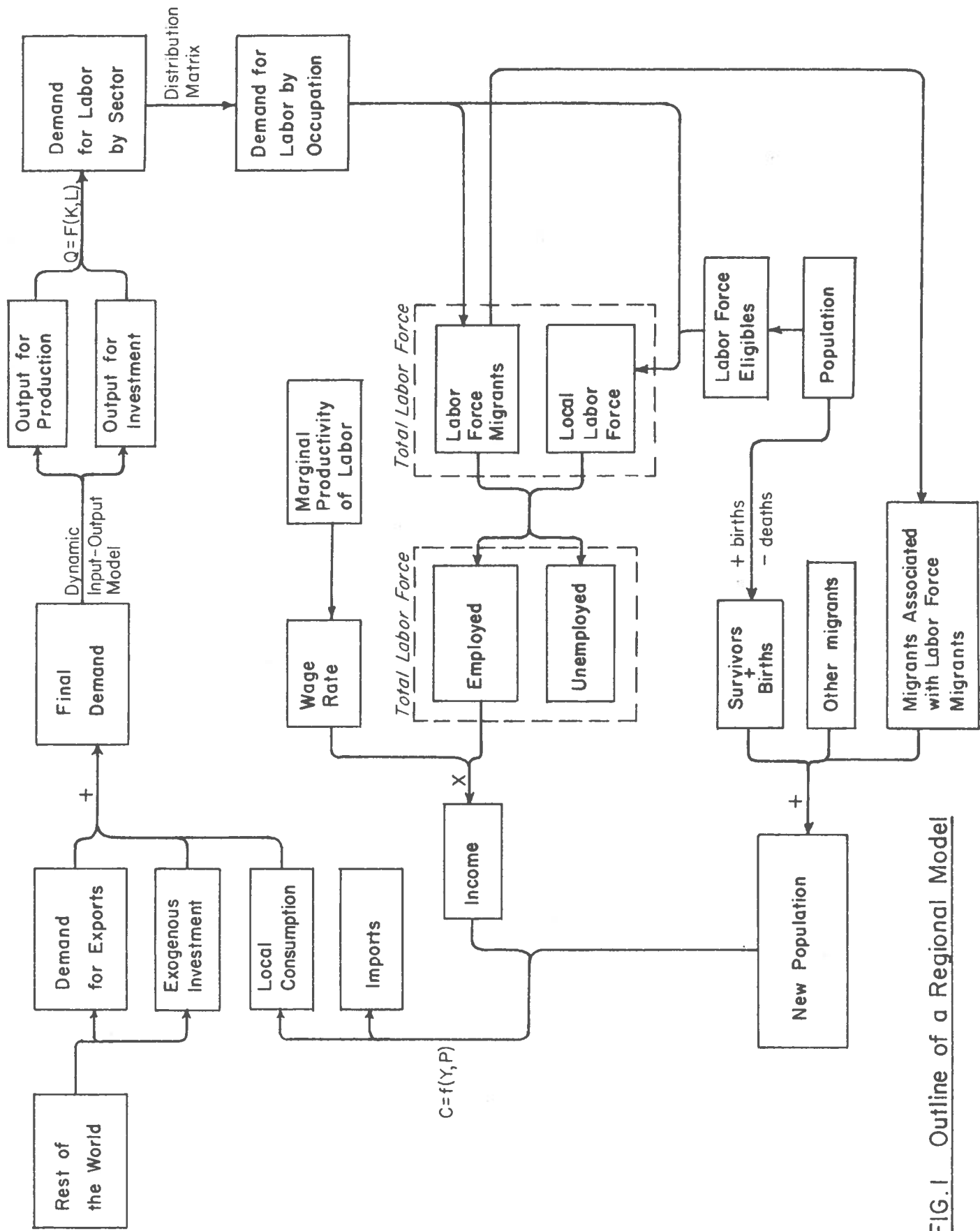


FIG.1 Outline of a Regional Model

The model can be solved recursively if certain assumptions are made. One is that the labor market is demand-determined, another that the wage rate is not affected by the relationship between supply and demand of labor, and finally, that export demand at a given time is determined independently of local demand at that time.¹ The implications of these assumptions will be noted where appropriate in the discussion that follows.

For our description of the model, we use total demand for output as starting point. It consists of demand for exports, exogenous investment, and demand for local consumption. Local consumption is determined from the existing population and its income in a manner to be described later in this discussion. Exogenous investment is predominantly government investment and, because it does not necessarily depend on economic factors, must be estimated on the basis of judgment rather than on past economic activity. Demand for exports is the link with the rest of the world and the method of its estimation is particularly important because it embodies a theory of regional economic growth.

