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# Population Change and Demand, Prices, and the Level of Employment

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EVER since Keynes set forth his theory of income determination, demographic variables have been discussed as possible determinants of effective demand, and consequently of the level of unemployment. Declining population growth was one of the major features of the secular stagnation thesis in the late 1930's, and its present rapid growth in the United States is often cited as a basis for optimism about the future of business in the 1950's.

This paper will be a reexamination of the effect of population change on aggregate demand. Its scope is deliberately restricted to demand, and effects on the capacity of the economy to produce will be intentionally neglected. We shall be concerned with how fully productive factors are used rather than with their capacity when used; with unemployment and inflation rather than with the level of living that an economy could provide at full employment. The most primitive Keynesian model of income determination will be used. It will be assumed that when alternative levels of national income are visualized, consumption expenditures will be a rising function of income; that net private investment is not directly dependent on current income, or perhaps is higher at higher alternative national income; and that government expenditures for goods and services are (with exceptions to be noted later) to be considered an independent variable. National income settles at a level where the three major components equal the total, or where (in the familiar diagram of Samuelson's *Economics* or other introductory texts) $C$ plus $I$ plus $G$ intersects the 45° line. As part of this theory, it is assumed that for ranges of income implying substantial unemployment, higher national income usually takes the form of increased output and employment, while with full or nearly full employment a higher equilibrium national income implies merely higher prices.

Demographic variables affect aggregate demand (and thereby national income and employment or prices, or both) by having an effect on (*a*) the consumption function; (*b*) net private investment; or (*c*) government expenditures on goods and services. In considering the effect of population on each of these components I shall attempt, where possible, to estimate the magnitude as well as the direction of the relationship. An estimate will also be made of how much difference there would have been in income and employment in years prior to 1957 had certain demographic features of 1957 been present.

The basic technique of analysis that will be employed is simple. A schedule relating one of the principal components of national income to alternative levels of the total will be assumed *with a given population*. Our question will be: How would the schedule be changed if the population differed in various ways?

A word must be said about the demographic variables that will be considered. These will be various measures relating to the *age composition* of the population, and the *growth rate* of the population. It will frequently be convenient to treat age composition and growth independently, despite the fact that variations in the growth rate typically cause changes in age composition—and that the growth rate in turn is powerfully affected by age composition.[1]

When age distribution is the variable, the comparison will be among populations with the same number of persons in the ages of most intense labor force participation (roughly ages 17 to 69 for males), but with different numbers above and below these ages. We shall ask, for example: How would the consumption function be changed if the given number of persons aged 17–69 had more persons under 17 and over 70 dependent on them?

When growth is the variable, the basic comparison will be of populations the same in size, but differing in growth rate. We shall ask, for example: How would the levels of investment be affected if a given population were and had been growing steadily at a higher rate than the actual one?

### *Age Distribution and the Consumption Function*

The consumption function defines the consumption expenditures that would take place at all relevant levels of national income. If it is to be a determinate function, forces other than national income (distribution of personal income among spending units, retention of earnings by corporations, tax rates, anticipated price changes, and so on) that might affect consumption must be either trifling, or must themselves vary in a predictable way with national income. One of the forces that might affect

[1] Cf. Frank W. Notestein's paper herein; A. J. Coale, "How the Age Distribution of a Human Population is Determined," *Cold Spring Harbor Symposia on Quantitative Biology*, Vol. XXII, pp. 83–88, and the references cited there.

consumption is the number of dependents that income recipients support. The number of dependents differs at different levels of national income, even if the population itself is assumed identical. At lower levels of employment, formerly self-supporting persons become dependent. Such differences in dependency status at different national income levels are, however, allowed for within the consumption function. The question we want answered is this: Would consumption expenditure at each alternative national income be different if, because of more persons under 17 and over 70, income recipients had more dependents to support? The answer, both from common sense and from empirical evidence, is yes.

Suppose a larger population is compared with the given population, the extra persons all being under 17 or over 70. Suppose further that the additional dependents are pictured as belonging to existing households. The most likely effect upon household budgets at any given disposable income would be an increase in expenditures. True, there might be an offsetting tendency to save specifically for the future welfare of children. Thus a family with an additional dependent child might save more (out of a given income) with the aim of establishing a fund for the child's college expenses. On balance, however, most households would find their consumption enlarged and their saving reduced by an extra member.

Analysis of the results of surveys of consumers' expenditures supports this conclusion. After examining some half a dozen surveys conducted between 1888 and 1948 in the United States, Dorothy Brady has estimated that at a given income level consumption expenditures increase at the 6th root of family size.[2] On this basis, one would expect a consumption function nearly one per cent higher at every point if extra dependents made a population 6 per cent larger.

The consumption function, it appears, is sensibly affected by demographic variables. The upward shift of the consumption function arising from a 6 per cent greater population if the increase consisted entirely of dependents would yield a national income nearly $k$ per cent higher, where $k$ is the multiplier. The effect on national income might be some 2 or 3 per cent.[3]

[2] Raymond Goldsmith, Dorothy Brady, and Horst Mendershausen, *A Study of Saving in the United States*, Vol. III, Princeton University Press, 1956, p. 211.

[3] If the extra dependents are visualized as constituting in part *additional households* it seems clear that the effect on the aggregate consumption function would be enlarged, since there are economies of scale in consuming while "doubled up"; and with separate households, aggregate consumption (for a given total income) would tend to be higher still.

### *Population Growth and the Consumption Function*

An implication of the 6th root relationship estimated by Brady is that an $x$ per cent annual growth of population raises the consumption function annually by something like $x/6$ per cent.[4] If non-consumption expenditures $(I + G)$ were unchanged, equilibrium national income would increase annually by $kx/6$ per cent.

### *Population Growth and Investment (Other than Housing)*

The most discussed effect of population on aggregate demand is the effect of population *growth* on net *investment*. The belief that population growth serves to stimulate investment gave population growth a prominent part in the theory of secular stagnation. Most formulations of this doctrine merely pointed out that investment is needed if a growing population is to have even a constant level of living, and did not show in detail how this need is translated into decisions to invest more.[5] Some elaboration of this question is justified.

The Keynesian view is that additional investment occurs as long as the marginal efficiency of capital exceeds the interest rate, or, alternatively, as long as the net receipts expected as the consequence of the purchase of capital equipment exceed its cost. Why should expected returns from capital equipment be greater with a faster growth of population?

