STATIONARY POPULATIONS:
ECONOMIC AND EDUCATIONAL IMPLICATIONS*

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Résumé—Il s'agit dans l'étude qui suit d'une analyse des conséquences de l'accroissement de population à zéro. Une population peut atteindre un degré stationnaire en différentes façons. Si on veut que le nombre de naissances soit fixe on doit attendre pendant plusieurs décades avant que la Fécondité Totale converge vers le niveau de remplacement. D'autre part, si la Fécondité Totale s'avance vers le niveau de remplacement immédiatement, le nombre annuel de naissances baissera. C'est plus facile pour une économie de s'adapter à une baisse en fécondité et au nombre de naissances si ce nombre ne fluctue pas.

Dans une population stationnaire (comparable à une population croissante), la productivité potentielle par tête est plus grande et la possibilité d'éduquer la jeunesse est meilleure. Le rapport main-d'oeuvre/population totale et le rapport nombre de retraités/main-d'oeuvre se transformeront lorsqu'une population s'approche du dégré stationnaire. Ce dernier a une grande influence sur un système d'assurances sociales lequel l'aide aux retraités est allouée sur une base "paiement au départ." Le maintien d'une équilibre interprofessionnelle est plus difficile dans une population stationaire. Une population croissante sera plus mobile.

Dans une population stationnaire la mobilité ascendante sera ralentie par une grande espérance de vie des personnes d'âge de travail et par la dépyramidation de la structure infra-65.

Sous certaines suppositions, la séléction génétique dans une population caractérisée par une croissance zéro sera plus défavorable. L'effet d'une structure d'âge dans une population stationnaire sur l'innovation, l'acceptation d'un changement, la confiance d'entrepreneur, l'investissement et la tendance à concentrer le pouvoir chez les personnes âgées y sont aussi abordés.

Abstract — The consequences of zero population growth are explored in this paper. A population can approach a stationary state through a number of different paths. If the number of births should become fixed several decades may have to pass before total fertility converges to replacement level. On the other hand if the total fertility moves to replacement level immediately the annual number of births will decline. It is much easier for an economy to adjust to decline in fertility and the number of births if this number does not fluctuate.

In a stationary population (compared to a growing population) potential productivity per capita is greater and the capacity to educate its youth is higher. The ratio of labour force to total population and the ratio of retired people to labour force will be altered when a population approaches stationarity. The latter has great impact on a social security system where the support of the retirees is on a "pay as you go" basis.

Maintenance of horizontal occupational mobility and interoccupational balance is more difficult in a stationary population. A growing population will be more mobile.

In a stationary population upward mobility will be slowed down by high life expectancy of persons in working age and by the depyramiding of the infra-65 structure. Under certain assumptions genetical selection in a population characterized by zero growth will be more adverse. The effect of age structure in a stationary population on innovation, acceptance of change, entrepreneurial confidence, investment and the tendency of concentration of power in older persons are also discussed.

    While my concern in this paper is with the economic implications of a stationary population, I shall direct attention equally to related implications for education. For

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*An invited paper.

purposes of illustration, I shall have to use American data, but I believe they will fit the Canadian case.

I Stationary Population; Paths Thereto

A stationary population corresponds to a life table population since the assumed number of births equals the number of deaths implied by the life table chosen. If life expectancy at birth is low, the population will include a relatively large number of young persons, since by definition fertility must be relatively high to offset high mortality; if life expectancy is high, this relative number will be smaller. A life table population totals be^o where b denotes the annual number of births (= the annual number of deaths) and e^o denotes life expectancy at birth. Accordingly, the lower e^o, the faster an initial cohort of births is reduced and therewith the relative number of older survivors. This is illustrated in Table 1 based upon male populations.

TABLE 1. LIFE EXPECTANCY AND AGE STRUCTURE IN STATIONARY POPULATIONS

Age Group	Expectation of Life at Birth		
	32.48	58.84	73.90
0–4	10.93	7.79	6.68
5–14	19.07	15.15	13.31
15–19	9.05	7.47	6.64
20–64	55.87	58.61	57.42
65+	5.08	10.98	15.95
Total	100.00	100.00	100.00

Source: A. J. Coale and Paul Demeny. 1966. Regional Model Life Tables and Stable Populations. Princeton: Princeton University Press, pp. 134, 156, 168.