There are two principal theories of regional economic growth: the sector theory and the export base theory. Briefly, the sector theory maintains that economic growth occurs mainly through internal development of specialization and division of labor. Stages of development from a subsistence economy to a highly industrial economy with a high export level can be identified, but a developing region in an industrialized country would not necessarily go through all the stages. According to export base theory, regional growth occurs when outside demand for its exportable products increases. The expansion of export-based industries

¹This, of course, does not eliminate the possibility of a multiplier effect of export demand on local activity, or the possibility that local activity affects the future export demand.

through a multiplier effect, results in expansion of locally-oriented industries such as trade and services. Clearly, neither theory alone is sufficient. The export base theory overemphasizes the role of exports and the sector theory concentrates too heavily on internal relationships. Each theory, however, contributes to our understanding of regional growth, and the ideas of both must be incorporated into our export demand function.

In our estimation of the level of exports demanded by the rest of the world, several factors must be taken into consideration. The ability of the rest of the world to consume a region's potential exports is one. The intimate relationship between the prosperity of the region and the prosperity of the rest of the nation cannot be ignored. Another is the ability of the region to produce goods that will be demanded for export. There has to be a reason why one region produces a product and exports it to another rather than the second region producing its own. The most plausible one is that the region has a comparative advantage for the production of certain outputs -- for some reason the cost of production may be lower at the exporting region. A cheap, abundant supply of one of the factors of production often creates such an advantage. Another factor is that the ability of a region to produce export goods is influenced by the size of that region. As a region grows, it becomes possible to produce a wider variety of goods (as postulated by the sector theory), which it can then export to regions not yet diversified enough to produce them.

The relationship of the regional economy to the rest of the economy can be taken into account by making export demands proportional to some measure of national prosperity such as the GNP. In fact, this is a convenient way of linking a regional model to a national one.¹ This takes

¹Bell (1967).

care of growth in a region due to overall growth of the national economy, but this is not sufficient because if a region is growing quickly relative to other regions, its share of the GNP may be increasing. Thus the size of the region relative to the nation and other regions must be explicitly taken into account. This particular relationship in our model needs further investigation and more precise specification.

The next step is to apply the dynamic input-output model to find the requirements for production and investment for each sector. The production requirements depend on the level and type of output demanded while the investment requirements depend on the rate of change of output over time. The latter relationship implicitly takes care of growth stimulated by either internal specialization or the multiplier effect. As a region grows, the proportion of consumer-demanded output produced locally will increase and the level of exports demanded will rise, both of which result in increased production and increased investment.

Assuming that natural resources and capital are abundant enough to allow the demand to be met, the input requirements of the other factor of production, labor, can be determined by introducing some form of the general production function, $Q = F(K,L)$, which relates output to capital and labor. Some of the many possible forms of this function are described in a previous report.¹ This is an important extension to the basic input-output model because it introduces a demographic variable, the labor force, that can be used as a link between the economic and demographic models.

It is important to note that the demand for labor in our model is a derived demand. It is not determined jointly with supply, but depends

¹Rogers and Choy(1969).

directly on output and the relationship between labor and capital. Herein lies a fundamental difference between national and regional models. At the national level the supply of labor is more or less fixed so investment must be manipulated to produce the desired level of output. The quantity of labor used under these circumstances is not independent of the supply. At the regional level, however, because of the mobility of labor, it is reasonable to assume that the supply of labor adjusts to meet the demand. For this reason, in a regional model the demand for labor can be derived from the demand for output without consideration of the supply of labor.

Since our population is better classified by occupation than sector of employment, a distribution matrix is used to transform demand for labor by sector into demand for labor by occupation. This is a refinement that is not crucial, but can be included if the occupational structure of the sectors is known and it definitely contributes to the realism of the model.

The assumption of a demand-determined labor market requires us to believe that the demand calculated using the above procedure will in fact be met. At first glance one might conclude that, because the labor market is demand-determined, the labor force size is known and the total population can be calculated from that. Also, the consumption function could be determined on the basis of this estimate of the population, making it unnecessary to introduce the demographic model at all. It is true that this would give us a rough approximation of the situation, but the model can be made far more realistic by using the demographic information provided by the population model.

Although it is known that the quantity of labor demanded will be supplied, it is important to know whether it will be supplied by the resident population, migrants, or both, because the particular combination that

results has important implications for the rest of the model. In-migration implies a larger population whereas changes in the labor force behavior of the residents does not. Moreover, a change in the labor force participation rate or a decrease in the unemployment rate will result in a greater income per capita because a larger amount of money is going to the same number of people. The size of the population and the income per capita are crucial to the determination of an accurate consumption function. Therefore we use the information about the characteristics of the resident population from the demographic model to help determine the potential of the resident population to supply labor. Migrants will make up the difference between labor supplied by the residents and labor demand. This is not to imply that the migrants only fill vacancies the resident population cannot fill. On the contrary, the two sources of supply react at the same time and are competing for the same jobs. The point is that the existing population has a limit on its ability to supply labor and if this potential is exhausted, the deficit will be made up by migrants rather than result in a shortage of labor. Only if we take into account these facts will we be able to construct a reasonably accurate description of the new population.