The principal element making expected returns more promising is an expected higher demand for the product. As a general proposition, expected total demand for products can be taken to depend on the expected course of national income. Total national income can rise without population growth, provided there is an increase in per capita income. In fact, with no growth at all, it takes only a sufficient expected increase in per capita income to yield *any* specified rise in expected total sales. This was a point made repeatedly by opponents of the stagnation thesis—that "investment outlets" exist so long as per capita incomes can be raised.

While rising individual incomes can provide greater prospective sales

[4] This conclusion is somewhat compromised by an implicit assumption that a given income would be distributed to the same earners in both years, and spent on a larger number of consumers in the second year. If we permit income redistribution as a concomitant of growth, the applicability of Mrs. Brady's rule is not so clear.

[5] Keynes did say on this score that investors are predominantly influenced by past experience. Past experience in turn would show that population growth tended eventually to rectify mistakes of overinvestment. However, as a general proposition it is growth of *income* (not population) that makes demand overtake any given potential supply. J. M. Keynes, "Some Economic Consequences of a Declining Population," *The Eugenics Review*, Vol. 29, no. 1, April, 1937, pp. 13–17.

to justify investment, the question remains: *ceteris paribus*, does faster population growth make the growth of total income more likely or more rapid? There are two reasons for supposing it would. First, a faster growing labor force can be expected eventually to cause a higher level of future employment and (with a positive marginal product of labor) a larger national income. Next year's increment to the labor force might simply be added to the unemployed. However, it is surely a reasonable expectation that in, say, fifteen years a steady annual increase in the labor force would add to the number employed. To assume that employment would *not* increase with growth even during the life of very durable equipment is to postulate a very inflexible economy indeed. Second, growth tends to raise the consumption function, as was shown earlier.

Finally, some forms of investment involve less risk when population is growing, even though the expected course of total income is considered independent of population growth. Such investment is in industries where the demand is particularly responsive to numbers and relatively insensitive to average incomes. Food consumption, the purchases of certain consumers' durable goods (household "necessities" such as refrigerators), or of semi-durables (such as children's clothing) might be expected to increase with a *constant* total national income but a growing population. Investment in these industries would take place more readily with rapid than with slow population growth, even with no assumed relation between growth of total income and numbers of persons.

Aside from these rather abstract arguments, there is ample testimony that investors are reassured by rising numbers. A few citations will document what most newspaper readers have noticed: business analysts and spokesmen consider population growth a favorable factor of major importance. *Business Week* ran an article entitled: "The Why behind the Dynamic 1950's. Overall Population Growth is One of the Mainsprings of Prosperity. . . .", (November 10, 1956), and *U.S. News and World Report* carried another entitled: "A Bonanza for Industry—Babies. 60 Million More U.S. Consumers in the Next 19 Years." (January 4, 1957).

I suspect that the basis for the confidence that the business community derives from the prospect of population growth is partly psychological. The future of human events (especially of business trends) is so opaque that an element whose future appears relatively assured is given grateful attention.[6] An investor who must decide the likely course of public

[6] Any great confidence in the validity of forecasts of future births and future population growth is misplaced. See Harold F. Dorn, "Pitfalls in Population Forecasts and Projections," *Journal of the American Statistical Association*, 45, 1950, pp. 311–334; John Hajnal,

tastes, of government tax policies, of competitors' behavior, of wages, and the prices of materials is gratified to find that the Census Bureau publishes a set of estimates of future population growth.[7] When the investor finds a variable projected convincingly and apparently competently by experts, it is not surprising that he gives it great weight.

While it is clear enough that population growth influences investment, there is no very satisfactory basis for expressing the relation in quantitative terms. All that can be asserted with confidence is that the prospect of faster growth leads to more investment. Any numerical formulation of investment as a function of simple demographic variables is more specific and invariant than is warranted. On the other hand, to omit such an important demographic force from our quantitative estimates would be more misleading still.

In the absence of a formula that can be accepted as truly representative, the best choice is a simple one. The simplest assumptions are that investors expect the indefinite continuation of current growth rates, and that extra people are expected to have the average income that would prevail in their absence. These assumptions lead to the following expression:

$$I = (r' - r)(NI)m \tag{1}$$

where $I$ is the increment in non-housing investment that results from an annual growth rate of $r'$ rather than $r$, $NI$ is the national income expected (next year) with the growth rate $r$, and $m$ is the non-housing capital/output ratio. $NI$ may (as a further simplification) be taken as approximately equal to current national income.

### *Demographic Factors and Investment in Housing*

This section might logically be devoted to a discussion of investment by households. The usual convention followed by national income accountants is to consider only additions to the stock of houses for owner occupancy as the only investment made by households, and to count

"The Prospects for Population Forecasts," World Population Conference, Rome, 1954, Proceedings, *Papers*, Vol. 3, United Nations Publications, 1955, pp. 43–53; Robert J. Myers, "Comparison of Population Projections with Actual Data," World Population Conference, Rome, 1954, Proceedings, *Papers*, Vol. 3, United Nations Publications, 1955, pp. 101–112; Joseph S. Davis, *The Population Upsurge in the United States*, War-Peace Pamphlet no. 12, Food Research Institute, Stanford University, 1949, 92 pp.

[7] The Bureau is under continual pressure by business users to reduce the apparent uncertainty of population projections by publishing a *single* projection rather than a range of estimates of future population growth.

expenditures on other durable consumers' goods as consumption.[8] In other words, a new house is considered as an addition to wealth, while a new automobile or rug is considered as consumed when purchased.

This convention is clearly arbitrary but, fortunately, it has little effect on our analysis. If purchases of durable consumers' goods were considered as household investment, the schedule of total investment would be higher, would slope upward more steeply as a function of national income, and would be more responsive to demographic factors; while the consumption function would be lower, less steep, and less responsive to demographic factors. But the sum of investment plus consumption would not be altered.

However investment by households is defined, it has not been included in the consumption function or the forms of investment discussed earlier; expenditures on new housing (the conventional definition of investment by households) surely depend on demographic variables; and a separate discussion is required.

Expenditures for residential construction can be fitted into our general scheme by imagining a housing investment schedule that has different values for alternative national incomes. The question is: How would such a schedule be affected by demographic variables?[9]

The demographic factor most clearly related to expenditures for new houses is population growth. More people mean more shelter space needed; and the simplest assumption is that expenditures on new housing are such as to increase the stock of housing in the same proportion as population grows.

This simple assumption can be made more precise by noting that additions to the stock of housing take two forms: (1) new dwelling units (formed by construction from the ground up, or by subdivision of existing large units); (2) additions (or alterations) to existing dwelling units. The significance of these two forms is that an increase in the number of

[8] An exception occurs in Goldsmith's monumental study, where only depreciation and upkeep of durable goods are considered as consumption expenditures. Raymond W. Goldsmith, *A Study of Saving in the United States*, Princeton University Press, 1956, 3 volumes.