In Table 2 are presented the age structure of the U.S. population as of 1970 and that which would result should, there be no immigration, total fertility drop immediately (i.e., in 1972) to the replacement level 2.11, and stationarity be attained in 2039. This stationary population would number about 15 million less than would result, were fertility to move gradually to the replacement level and attain stationarity by 2062. In each instance, however, most of the destined growth would be attained by 2025. The age structure of the 1970 population is somewhat misleading, for it reflects the upsurge of births after the war and the low birth rates of the 1930s and early 1940s. This is evident in that in 1970 the number aged 0-19 was 1.59 times as large as the number 25-44; in 1950 it was only 1.14 times as large. In the last column of Table 2 the expected changes in age structure are indicated; there is a large

TABLE 2.   STATIONARY POPULATION, UNITED STATES, 2062

Age	1970	Stationary (2039)	Change Between 1970 and 2039
Under 5	8.38	6.78	−1.60
5–14	19.86	13.51	−6.35
15–19	9.44	6.73	−2.71
20–54	43.44	45.56	+2.12
55–59	4.88	5.88	+1.00
60–64	4.22	5.48	+1.26
65–69	3.34	4.91	+1.57
70 and over	6.01	11.13	+5.12
	99.57	99.98	0
Median Age	27.9	37.3	—

Source: Current Population Report, April 1972.   Series
P-25, No. 480, p. 20.

decrease in the relative number under twenty and a considerable increase in the relative number over twenty, especially in the relative number over 54. This change reflects the increase in median age from 27.9 in 1970 to 37.3, the median age in the stationary population.

A population approaching a stationary state may proceed along a path entailing little variability in the number of births as it moves downward to a level equal to the number of deaths in what is now becoming a stationary population. Past variation in the annual number of births produces echo effects in the subsequent age structure and hence may affect births a generation later until these effects are finally dampened out. If the number of births should become fixed, several decades may have to pass before total fertility converges on the replacement rate. Should total fertility move to the replacement level and remain there the annual number of births will decline to that characteristic of a stationary population but it will not vary much about the path to stationarity. Should population growth be halted immediately by making births equal to deaths the crude birth rate would fluctuate for several centuries.[1] For reasons examined in Section VII it is much easier for an economy to adjust to a decline in fertility and the number of births if this number does not fluctuate.

II *Age Structure*

The implications of the age structures of stationary populations for potential productivity per head and for a population's capacity to support education may now be examined.

(1) Potential productivity per capita is somewhat greater *ceteris paribus* when a population is stationary than when it is growing. Thus, if we use as a measure of potential productivity per capita the ratio of the male population aged 20-64 plus one-half those 15-19 to the total male population in stable populations growing 0, 0.5, 1.0, and 2.0 per cent per

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year, respectively, we get the following results, with a life expectancy at birth of 73.9 years:

Rate of Population Growth	Ratio
0.0	0.6074
0.5	0.5978
1.0	0.5852
2.0	0.5460

This potential might not materialize should males 60 and over withdraw from the labour force because of disability or forced retirement. This possibility is considered later.

(2) Among the factors which condition a country's capacity to educate its youth and others is the age structure of that country's population. Upon this structure depends the ratio of those from among whom educators are drawn to those seeking education. For illustrative purposes I shall use the ratio of the male population aged 20-64 years to the male population aged 5-19.

This ratio depends upon a population's rate of natural increase. There follow data from a male stable population based on a male life expectancy at birth of 71.19 years. With this life expectancy have been combined gross reproduction rates giving rates of population growth of 0, 1.0, and 2.0 per cent per year. The ratios in the last column of Table 3 indicate that, in terms of personnel, the capacity of a population to educate its youth is highest when the population is stationary, and that this capacity varies inversely with the rate of population growth in a stable population from which transient changes in age structure have been eliminated by stabilization.

TABLE 3. RATIO OF MALES AGED 20-64 TO MALES AGED 5-19, BY RATE OF GROWTH

Rate of Population Growth	Fraction of Population Aged		(20-64) ÷ (5-19)
	5-19	20-64	
0	19.95	57.42	2.9
1.0	25.26	54.52	2.2
2.0	30.46	50.03	1.6

Source: A. J. Coale and Paul Demeny, op. cit., p. 166.