Once the amount of migration has been established, the new population can be determined. The total income of the population can be calculated by multiplying the wage rate by the labor force. This assumes that the wage rate is determined by the marginal productivity of labor rather than the relationship between supply and demand, but since the labor market is demand-determined, this seems to be the most reasonable assumption.

With information about the population and its income it is possible to derive a consumption function to determine the level and type of local consumption. The goods demanded that are not produced locally will be

imported. Since investment depends on the rate of change of output, consumption of locally-produced goods stimulates further activity but imports do not. As a region grows, the proportion of locally produced goods will increase relative to imports.

One iteration of the model is now been complete. The local consumption is added to estimated export demand and another cycle of calculations started. If desired, the coefficients of the input-output matrix and the birth and death rates of the cohort-survival model can be changed at this point to allow for changing technology and changing conditions of fertility and mortality.

This model has not yet been specified in enough detail to allow immediate application. However, hopefully it provides an outline of a suitable approach for linking demographic and economic models and provides a framework for the study of the role of labor, which is our main concern at this stage.

III. LABOR SUPPLY

In this section the type and magnitude of the responses of the various sources of labor supply are examined. The total supply of labor is determined by the demand for labor but the supply from any particular source depends on other factors as well as demand. An increase in the demand for labor can be satisfied from any or all of four sources: migrants, natural increase in labor force eligibles, unemployed persons, and labor force eligibles not presently in the labor force. Each source will not contribute equally, but it is probable that each source will contribute some of the new supply.

The important implications of the particular combination that makes up the new supply are mentioned in the Introduction but should be reiterated here. A change in the labor force participation rate or a decrease in unemployment will result in a greater income per capita because more wages will be going to the same number of people, but the size and structure of the population will not be affected. In-migration, on the other hand, implies a larger population and possibly a different age and sex structure, depending on the characteristics of the migrants.

Natural Increase

It can be safely said that the natural increase in the number of labor force eligibles at any given time is independent of the economic conditions and other sources of labor supply at that particular time (although it may not be independent of the conditions of some previous time). During each time period a number of people become eligible for the labor force (most frequently assumed to be 14 years of age) and a number of labor force eligibles die. Thus the size of the natural increase can be readily calculated by applying survivorship rates to the relevant segment of the population.

Labor Force Participation

In general terms, labor force participation depends on employment opportunities, competition for the jobs, and motivation to seek work. More specifically, employment opportunities include availability of jobs, attractive wages, or steady employment. Competition comes from any or all of the other sources of labor supply. Motivation includes the presence of other labor force members in the family, education, alternatives to labor force participation (for example, school attendance or work in the home) and so on. It would be expected that an increase in job opportunities would result in increased labor force participation, but it is possible that competition from other sources would tend to offset the increase at least slightly and perhaps significantly. Motivation is certainly very important at the individual level, but whether or not generalizations can be made about whole age and sex groups is another matter.

A fairly large number of studies of labor force participation has been done.¹ In the past, concentration has been on proving or disproving the "added worker" and "discouraged worker" hypotheses. Briefly, the "added worker" hypothesis is that during periods in which demand for labor is low, additional workers are encouraged to enter the labor force to supplement the family income. The "discouraged worker" hypothesis states that, when labor demand is low, potential workers are discouraged from entering the labor force and do not even bother to seek work.

The general concensus seems to be that both effects exist simultaneously and that the discouraged worker effect is dominant under at least some circumstances. That is, a decrease in employment opportunities results in a decrease in the labor force participation rate. However, the

¹Mincer (1966) is an excellent review of work done in this area to that time.

results are still being debated. The measure of economic conditions, one source of controversy, has most frequently been unemployment, and the conclusions have been drawn on observance that when unemployment increases, labor force participation decreases. However, unemployment is not a good measure of job opportunities. For one thing, it is possible that the competition effect is also being measured. The presence of a large number of persons seeking a few jobs may be discouraging as well as the scarcity of jobs. Also, unemployment may increase for reasons other than a scarcity of jobs.

Another interesting finding has been that the response to employment opportunities is very sensitive to age and sex. Prime-age males are relatively insensitive to changes in economic conditions in deciding whether or not to enter the labor force, while secondary workers are extremely sensitive.

A few studies of labor force participation have included mention of the influence of migration, but no one has been entirely satisfied with his interpretation of the results. Mincer was the first to consider it¹ and suggested that migrants are likely to have higher labor force participation rates than the population as a whole, which sounds reasonable. As a result, he believes that out-migration from an area lowers the labor force participation rate of that area while in-migration raises the rate for the area of destination. Empirical tests of this have been limited and conducted primarily to ascertain whether or not inclusion of a migration variable changes the value of the coefficient of the employment opportunities variable rather than to study the relationship between labor force participation and migration itself. The results have been inconclusive (see also

¹Mincer (1966) p. 80-81.