[9] The housing investment schedule for a stationary population would be positively inclined with national income, though not markedly or dependably so. Louis Winnick has calculated a regression equation with proportionate changes in the number of persons per room as the dependent variable, and changes in the average number of persons per household, in median income, and in average rent per room as the independent variables. The changes were from 1940 to 1950. The data (from the decennial censuses of housing) related to 89 cities with a population in 1950 of over 100,000. His analysis shows a small multiple regression coefficient with the income variable, and also a small partial correlation coefficient between persons per room and income. See Louis Winnick, *American Housing and Its Use*, John Wiley and Sons, 1957, pp. 117–126.

households implies increase in the number of dwelling units, while a rise in the number of persons in existing households tends to cause additions to existing units.

Winnick's analysis indicates that, with income constant, households with more members occupy much less than proportionately more space; and the effect of income on space per person (or more precisely rooms per person) in households of a given size is relatively slight. Consequently, we may infer that if the *average size of household* remains constant (and hence the proportionate increase in the number of households and persons is the same), the stock of housing would tend to grow nearly in proportion to population; while if the *number of households* remained constant (and growth took the form of an increase in the average size of households), the amount of occupied dwelling space would tend to increase substantially *less* than in proportion to population.[10]

Thus population growth can be factored into two components having different implications for house construction: growth in the number of households, and growth in their average size. Until very recently there has been in the United States a nearly continuous *reduction* in household size, combined with a growth in the number of households that was more rapid than that of population.[11]

At any given level of national income there is associated with an annual growth in the number of households (at a rate of $s$ per year) an expenditure on housing construction of $\alpha$ times $s$ times (value of the stock of houses), where $\alpha$ is a number slightly less than one; and, associated with an annual growth in the size of household (at a rate of $u$ per year), is an expenditure of $\beta$ times $u$ times (value of the stock of houses), where $\beta$ is substantially less than one.

If there is an annual proportional increase in households ($s$), and in average size of household ($u$), the expenditure on housing construction *at a given level of national income* will equal the expenditure at that level with no population change, plus $(\alpha s + \beta u)S$ where $S$ is the value of the housing stock. From Winnick's data, $\alpha$ can be crudely estimated as 0.95

[10] It is here assumed that "stock of housing" means the value of houses at constant prices, and that this value changes about in proportion to the total number of rooms.

[11] If $P_t = P_{t-1}(1 + r)$, $H_t = H_{t-1}(1 + s)$, and $L_t = L_{t-1}(1 + u)$

where $P_t$ = population at time $t$, and $r$ is annual rate of growth of population; $H_t$ = number of households at time $t$, and $s$ is the annual rate of growth of the number of households; $L_t$ = average number of persons per household and $u$ is the annual rate of growth of household size.

Then $1 + r = (1 + s)(1 + u)$ and $r = s + u$.

and $\beta$ as 0.6.[12] In other words, an increase of $s$ in the number of households and $u$ in their average size would raise the schedule of housing investment by approximately $(0.95\,s + 0.6\,u)S$.

This formulation raises a further question—what determines changes in average household size and the rate of household formation? National income is a factor, because at higher incomes young people more readily marry and set up separate households, and also "doubled up" families undouble if income increases. Changes in custom—in age at marriage, in the proportion ever marrying, in the strength and extent of family ties—are also important determinants of size of household.

Even though these factors help to determine the size distribution of households, the *age distribution* of the population has played a dominant role in the United States. From 1890 to 1950, factors that changed the proportion of persons at each age heading a separate household accounted for 1/6 of the decline in average household size, while changes in age composition—especially the decline in the proportion of children—accounted for 5/6.[13] Age-specific "headship rates"—the proportion by age who are heads of households—can be used to factor a given change in population into growth in the number of households and growth in size. Apply the age-specific "headship rates" of the given population to the population one year later. The resultant number of household heads represents the number of households that would exist next year with unchanged nondemographic conditioning factors. If growth were of a form that involved no change in age composition, the number of households would increase as fast as population. If the number in dependent ages grew more rapidly than the rest of the population, the increase in number of households would be less than population growth, and average size of households would increase.

[12] Winnick derives an equation for the proportionate change in persons per room as a linear function of proportionate changes in median income, average rent, and size of household. The regression coefficients are $-0.045$, $+0.073$, and $+0.395$ respectively. If the size of households were constant, a larger population would necessarily be accompanied (at a given total national income) by a smaller income per household. For an $x$% smaller average income per household there would be approximately an $0.05x$% increase in persons per room, or an $0.05x$% *decrease* in rooms per person. The over-all increase in rooms occupied would be about $(x - 0.05x)$% or $0.95x$%; thus $\alpha = 0.95$. By a similar argument, the coefficient of about 0.4 applying to the proportionate increase in household size in Winnick's equation implies a $\beta$ of about 0.6. The data are (as stated earlier) really not suited to drawing accurate inferences about population change, and there are a number of questionable statistical procedures involved in arriving at the above estimates of $\alpha$ and $\beta$. However, a general range of 0.9 to 1.0 for $\alpha$, and of 0.4 to 0.8 for $\beta$ is plausible on common-sense grounds, and these values will serve at least illustrative purposes.

[13] Winnick, *op. cit.*, p. 82.

The effect of a given change in population on housing investment can now be expressed in formulae. Suppose a population at time $t - 1$ with a specified number of males at each age $M(a, t - 1)$, and of females at each age $F(a, t - 1)$. Suppose the observed proportion at each age and sex who are heads of households is $H_m(a, t - 1)$ and $H_f(a, t - 1)$ for males and females respectively. Then the number of households at $t - 1$ would be given by:

$$(2) \quad H(t-1) = \sum_a [H_m(a, t-1)M(a, t-1) + H_f(a, t-1)F(a, t-1)]$$

The number of households at time $t$ would be given by:

$$(3) \quad H(t) = \sum_a [H_m(a, t-1)M(a, t) + H_f(a, t-1)F(a, t)]$$

The growth rate in the number of households would be:

$$(4) \quad s = \frac{H(t) - H(t-1)}{H(t-1)}$$

and the growth rate of household size would be:

$$(5) \quad u = r - s = \frac{P(t) - P(t-1)}{P(t-1)} - s$$

Finally, the effect of the given growth on housing investment would be an increase in the housing investment schedule by an amount:

$$(6) \quad I' = (0.95\, u + 0.6\, s)S(t)$$

where $S(t)$ is the value of the stock of houses at time $t$.[14]

### *Demographic Variables and Government Expenditures*

The response of households to demographic variables is to attempt to maintain living standards under the strain of more members, with a consequent upward shift in both the consumption function and the housing investment schedule. These shifts represent a diminution in savings for a given income, and a reallocation of some of the savings to housing rather than other forms of wealth.