Bowen and Finegan,¹ Cain,² and Parker and Shaw³) leaving no one sure as to how to deal with migration. Those who have considered migration, however, have expected the relationship to be positive and were puzzled when it was negative in some cases.

The relationship clearly needs more careful consideration. If the number of migrants arriving in an area were large relative to the size of the receiving population, the effect might well be to raise the overall participation rate. However, if the number of migrants were not relatively large, there is evidence to indicate that the net effect of migration may not be to raise the overall labor force participation rate.

First of all, in-migrants are a source of competition for jobs for those thinking about entering the labor force and may have a discouraging effect on the resident labor force eligibles. Secondly, Vanderkamp⁴ suggests that return migration is an important part of total migration and that new migration, from A to B, for example, is stimulated by better employment opportunities at B, whereas return migration from B to A will be stimulated by unfavorable conditions at B. If this is the case, and his empirical results substantiate his theory, migrants may not always have a higher labor force participation rate than the population as a whole.

Some of the confusion about the relationship between labor force participation rates and migration may be a result of the formulation of the relationship. Previous studies have tried to relate participation rates

¹Bowen and Finegan in "Discussion" following Mincer (1966) p. 115-117.

²Cain (1967)

³Parker and Shaw (1968)

⁴Vanderkamp (1968)

to migration when in fact the change in the rates may be more appropriate for study. If it is assumed that migrants do not displace residents already employed, we could not expect the labor force participation rate itself to be influenced by migration. However, since migrants are a source of competition for new jobs, the change in the labor force participation rate over a period of time would be expected to be affected by the migration rate during that time period. (For similar reasons, all the variables are formulated in terms of changes in the variables over time.)

Motivation for entering the labor force has been shown to be significant in some studies where the population has been broken down by age and sex. For example, the labor force participation rate of young people 14-24 may be related to the number enrolled in school, and the labor force participation rate of married women may depend on their husbands' incomes, their own education, and so on.

The basic relationship to be examined in this study is

$$L_i = f(D, C_L, X_i) \quad (i = 1, \dots, n)$$

where

L_i = change in the labor force participation rate for the i^{th} age and sex group,

D = change in the demand for labor,

C_L = competition relevant to labor force eligibles not presently in the labor force,

X_i = other factors specific to the i^{th} group,

n = number of age and sex groups.

Unemployment

The importance of the unemployed as a source of labor supply is difficult to determine because it is very possible that a significant

proportion of the unemployed are actually unemployable given their skills and the character of the existing demand. If this is the case, all the unemployed are not a source of competition. If the proportion of unemployable to unemployed is relatively constant, our results would not be much affected, but if it is not, the unemployed as a source of labor supply may be difficult to account for. It would certainly be advantageous to subtract out the unemployable in labor supply studies of this type, but it is not attempted here.

The principal determinants of unemployment are the availability of jobs, competition for the jobs, and the suitability of the unemployed for the jobs. As the demand for labor increases, the unemployment rate should decrease. Differential responses to employment opportunities according to age and sex might be an indication of the "employability" of that group. The presence of competition (from migrants, natural increase in the number of labor force eligibles, and new entrants into the labor force) should tend to raise the unemployment rate. Suitability for jobs available can be measured by comparison of the demand for labor by occupation with the occupations of the unemployed. However, in this study we do not have such detailed data so our formulation of the relationship of unemployment to its determining factors does not include a variable to represent suitability.

The relationship to be examined in this study is

$$U_i = f(D, C_U) \quad (i = 1, \dots, n)$$

where

U_i = change in the unemployment rate for the i^{th} group,

D = change in the demand for labor,

C_U = competition relevant to the unemployed,

n = number of age and sex groups.

Migration

Migration is a crucial component of labor supply. The response of the resident labor force to increased demand for labor has a limit so if the demand is to be met, the burden of adjustment falls on the migrants.

Migration is very difficult to study. For one thing, definition of migrants requires boundaries to be defined and they are inevitably somewhat arbitrary. The appropriate time period is also difficult to define and the one chosen is also arbitrary.

Migration is a multi-dimensional phenomenon, but studies of it are of three major types, each of which illuminates a different aspect:

- (1) place-to-place flows,
- (2) population change of a place due to migration,
- and (3) characteristics of migrants.

Analysis of place-to-place migration treats migration as a directional flow, with the explanation of these flows resting primarily on differences between the places such as relative income, relative unemployment, and the distance between the places.

Lowry presents a very interesting hypothesis about the assymetry of migration, maintaining that out-migration from a place is a function of the size and structure of that population and that in-migration is dependent on the attractiveness of that place.¹ The important implication of this finding is that the explanation of net in-migration can be found without direct comparison of the characteristics of the receiving area to those of the sources of the migrants. In other words, a certain number of people move anyway, and the conditions in a region determine what its share of the movers will be. This conclusion validates the second kind of study. Lowry suggests that this type of

¹Lowry (1966) p. 23-25.

analysis is less useful for scientific explanation, but may be a more useful tool for forecasting the migration component of population change in specific areas. Since this is our primary motive for studying migration at this time, Lowry's findings are of great interest to us.

The third type of analysis, the study of the characteristics of migrants in general terms without reference to place, provides useful information about the socio-economic characteristics of migrants and their motives for moving. People seem to move to better their economic situations, which covers a wide range of possibilities, including finding a job when unemployed, finding a better job, better wages, and so on. The probability of migrating varies with age, sex, occupation and other socio-economic characteristics.

In this study we are concerned with population change due to migration, and, accepting Lowry's conclusion, therefore focus attention on the conditions of the receiving area. The important conditions are assumed to be economic opportunities and competition.

Lowry has done a cross-sectional study of net migration into SMSA's from 1950-1960. The migration rate was found to be very significantly positively related to change in employment (used as a measure of demand for labor) and negatively related to the rate of natural increase. The latter relationship strongly supports the competition hypothesis and Lowry, in fact, hints at this in his interpretation of the results. In this model we suggest that the unemployed and potential labor force members are additional sources of competition.

In a study of immigration (from foreign countries)¹ immigrants are viewed as substitutes for native workers and it is suggested that immigration of foreigners will displace secondary workers, lessen rural-urban migration, and raise the unemployment rate of natives. Since all of the effects could be

¹Reder (1963).

caused by in-migrants from other areas too, this may be interpreted as another formulation of the competition hypothesis. Unfortunately, he has not attempted to test this idea empirically.

High income levels and increasing income levels would be expected to encourage in-migration, but Lowry, expressing income as change in income (1950-1960) and also as average income, obtained negative coefficients in both cases. This is difficult to account for. It is possible that a high average income merely implies a high cost of living, which migrants may attempt to avoid. The cost of living varies significantly with the city in question and as a result makes comparison of wages difficult. Also, the average wage of a region is likely to depend on the employment structure of that region. A high average wage in one area does not imply that the wages paid to a machinist, for example, are any higher in that area than in any other place.

Because of these complications, and the relative lack of success in the use of this variable in previous studies, we will not attempt to include an income variable in this study, although we realize that at the individual level expected change in income is very important in making the decision to move.

In this model we will estimate migration as follows:

$$M = f(D, C_M)$$

where

M = net migration rate

D = demand for labor

C_M = competition relevant to migrants.

We will not try to estimate migration by age and sex, although certain groups definitely have greater propensities to migrate than others. When a member of the labor force responds to economic conditions by migrating, he takes with him members of other age groups (his family). Misleading results

would be obtained, then, if we estimate the response of middle-aged women, for example, to employment opportunities. A better approach would be to estimate the number of labor force migrants and from study of the general characteristics of the labor force determine the change in total population due to migration of labor force eligibles.

IV A LABOR SUPPLY MODELFormulation of the Model

The model to be estimated has 13 equations:

$$(1) - (6) \quad L_i = \alpha_{i0} + \alpha_{i1}C_L + \alpha_{i2}D + \alpha_{i3}X_i + e_i \quad (i = 1, \dots, 6)$$

$$(7) - (12) \quad U_i = \beta_{i0} + \beta_{i1}C_L + \beta_{i2}D + e_i \quad (i = 1, \dots, 6)$$

$$(13) \quad M = \gamma_0 + \gamma_1C_M + \gamma_2D + e$$

where L_i = change in the labor force participation rate 1950-1960 for the i^{th} population group,

U_i = change in demand for labor 1950-1960 for the i^{th} population group,

M = net migration rate 1950-1960,

D = change in demand for labor 1950-1960,

C_L, C_M, C_M = competition for labor force eligibles, not in the labor force, unemployed, and migrants, respectively,

X_i = variable specific to the i^{th} population group,

α, β, γ = parameters,

e = error term.

Our study is a cross-sectional one using 1950 and 1960 data for 41 SMSA's. (A list of the SMSA's can be found in the Appendix.) The labor supply problem is probably better studied in time series than cross-section because the adjustment of the labor supply to economic opportunities is clearly a dynamic process, but there are serious data problems encountered in finding time series data for small areas. The most serious problem is the lack of information about migration. The only direct source of information about migration is from the census question as to where you lived a specified number of years ago. However, the number has varied and has never coincided with a decennial census. Nevertheless, net migration can be found indirectly.

The difference between the expected population in 1960 as calculated by applying survivorship and birth rates to the 1950 population and the actual 1960 population gives the net migration component of population change. Because of the importance of migration in our model, we are forced to use a time period for which migration data is available. Otherwise, such a long period would probably not be used.