The response of businesses is to increase investment in anticipation of higher demand as an expected consequence of population growth.

[14] This formulation is based on the assumption that this year's housing expenditures are affected by population changes since last year. Actually, the effect of growth would be felt with various lags and leads. Some construction may be in response to growth that has been pent up for several years; in other instances households might invest in larger houses in anticipation of additions to the population yet to come.

Government expenditures would undoubtedly respond in ways analogous to these private responses—increased expenditures on current account made to provide the same standards of government services to more people; expanded capital expenditure both on service facilities and on government-provided productive equipment (such as highways) in anticipation of higher demand in the future. If so, the degree to which a hypothetical schedule (listing government expenditures as a function of alternative levels of national income) would be shifted by a different number of dependents or a different rate of growth could be estimated.

The difficulty with a completely parallel treatment of government expenditures is that two important forces in government finance must be allowed for—the necessity (or desire) to balance budgets, and the possibility of deliberate compensatory fiscal policies. In particular, balanced budgets are the aim of state and local governments because of the limited credit they command. It is considered sound for these governments to finance all expenditures on current account out of current revenues, and to incur indebtedness only for capital expenditures. Thus (to oversimplify somewhat) only *expenditures on capital account* of governments below the federal level should be considered as simple changes in the schedule of total government expenditures. Expenditures on current account should be considered as also causing a reduction in the consumption and investment functions (because of the effects of increased taxes on disposable income).

In the federal government there is always an articulate group advocating a balanced budget per se, and other advisers advocating the use of fiscal measures to avoid severe unemployment or inflation. If such considerations prevail, the effect of demographic variables on federal expenditures (as well as non-federal) may be mitigated by compensating changes in taxes (or otherwise).

As a consequence of these complications, no serious quantitative estimate of how demographic variables affect over-all government expenditures will be attempted. The implications of population variables for government expenditure are somewhat clarified by a list of the government activities that would be most directly affected (most of which are responsibilities of state and local governments, to which balanced budgets are almost a necessity).

Perhaps the most obvious activity is education. With a given national income, the current operating expenses of public education are more or less proportional to the number of children of school age, and educational expenditures on capital account have a component proportional to the *growth* of the school-age population.

Services demanding support in proportion to the size of population (at a given level of national income) include police and fire protection, health, and postal service. Expenditures on new highways, hospitals, streets, sewers, and water facilities would tend to vary more or less in proportion to population *growth.*

At the other end of the spectrum, expenditures on defense, veterans' benefits, interest on the national debt, and foreign assistance—all in the federal sphere—would be affected only indirectly (if at all) by differences in dependency and the current rate of growth.

The pressure to spend more could be met by a reduction in the standards of service provided by the government, or offset in part by a change in the tax structure. A reduction in standards has been the response of many areas to the educational needs of the rapidly increasing school population of the past few years. If increased tax revenues were equal to additional expenditures, the enlarged budget would leave disposable incomes essentially unchanged. Furthermore, there are special obstacles to a reduction in disposable income when there is a greater proportion of dependents in the population. First, with no change in the tax structure, income tax payments would decrease because of more exemptions. Second, transfer payments for the various social security programs would increase.

The range of possible influence of greater population growth and more dependents on effective demand *via* government expenditures thus extends from minor increases in budgets financed by increased taxes to substantial increases in budgets with somewhat *reduced* revenues. The smallest effect would result if increased needs arising from more dependents and faster growth were met by reduced standards of service, and if a firm policy of budget balancing were followed. The greatest effect would arise from maintaining fixed standards of service and unchanged tax schedules.

The conclusion that emerges from this survey of demographic influences on government expenditures is that those demographic forces that tend to increase private components of effective demand also tend to add to effective demand on the part of the government. The government may, as a matter of deliberate policy, resist such a tendency. But the ease with which compensatory fiscal policy can be implemented is affected by demographic variables. If the government tries to exercise a restraining influence on effective demand in a period of inflation, it would find this course more difficult in the presence of many dependents and rapid growth. Conversely, it would be easier with many dependents and rapid growth for the government to assume a stimulating role during a period of heavy unemployment.

### *A Quantitative Estimate of the Effect of Demographic Variables on Aggregate Demand*

As we have seen, an increase in the proportion of persons under 17 and over 70 increases private (and possibly public) expenditures on consumption, while an increase in the rate of population growth creates pressure for households, businesses, and governments to enlarge their expenditures on capital. More dependents raise the consumption function ($C$); growth raises the level of investment ($I$); and both exert upward pressure on government expenditures ($G$). The next issue is the magnitude of the over-all effect of a shift from an observed demographic situation to a reasonable alternative.

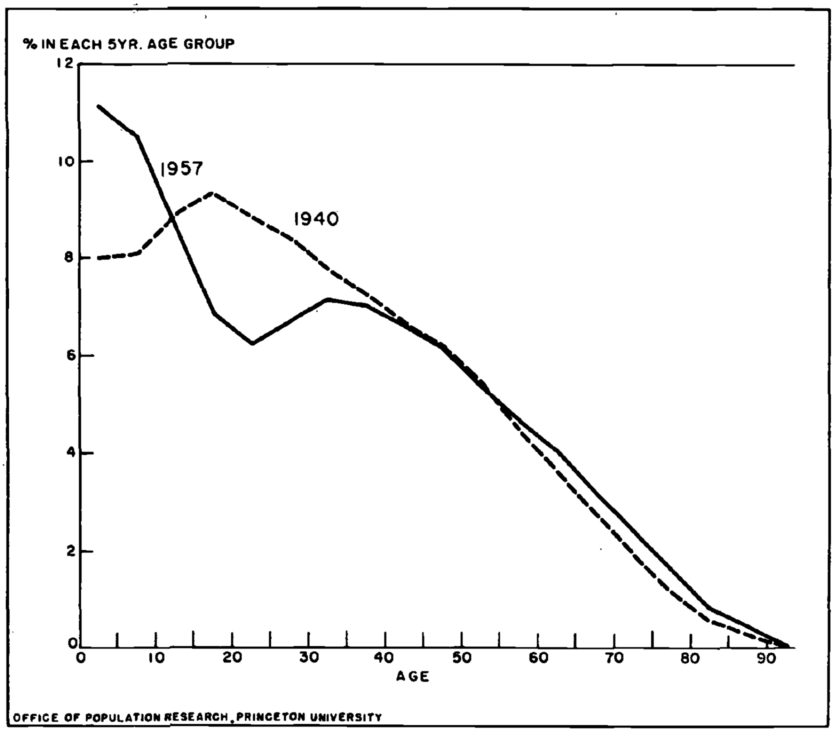
I shall first compare the United States population of 1940 with the population there would have been had the 1957 proportion of dependents/working-age population, and the 1957 growth rate prevailed in 1940.

Chart 1 shows the age distribution in the two years. Note that the proportions at both ends of the age distributions—young children and persons above the age of retirement—were higher in 1957. The ratio $\frac{\text{total population}}{\text{persons 17–69}}$ was about 1.63 in 1957, and only 1.485 in 1940. Had the dependency burden of 1957 existed in 1940, the population 17–69 would have had to support a total nearly 10 per cent bigger. If it is assumed that the extra dependents would be added to existing households, and if Dorothy Brady's 6th root rule is accepted, consumption expenditures at each alternative level of national income would be multiplied by $\sqrt[6]{1.097}$, or increased by 1.55 per cent.

The application of 1940 "headship rates" to the 1939 and 1940 age-sex distributions yields an expected increase in the number of households on account of demographic factors of 1.46 per cent, and a *decrease* in the average size of household by 0.51 per cent. If 1940 headship rates had applied to 1956–1957, the number of households would have increased by 1.13 per cent, and the average size by 0.69 per cent.[15] It was argued

[15] The relatively small increase (in 1956–1957) in number of households reflects the small numbers passing through the ages (18–25) of most frequent household establishment. These small numbers, in turn, are a consequence of low birth rates from 1932 to 1939. On the other hand, the increase in average household size (in contrast to the

## CHART 1
Age Distribution for United States, 1940 and 1957




*decrease* in 1939–1940) resulted from the sustained "baby boom" in the 1940's and 1950's. It must be noted that the changes in number and size of households are hypothetical changes that would occur with fixed "headship" rates. During the interval 1940–1957 there were two major changes in marriage patterns: an increase in the proportion ever marrying, and a decline in average age at marriage. As a consequence of these changes (and slightly decreasing proportions of married couples at given ages "doubled up"), the number of households increased much more than the hypothetical increase with constant age-sex-specific "headship" rates. The changes in married status by age could certainly be considered as demographic, but they are not so considered here. Only variations in growth and age distribution are analyzed.

above that investment in new house construction in excess of investment with a stationary population would be approximately:

$$I' = (0.95s + 6u)S \tag{7}$$

where $s$ = proportionate increase in the number of households

$u$ = proportionate increase in the average size of household

$S$ = value of the stock of houses.

The difference in $I'$ resulting from the substitution of 1956 to 1957 population changes for those from 1939 to 1940 is $0.0041S_{1940}$.

Population growth from 1939 to 1940 was 0.95 per cent, from 1956 to 1957, 1.82 per cent. According to Formula (1) the 1956–1957 growth would have yielded enlarged non-housing investment given by:

$$I = NI(0.0182 - 0.0095)m \tag{8}$$

where $m$ is the non-housing capital-output ratio. Assuming $m = 2$,[16] the effect of substituting 1956–1957 growth in 1940 would be an extra non-housing investment of \$1.40 billion.

In short, 1957 demographic variables would have raised the 1940 consumption function by $(0.0155)C$, the housing investment schedule by $(0.0041)S$, and the non-housing investment schedule by $(0.0174)NI$. Using Department of Commerce figures for national income and consumption, and figures for $S_{1940}$ by Grebler, Blank, and Winnick,[17] we find that the rise in the consumption function in the neighborhood of the 1940 national income would be \$1.11 billion, and in the housing investment schedule, \$0.35 billion. The combined rise in schedules would be \$2.86 billion.[18] If we assume a multiplier of 3, the equilibrium national income would have been \$8.6 billion higher—an increase of somewhat more than 10 per cent. It is estimated that 14.6 per cent of the labor force was unemployed in 1940.[19] If we assume, finally, that a 10 per cent increase in aggregate demand would have increased employment by 10 per cent, it appears that the dependency burden and growth rate of 1957 would have absorbed more than 60 per cent of the unemployed in 1940.

[16] R. A. Gordon, "Population Growth, Housing, and the Capital Coefficient," *American Economic Review*, Vol. 46, no. 3, June, 1956, pp. 307–322.

[17] Leo Grebler, David M. Blank, and Louis Winnick, *Capital Formation in Residential Real Estate*, published for the National Bureau of Economic Research by Princeton University Press, Princeton, 1956, pp. 360–361.

[18] It is interesting that only 18 per cent of this rise is attributed to business response to population growth.

[19] Stanley Lebergott, "Annual Estimates of Unemployment in the United States," in *The Measurement and Behavior of Unemployment*, published for the National Bureau of Economic Research by Princeton University Press, Princeton, 1956, p. 216.

No allowance has been made in these calculations for the effect of demographic variables on government expenditures, because of uncertainty about how budgets would be altered in the presence of greater needs. However, to show that the adjustment in government expenditure needed to maintain unchanged quality of service is not trivial, I shall present some estimates of the extra expenditures on education that the 1957 age distribution would require. The ratio $\frac{\text{Children 5–14}}{\text{Population 17–69}}$ was nearly 25 per cent larger in 1957 than in 1940. Moreover, the number of children 5–14 rose 3.8 per cent between 1956 and 1957, while the number fell 1.5 per cent between 1939 and 1940. Current expenditures on education in 1940 were about \$2 billion;[20] 25 per cent more children of school age would have required about \$0.50 billion additional spending on school operation. A growth of 3.8 per cent in the school population (instead of a reduction of 1.5 per cent) would take an extra investment at least equal to 3.8 per cent of the value of school buildings, or about \$0.28 billion.[21] If current expenditures were met by increased taxes, the additional aggregate demand would be (\$0.50 + \$0.78) = \$1.28 billion,[22] or 1.6 per cent of the national income. Further possible additions to demand would be uncovered by examining other government sectors. Even when a conservative view is taken of how the government would respond to needs generated by demographic circumstances, a further substantial reduction in unemployment caused by government expenditures is plausible. With a multiplier of three, it seems a reasonable conjecture that the demographic features of 1957 would—if transferred to 1940—have averted 75–90 per cent of 1940's unemployment.

Conversely, had the slow growth and light dependency burdens of the end of the thirties characterized the 1950's, inflationary pressure would have been much less, and in the absence of compensatory forces, unemployment rates of 7 to 12 per cent instead of 3 to 5 per cent might have prevailed.