Treatment of Variables and Data

Change in labor force participation rate (L_t) -

The change in the labor force participation rate is the difference between the rates in 1950 and 1960, the rate being the percentage of the population in a particular population group that is in the labor force (that is, employed or unemployed looking for work). The six population groups are ages 14-24, 25-54, and 55+ for males and for females. These particular groups were chosen because they are roughly representative of the stages in labor force participation. In the youngest group participation is not always necessary because these people might be still supported by their parents or enrolled in school. In other words, alternatives to labor force participation are available. Males in the middle age group do not usually have much choice and would be expected to have a fairly constant participation rate. A large proportion of females in this group, however, have families and therefore have work in the home as a strong alternative. For the oldest age groups, retirement becomes a significant alternative. The decision to retire at any particular time might well be related to job opportunities at that time.

Change in demand for labor (D) -

There does not seem to be any controversy over the appropriateness of demand for labor as a measure of employment opportunities, but there is disagreement over how it should be measured. Change in employment is often used as a proxy for change in demand, but employment will always be a large and

positive component of the labor force and therefore is not a good measure. Since employment is part of the labor force, any sampling errors in employment will also appear in the labor force. Additionally, some groups may experience employment-demand fluctuations independent of the overall market or specific labor-supply fluctuations that result in employment fluctuations of those groups. Each of these errors tends to bias the coefficient upwards.¹

Unemployment is also sometimes used as a measure of demand, but it is not a good indicator of job availability because it includes the unemployable. Mincer says that the success of its explanatory power in labor force participation studies may be due to the fact that the labor force appears in the denominator of the unemployment rate and the numerator of the labor force participation rate, possibly leading to a spurious negative correlation.²

Clearly, a variable more independent of the labor force is desirable. One possibility, suggested by Mincer³ and used successfully by Pfannestiel,⁴ is the help-wanted advertising index, a measure of job vacancies.⁵ Pfannestiel found the index positively related to labor force participation rates and Mincer found that the graphs of the national labor force participation rate of secondary workers and the national help-wanted advertising index over time show marked similarity. We represent change in economic opportunities as the ratio between the index in 1960 and 1951. (1951 is used because the new

¹Mincer (1966) p. 89.

²Mincer (1966) p. 79.

³Mincer (1966) p. 93.

⁴Pfannestiel (1968).

⁵National Industrial Conference Board (1964).

index has not been calculated for 1950. Since we are considering change over a ten-year period, which means we are probably measuring only long-run adjustments, this should not cause a great deal of difficulty.)

Change in unemployment rate (U_i) -

To avoid spurious negative correlation, we express the unemployment rate as the percentage of the population in specific group that is unemployed, rather than as the percentage of the labor force that is unemployed, which is more common. The change in the rate is the difference between the 1950 and 1960 rates and the population groups the same as used for the labor force participation rates. Because each age group denotes a different "stage" in labor force behavior, the unemployment characteristics of the group might be different too.

Net migration rate (M) -

Net migration data was obtained from a published source¹ where it was calculated as a residual after finding the population expected in the absence of migration. Only the population over 15 years was included. The rate is expressed as the number of migrants per 1000 1950 population 15 years and over.

Competition (C_L , C_U , C_M) -

For each source of labor supply the competition comes from the natural increase in labor force eligibles and the two sources of labor supply other than itself. The natural increase is calculated here as the difference between the population in 1960 and 1950 excluding migrants. The rate of natural increase in the number of labor force eligibles is expressed as the natural

¹U.S. Department of Agriculture, Economic Research Service (1965).

increase per 1000 1950 population 15 years and over. To make the components additive, the labor force participation and unemployment rates are expressed as rates per 1000 population rather than percentages.

Other variables (X_1) -

In three cases additional variables are included to explain the change in labor force participation rates. For both male and female first age groups we include the change in the percentage of that age group enrolled in school (SC). An increase in the percentage enrolled in school implies a decrease in the labor force participation rate. Unfortunately, though, some people enrolled in school also have part-time jobs and therefore are considered to be in the labor force too, which leads to some double-counting.

The other variable included is the change in the percentage of women over 25 years who have completed high school (HSF). This was thought to possibly be influential in determining the change in the labor force participation rate of women 25-54 as women with a high school education might be better prepared for jobs and therefore more inclined to work.

Change -

The measurement of change deserves some consideration because there are different ways of expressing change. Because the demand for labor measure is an index, change in demand for labor must be expressed as a ratio rather than as absolute change. Changes in the other variables can be expressed as absolute changes or as ratios too. Regressions were done using both, but since the latter yielded far more reasonable results, we will focus our attention on this expression of change.

Results

When the competition variables are constructed as suggested in the previous section there are three jointly determined variables in our system of equations: the change in the labor force participation rate, the change in the unemployment rate, and the net migration rate. In other words, these variables appear as both dependent variables and as components of independent variables, making it necessary to solve the equations simultaneously. In such cases three stage least squares is an appropriate regression technique to use to obtain efficient estimates of the coefficients.