The results of a further quantitative exercise are shown in Charts 2 and 3. Chart 2 shows the variations from 1921 to 1957 in rate of growth and in dependency. Note that growth provided the least stimulus during the early and middle 1930's, while dependency continued to decline

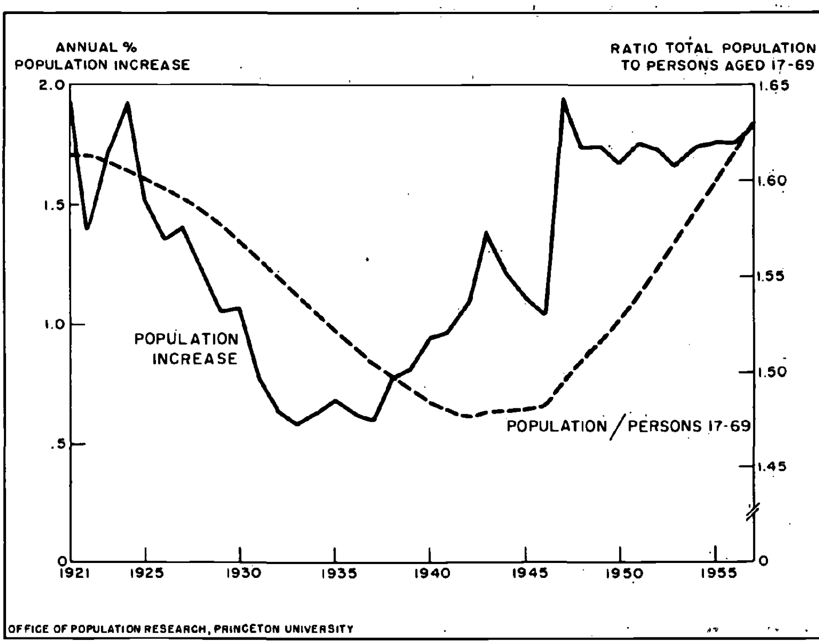
[20] U.S. Bureau of the Census, *Statistical Abstract of the United States, 1957*, p. 14.

[21] Value of school buildings taken as 90 per cent of the value of school property. U.S. Department of Health, Education, and Welfare, Office of Education, *Biennial Survey of Education in the United States, 1950–1952*, ch. 1, p. 18.

[22] Assuming a multiplier of one for balanced-budget extra expenditures, and of three for deficit-financed expenditures.

CHART 2

Annual Percentage Increase in Population, and Ratio of Total Population to Persons Aged 17–69, United States, 1921–1957




until the early 1940's. In Chart 3 the extra employment (as a per cent of the labor force) that would result from substituting 1957 dependency and growth rates for those of the given year is shown in conjunction with the unemployed (also as a per cent of the labor force). No allowance is made in Chart 3 for government expenditures. Their effect would be to amplify the variations shown.

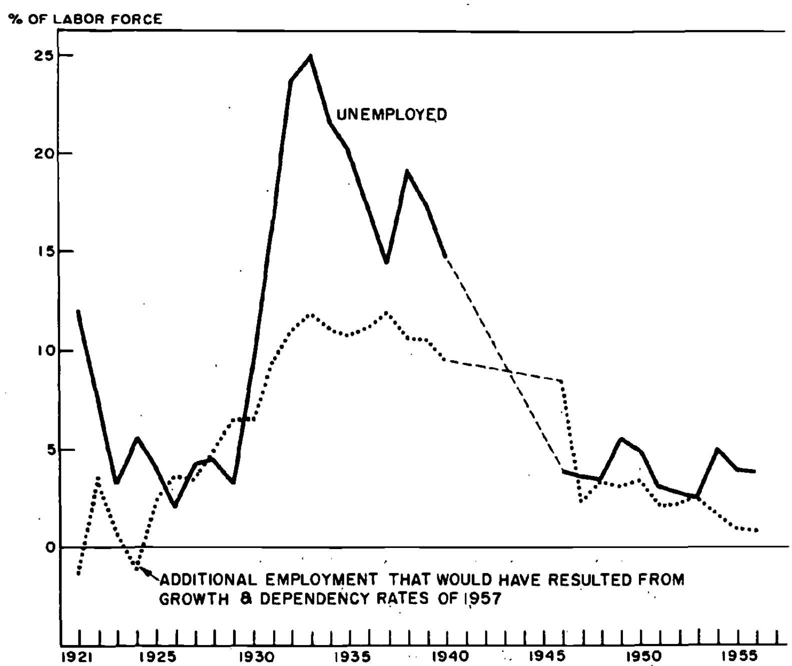
The demographic features of 1957 would scarcely have been sufficient to prevent unemployment during the great depression, nor were changes in population sufficient to account for the substantial boom since the early 1940's. I am not proposing a demographic theory of business fluctuation, however, but merely suggesting that age distribution and growth are quantitatively significant elements in effective demand.

### *Amendments, Extensions, and Qualifications*

A major weakness of the foregoing analysis is the coarse definition of the variables it treats. If the "fine structure" of the economy were taken into account, the conclusions would doubtless be modified. For example, the

CHART 3

Proportion of Labor Force Unemployed, 1921–1956, and Estimated Added Proportion with Population Growth and Dependency of 1957

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combination of the "sixth root" rule of household expenditure and variations in age composition makes no allowance for variant trends of household size among groups with different incomes. If the decreases in fertility during the twenties and thirties were confined primarily to upper-income families, the effect on saving would be greater than if the decrease were uniform.

Similarly, the recognition of only three age groups (under 17, 17–69, and 70 plus), and the failure to differentiate products beyond a division into consumers' goods, houses, and producers' goods conceal the effects, *inter alia*, of shifting demand (for example, from baby buggies to false teeth) as age composition changes.

Finally, the numerical calculations summarized in Charts 2 and 3 can scarcely be considered as precise. The estimate of 3 for the multiplier cannot be defended. If the reader has another estimate he can easily alter the results shown in Chart 3—raising or lowering them according to whether he believes the multiplier higher or lower than 3. Much of the other material used in constructing quantitative estimates is not much more reliable than the estimate of 3 for the multiplier. The effect of the demographic variable on consumption, housing investment, or business investment could easily be off by a factor of 2.

These imperfections are less important than a major issue that the analysis does not treat at all: many dependents and rapid growth are a stimulus largely because they constitute an extra burden on the economy. A high birth rate, which ultimately produces both rapid growth and a large proportion of dependents, is an economic advantage only in the sense that an excess of exports over imports is favorable. Both promote demand; but if the economy were already straining its productive capacity, either would reduce the product available per capita.

Edgar Hoover and I have stated (in a study of low-income countries) that when deficiencies of aggregate demand can be ignored, faster growth and more dependents yield lower income per capita than slower growth and fewer dependents. For at least 25 or 30 years, in fact, a lower birth rate would bring a larger *total* national product as well as a smaller population than a high birth rate would bring.[23] The reasoning we developed also applies to countries with high incomes, so long as aggregate demand can be counted on to keep available productive resources at work.

A higher consumption function means that less of current full employment output is devoted to expansion of future output (because more is devoted to current needs). More investment (and more government expenditures) inspired by population growth means more equipment and shelter diverted to put additional population on the same terms as the current population, and less available for increasing the per capita stock of equipment and housing.

In other words, the demographic features that stimulate effective demand are also features that can keep the economy from achieving the maximum growth in output per capita. A striking instance of the favorable effect of *low* dependency and growth is during World War II. Dependency was at its all-time minimum during the war, a fact that in the absence of war might have continued to retard recovery from the great depression. But in wartime the small number of dependents made it easier to divert more resources to the military effort. In a similar

[23] Ansley J. Coale and Edgar M. Hoover, *Population Growth and Economic Development in Low Income Areas,* Princeton University Press, 1958.

fashion, under some peaceful circumstances, fewer dependents would permit more resources to be used for growth.

A final word about demographic and economic prospects in the United States. Population projections prepared by the Census Bureau indicate that if fertility remains at present levels, dependency will steadily increase and rapid growth continue during the next twenty years; while if fertility were to resume its historic downward trend, dependency and growth would again start to fall. Thus a continued secular economic boom could gain partial support from a continued baby boom. But after a century this trend would produce about a billion Americans, and after two centuries some six billion. There must be a better way to stimulate employment.

## COMMENT

MARGARET G. REID, University of Chicago

Ansley J. Coale based his estimate of the relation of demographic changes to investment in housing on the assumption that the "effect of income on space per person is relatively slight." This seems a little surprising in view of the widespread notion that room-crowding is a characteristic of poverty.

Available evidence in the U.S. Census of Housing, as I read it, indicates that demand for space rises sharply with income. Such evidence comes from a comparison among census tracts.[1] One estimate shows the following correlation:

$$(1) \qquad X_{pr} = 10.70 - 2.922X_i + 0.256X_p \qquad R^2 = 0.85$$

where $X_{pr}$ is the percentage of households with more than one person per room, $X_i$ is the median income of families and unrelated individuals, and $X_p$ is the mean number of persons per household, with variables $X_{pr}$ and $X_i$ expressed in log form.[2] Thus two variables explain 85 per cent of the variation among tracts in the percentage of households with 1.01 persons per room. In this relationship, income is the dominant factor. Among

[1] The tracts were selected in order to maximize the likelihood that income reported by census tracts approximated that of primary units of households. The set includes all tracts in the Chicago metropolitan area in which at least 99 per cent of the population was living in households, and in which there were at least 99 families per 100 families and unrelated individuals. There were 144 census tracts with these characteristics. The data come from *Census of Population, 1950*, Vol. III, *Census Tract Statistics*, ch. 10, Tables 1 and 3. Various analyses which I have made indicate that Chicago is fairly representative of metropolitan areas in the relationships here described.

[2] Each tract has a weight of one.

the set of 144 tracts $X_{pr}$ ranged from 1.4 to 42.4 per cent. Median income of these two tracts was $8,325 and $2,657, respectively. Income alone explains 76 per cent of the variation in $X_{pr}$.

Thus estimates based on data aggregated by census tracts indicate that income has a powerful effect on demand for space. On the other hand many sets of disaggregated data indicate that increase in income increases only slightly the demand for space. Coale's assumption rests on such evidence. A comprehensive comparison between these two types of evidence has yet to be made. In my opinion, comparison among census tracts provides more reliable evidence of basic tendencies related to income than does comparison among families. Data aggregated by census tracts are less affected by random reporting error in income and by income variation related to the age of the head and the number of persons currently employed in families. Both of these conditions account for much of the variation in income among families and they seem unlikely to have much effect on demand for space.[3]

Coale in addition cites an intertemporal demand for space based on certain changes between 1940 and 1950. He noted that "the evidence . . . indicates only a slight tendency to demand more rooms with higher income, size of household, and rent held constant." Coale recognizes that the data may be very crude, hence that this evidence may not be especially useful. He does not, however, note (*a*) that the estimates were undoubtedly affected by variation in the effect of rent control among the cities involved in the comparison, (*b*) that rent paid was assumed to represent price and that important changes had occurred in the stock of tenant-occupied dwellings, (*c*) that the income related to wage and salary workers irrespective of tenure, and (*d*) that the importance of owner occupancy had changed appreciably between 1940 and 1950. Thus I would like to underscore Coale's word of caution about using these data as indication of the nature of demand for space in relation to income.

In estimating the effect of change in number of dependents on aggregate demand Coale again relied on estimates derived from expenditure-income regressions among families. Such regressions for total expenditure

[3] It is of some interest that the fertility rate tends to be higher and doubling up in households of relatives in addition to those of the nuclear family more frequent among the poor than the rich. Thus it is not surprising that among the selected set of census tracts for which income is probably a fairly good measure of economic status, the number of persons per household is negatively related to average income. On the other hand, among consumer units, number of persons tends to rise with income. This tendency provides further reason for questioning the validity as to consumption-income relation observed among families as evidence of basic tendencies for products such as housing that are little affected by household size.

as well as for housing seems likely to be biased by random components in income. Average income and total expenditure are directly related to number of persons per consumer unit. Because of random components in income, the level of expenditure at a given income tends to be correlated with average expenditure of the respective groups of units. Such expenditure will hence be directly related to the number of persons[4] among groups stratified by number of persons. This difference tends to disappear when comparison is made at a given income position in the respective income distributions.[5]

Nevertheless a tendency for expenditure to increase with number of persons in a family experiencing no increase in income would not be surprising. Increase in funds can come from drawing on reserves, from a reduction of savings, or from an increase in debt. Such changes would not be surprising in the stage of family formation when persons are increasing but earners are not. Reserves used at this time may, however, be rebuilt and debts incurred may be paid off later when the ratio of earners to persons tends to increase or need declines.