However, when this was attempted¹, serious problems were encountered. The first stage of the computations involves obtaining estimates of the competition variables in terms of all the exogenous variables in the system (which are D, SC, HSF). In subsequent computations these estimates are used in place of the observed values of competition. The overwhelming importance of the change in demand for labor relative to the other exogenous variables in determining estimates of the competition variables causes the problem, because the estimates become almost proxy variables for change in demand for labor. In the structural equations, then, when both change in demand for labor and a close proxy of this variable appear as independent variables in all the equations, it is impossible to obtain reliable estimates of their coefficients because of their high degree of collinearity.

Rather than ignore competition entirely, however, in subsequent analysis we use natural increase in labor force eligibles as a measure of competition.² Since natural increase is not dependent on demand for labor there are no problems of collinearity. In this form of the model there are not jointly determined

¹Using a program by Zarembka (1968).

²Therefore $C_L = C_U = C_M = C$.

variables so our model can be treated as a series of single equations and ordinary least squares used to estimate the coefficients.¹ The results of the regressions are presented in Table 1.

First let us consider our results in terms of the effect of the change in demand for labor on our dependent variables. We should consider the reliability of the job vacancy variable as a measure of change in the demand for labor and also the importance of changes in the demand for labor in determining changes in the labor force participation, unemployment, and migration rates.

Our results indicate that the net migration rate is significantly related to our measure of change in demand for labor. It is widely accepted that migration is related to employment opportunities for almost any time period and, in fact, any measure of demand for labor that did not indicate this would be very suspect. Our measure's significance in determining the net migration rate suggests that it may be a good indicator of change in demand for labor and is at least a reasonable one.

Our results indicate that the influence of a change in the demand for labor on change in labor force participation rates is quite significant for some of the groups with other alternatives, males and females 14-24 and males 55+. The young people have school enrollment as a definite possibility and if jobs are scarce they are more likely to remain in school than if jobs are plentiful. For males over 55, retirement is a definite possibility and the decision to stay in or withdraw from the labor force may be influenced by an abundance or scarcity of jobs. As expected, the prime-age male group has the smallest coefficient, indicating that of all the groups, labor force participation of this one is influenced least by labor market conditions. The results also

¹Using a program by R. Choy (1968).

Table 1. Regression Results

		DEPENDENT VARIABLE	CONSTANT	C	D	SC	HSF
Change in Labor- Force Participation Rate	(1)	Males 14-24	2.085** (.5400)	-.0002 (.0009)	.1490 [†] (.0924)	-.9499* (.4177)	
	(2)	Females 14-24	1.656** (.5781)	.0009 (.0009)	.2190* (.0989)	-.7474 [†] (.4472)	
	(3)	Males 25-54	1.022** (.0725)	-.0001 (.0006)	.0895 (.0650)		
	(4)	Females 25-54	1.263** (.3923)	.0004 (.0009)	.1245 (.0930)		-.1400 (.3209)
	(4a)	Females 25-54	1.098** (.1003)	.0003 (.0009)	.1332 (.0899)		
	(5)	Males 55+	.8344** (.0809)	.0001 (.0007)	.1510* (.0725)		
Change in Unemployment Rate	(6)	Females 55+	1.228** (.1214)	.0017 (.0011)	.0960 (.1089)		
	(7)	Males 14-24	1.049** (.1372)	.0005 (.0012)	-.0904 (.1229)		
	(8)	Females 14-24	1.004** (.1442)	.0009 (.0013)	-.0381 (.1293)		
	(9)	Males 25-54	1.188** (.1409)	.0024 [†] (.0012)	-.3210* (.1263)		
	(10)	Females 25-54	1.244** (.1441)	.0015 (.0013)	-.2235 [†] (.1292)		
	(11)	Males 55+	.8029** (.1302)	.0038** (.0011)	-.1242 (.1167)		
Net Migration Rate	(12)	Females 55+	1.431** (.3312)	.0072* (.0029)	-.4287 (.2969)		
	(13)	Total Popula- tion 15+	-155.8** (71.92)	-.3215 (.6272)	330.5** (64.46)		

** Significantly different from 0 at the .01% level.

*Significantly different from 0 at the .05% level.

†Significantly different from 0 at the .10% level.

indicate that change in the demand for labor does not have much influence on labor force participation behavior of women from 25-54 and 55+. Since a large proportion of these women are married, they would be largely secondary workers and therefore would be expected to be sensitive to changing labor market conditions. However, this may be true only over shorter periods than the ten year one we are considering here. These people may account for an important part of the monthly flows in and out of the labor force but their long run behavior may depend on factors other than long run trends in labor market conditions.

All the coefficients for change in the demand for labor in the equations to estimate change in the unemployment rate are negative, as expected. However, for the younger and older groups they are not significantly different from zero. This might imply that these people are unemployed for reasons other than lack of jobs, such as unsuitability for available jobs. The results also imply that the sensitivity of changes in unemployment to changes in demand for labor is greatest for the middle groups.