Among types of units, that is, those differing in relationship among members and in number of persons, there is a tendency for expenditure per $100 of average income to be directly related to the number of persons.[6] The correlation[7] is, however, very low. It is increased markedly if the number of earners[8] is held constant. The correlations of these variables are as follows:

| | | $R^2$ |
|---|---|---|
| (2) | $X_{Reti} = \$102.06 + 0.154X_p$ | 0.0025 |
| (3) | $X_{Reti} = \$107.73 + 1.426X_p - 10.425X_{ea}$ | 0.26 |

[4] For interpretation of this characteristic of the data see Milton Friedman, *A Theory of the Consumption Function*, published for the National Bureau of Economic Research by Princeton University Press, 1957, pp. 121–122.

[5] This characteristic of relative levels of expenditure-income curves has been investigated systematically by Dorothy S. Brady and Rose D. Friedman, using data for families differing in average income. See "Savings and the Income Distribution," *Studies in Income and Wealth*, National Bureau of Economic Research, Vol. 10, 1947, pp. 247–265.

[6] The data used in this analysis are those for 1950 for consumer units reporting for the large cities in the north, a total of 3,853 units. The estimate is confined to this set because data for the urban set in general are not summarized. The report distinguishes 37 types. For many of these the number reporting is low. Hence some combinations are made of units differing in number of persons. The estimates relate to 24 subgroups with at least 30 consumer units in each group. The observations are weighted by the number of the reports. The data come from *Study of Consumer Expenditures, Incomes and Savings* (tabulated by the Bureau of Labor Statistics for the Wharton School of Finance and Commerce), University of Pennsylvania, 1956, Vols. I and II, Table 14.

[7] For this set of subgroups average expenditure and average income are highly correlated. With the variables expressed in the logs the elasticity of expenditure with respect to average income is 0.90 and $r^2$ is 0.92.

where $X_{Reti}$ is total expenditure[9] per \$100 of disposable income, $X_p$ is average persons per consumer unit, and $X_{ea}$ is average earners per consumer unit, for 24 subgroups of units differing in relationship among members and in number of persons. Thus the higher the number of persons, the higher tends to be expenditure per \$100 of income; the higher the number of earners per unit, the lower tends to be such expenditure.

This equation predicts with number of earners equal to the average of units in general, i.e. 0.90 earners that increase from three to four persons would increase $R_{eti}$ from \$102.59 to \$104.01, an increase of 1.4 per cent. This is much less than that predicted by the ratio of the sixth root of the family sizes, a coefficient that may well have been much influenced by the random components in income.

Even though there is some tendency for expenditure to rise with number of persons, one cannot assume that expenditure as a percentage of income will rise with increase in fertility rates and consequent tendency for the peak size of consumer units to rise. The tendencies observed above relate to a life cycle adjustment. The projection would have to take into account behavior over the entire life cycle.

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We must all be grateful to Coale for performing an ingenious and highly relevant calculation. The effect of employment on the level of income is one of those things which every economist talks about but few indeed have attempted to do anything about. In light of such discussions as those of the stagnation thesis, the relevance and the importance of Coale's conclusions are clear and they are best left to speak for themselves.

As a parochial theorist, there is relatively little I can say about the statistical calculations which lie behind the paper. I wish only to raise the omnipresent question of identification. For Coale leans heavily on other writers' correlations and it may well be asked whether a correlation which involves population growth and income shows the effect of demographic change on the economic variable or the reverse (or, for that matter, some mongrel combination of the two).

Coale's model suggests some further lines of theoretical investigation. It is easy to extend his construction into one which is completely analogous with the Harrod growth model. Coale's basic conclusion for this purpose

[8] The correlation of $R_{eti}$ and average number of earners, among the 24 subgroups, is significant at the 10 per cent probability level.

[9] Expenditure as here defined includes outlays for gifts and contributions.

is that effective demand (and hence demand for labor) is an increasing function of the rate of growth of population. If, for simplicity, we assume that the relationship is linear, this may be written:

$$L_{Dt} = k(P_t - P_{t-1}) + A \tag{1}$$

where $L_{Dt}$ is the demand for labor during period $t$, $P_t$ is the level of population during that period, and $A$ is the "autonomous" (nondemographically determined) demand for labor. For simplicity, $k$ and $A$ are taken to be constants, in accord with our linearity assumption.

Suppose now that the age distribution of population is more or less fixed and that the supply of labor is a roughly constant proportion of population, that is, that we have

$$L_{St} = cP_t \tag{2}$$

where $L_S$ is the supply of labor.

Then by (1) and (2), if labor supply is to be equal to the demand we must have

$$cP_t = k(P_t - P_{t-1}) + A,$$

that is,

$$P_t = (k/k - c)P_{t-1} - A/(k - c) \tag{3}$$

This first order difference equation has the well known solution

$$P_t = (k/k - c)^t P_O + K \tag{4}$$

where $K$ is constant and $P_O$ is the level of population during some arbitrarily selected "initial" period. We may draw the following conclusions:

(*a*) The time path of $P_t$ which is given by equation (3) represents a sort of equilibrating population growth pattern, for if and only if population grows at this rate will labor supply equal labor demand.[1]

(*b*) If $k > c$, the equilibrating population level will grow at a roughly constant geometric rate [cf. equation (4)].

(*c*) Paradoxically, if in these circumstances the growth of population falls short of its equilibrating rate, there will tend to be excess labor supplies and vice versa (equation 1).

(*d*) There is reason to suspect that the equilibrating time path will be unstable. For if the population growth exceeds its equilibrating rate, it

[1] Instead of a model which determines the equilibrating population growth it is easy to formalize one which purports to predict actual population growth. To do this we substitute demand for income in place of demand for labor in equation (1) and set up instead of (2) a second equation describing how population is affected by income. The criticisms of such a second relationship are, however, obvious.

follows from equation (1) that there will be "over-full" employment, that is, the excess demand for labor and the high standards of living which result may cause population growth to increase even further above its equilibrating level. A similar argument applies to the downward side of the equilibrating time path. However, it is clear that this conclusion rests on a rather tenuous assumption about the connection between income levels and population levels.

There is little point in extending the argument further. It is easy to revise equations (1) and (2) to take account of age distribution and some of the other complications which characterize the connection between population growth and demands. Much of this can be accomplished just by a careful retracing of Coale's calculations. However, the nature of the conclusions would not be affected materially.

Certainly the concept of an equilibrating population growth rate must not be asked to bear too much weight. As a normative concept it is subject to objections which have been raised against "optimum population" concepts. Moreover, the amount of demand for labor which must be induced by population growth in order to achieve full employment will vary with the level of the "autonomous demand," that is, that which results from the behavior of the strictly economic variables. I want only to indicate with the aid of this concept how demographic variables can once again be fitted comfortably into some of our economic analysis as Leibenstein has been at such pains to point out.