The coefficients of the competition variable are not significantly different from zero in the labor force participation equations and most have positive signs rather than the expected negative ones. However, when the model is reformulated omitting this variable, all the coefficients for change in demand for labor are larger, suggesting that when competition is ignored, the effect of changes in demand for labor is overestimated. Error from such overestimation is exactly the reason for introducing the competition variable in the first place.

The coefficients of the competition variable in the unemployment equations have the expected positive signs. The coefficients are considerably larger than for labor force participation, implying that, in the long run, competition affects unemployment more than it affects labor force participation.

The coefficient of the competition variable in the migration equation has the expected negative sign.

It is unfortunate that it is not possible in this model to use a complete measure of competition. Although the effects of natural increase in labor force eligibles seem to be small, they do seem to exist, suggesting that competition must not be ignored. In most SMSA's in our sample, net migration over the ten year period was greater than natural increase and in some cases, more than twice as large, so natural increase is by no means a complete measure of competition.

As expected, the increase in the proportion of young people enrolled in school tends to lower the labor force participation rate. The effect would be even greater if it were not for the fact that many students are both enrolled in school and participating in the labor force. The high school completed variable is not significantly different from zero and has the wrong sign. Therefore, the equation was reformulated without it. In the individual case, education might be influential, but it seems that it is not possible to make a generalization for a whole SMSA.

Conclusions

Although we have not developed a labor supply model ready for immediate use in a regional model, we have answered some important questions about the labor supply mechanism. For one thing, we have established that at least some part of each source of potential labor supply responds to changes in demand for labor over a ten year period. We can also conclude that competition among the sources should be taken into account.

However, many questions about the labor supply mechanism still need to be answered. One of the most important is the timing of the responses. Over long periods of time, natural increase and migration are probably the most important sources of labor supply, but in the short run (say in terms of months)

the major adjustments are probably made by changes in unemployment and movements in and out of the labor force. Thus, although for any time period there may be responses by each source of supply, their relative importances depend on the time period involved.

Time series studies for small areas are badly needed, but as mentioned above, migration data are scarce. Theoretically, net migration could be calculated for any time period as a residual if population and vital rates are available, but even for the ten year period there is enough discrepancy between net migration calculated as a residual and net migration estimated by adding and subtracting births and deaths to make some adjustments to the migration calculated as a residual necessary. It therefore might be difficult to obtain reliable migration data for small areas for short time periods using this method.

The question of age grouping is another aspect of the model that needs further attention. For example, perhaps married women with husbands present should be distinguished from other women when studying labor force behavior, or prime-age males should include those 24-65+ rather than 24-55+. As indicated above, classification by occupation would also be valuable if demand for labor could also be so classified.

Measurement of demand for labor is another problem. For reasons explained above, we did not want to use change in employment as a measure of change in demand for labor. However, if our model is to be a predictive one, the obvious measure of future demand for labor is the expected change in employment, not the change in job vacancies. This makes our labor supply model unsuitable for prediction in its present form.

In spite of the number of problems that still need to be solved before this labor supply model is ready for application, it is hoped that this study has contributed to the understanding of the labor supply mechanism. It is also hoped that by outlining the general form of the regional model of which the

labor supply model is a part, the role of labor as a link between demographic and economic models of regional growth has been clarified. The importance of using the information provided by both models in constructing a labor supply model to link them cannot be emphasized too strongly.

APPENDIX

The SMSA's used in the study were chosen on the basis of the availability of all the required data. The 1960 definition of each SMSA was used and data for 1950 were assembled to correspond with these boundaries by adding or subtracting counties for SMSA's whose definitions changed.

The SMSA's used in the study are:

Albany-Schenectady-Troy, New York

Allentown-Bethlehem-Easton, Pennsylvania

Atlanta, Georgia

Baltimore, Maryland

Birmingham, Alabama

Charlotte, North Carolina

Chicago, Illinois

Cincinnati, Ohio-Kentucky

Cleveland, Ohio

Dallas, Texas

Dayton, Ohio

Detroit, Michigan

Houston, Texas

Indianapolis, Indiana

Jacksonville, Florida

Kansas City, Missouri-Kansas

Knoxville, Tennessee

Los Angeles-Long Beach, California

Louisville, Kentucky

Memphis, Tennessee

Milwaukee, Wisconsin

Minneapolis-St. Paul, Minnesota

Nashville, Tennessee

New Orleans, Louisiana

New York, New York

Oklahoma City, Oklahoma

Philadelphia, Pennsylvania-New Jersey

Pittsburgh, Pennsylvania

Richmond, Virginia

Rochester, New York

Sacramento, California

Salt Lake City, Utah

San Antonio, Texas

San Bernardino -Riverside-Ontario, California

San Diego, California

San Francisco, California

Seattle, Washington

St. Louis, Missouri-Illinois

Syracuse, New York

Toledo, Ohio

Tulsa, Oklahoma

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