The ratio also depends upon life expectancy. The data in Table 1 indicate that when populations are stationary but differ in life expectancy at birth the ratio of persons 20-64 to those 5-19 varies inversely with life expectancy (which, by implicit definition, is inversely associated with fertility), for while Table 1 stable populations are male, corresponding female populations are characterized by a similar relationship. The ratios in Table 1, by life expectancy, follow:

Life Expectancy at Birth	Ratio
32.48	2.1
58.54	2.6
73.90	2.9

The advantage suggested by the demographically based measure of educational capacity could be wiped out, of course, were persons near 60 and over 60 eliminated from the labour force by disability or enforced retirement. For their support would then have to be provided by those in the labour force and therefore diverted from other uses to which income or inputs may be directed, among them educational facilities and personnel.

III. *Age and Labour Force Participation*

The ratio of the labour force to the population under given conditions depends mainly upon the degree of participation of women, of persons under 20, and of persons over 54 and 59; for participation tends to be high among those 20-54, especially 25-54. In the United States male labour force participation rates were somewhat lower in 1972 than in 1950 among those 16-24 and 45-64, and much lower among the 65 and over. Among females at all ages under 65 the rates were higher in 1972 than in 1950; among those 65 and over, they were not much lower in 1972 than in earlier years. Conditions that affect capacity for participation in the labour force are treated in the next section.

The rates among persons under 20 would be higher were waste squeezed out of educational systems such as the American. For, if years spent in educational institutions were cut one-fourth, young people could graduate from secondary school at 15 or 16, and from college at 18, enabling 90 per cent or more labour force participation by those aged 16 to 19.

Labour force participation in the United States among males 55 to 64 could be raised from a current rate near 80 per 100 to close to 95 per 100, and among those 65-74 appreciably above current rates in the neighbourhood of 30 per 100. As a result, close to 87 per cent of the males 16 and over would be in the labour force as they were around 1950 instead of only 80 as in 1972. It is only because female labour force participation has increased about 38 per cent since 1947 that the fraction of the American population 16 and over in the labour force in 1970-72 was about two per cent above the 1950 level instead of below it.

In the United States forces opposed to employing workers beyond age 54 or 59 have been gathering strength. One form sponsored by trade unions is "Thirty and Out," which calls for the worker to be retired on a high pension after he has worked 30 years — at 48 if he entered the labour force at age 18, or at 50 if entered at age 20. Under this arrangement a male worker, having been supported by society until he was 18-20 years old, would expect society to support him another 23-25 years, or himself and/or his wife another 26-28 years, after retirement. Corporations may favour early retirement if they believe that retiring workers before 65 will cut their current wage bill. The federal government limits the unpenalized earnings of persons on social security and under 72 to $200 a month because bureaucrats and legislators subscribe to the "fallacy" that the amount of "work" available is essentially fixed.

The policy here described cannot survive, immediately because inflation is eroding retirement income, and ultimately because, in the last analysis, support of retirees is on a "pay as you go" basis, flowing out of current output for whose production those actually employed are responsible inasmuch as "capital" does not run itself. Accordingly, as the ratio of employed persons to retired older persons declines, the income of the latter is endangered as employed persons, restive under the growing burden of supporting retired persons, oppose doing so at the polls and through strikes. Moreover, if governments attempt to finance retirement costs out of the general revenue, this attempt also will be fought at the polls.

The impact of early retirement under conditions of stationarity of population may be illustrated by drawing on Table 2 and postulating that 75 per cent of those aged 20-54 are in the labour force, 50 per cent of those 15-19, 60 per cent of those 55-64, and 25 per cent of

those 65-74. On these assumptions, 46.63 per cent of the population would be enrolled in the labour force; therefore the ratio of the number of persons in the labour force to the number of persons over 54 and not in the labour force would be 4.11 to 1. The ratio of labour force members to all non-members would be 0.87 to 1. Should all persons 55 and over be excluded from the labour force, these ratios would be reduced to 1.37 and 0.6, for the number remaining in the labour force is diminished. As a result the burden of supporting the population 55 and over as well as those under 20 and not in the labour force would become unbearable unless the level of support per older person were greatly reduced. In sum, with labour force participation limited to members of the age group 15-54, there is a critical level below which labour force participation rates among those 55 and over cannot be reduced. Moreover, as the participation rates of those over 54 are reduced, support of the aged competes increasingly with support of educational facilities and personnel.

The transfer of currently produced income to retirees may entail less inequity (if it entails any) than appears. Each year there is transferred to surviving generations by departing generations a large amount of assets owned by the latter. The order of magnitude of this transfer may be suggested as follows: In 1972 gross national product in current dollars approximated $1.2 trillion. If the overall wealth-income ratio is something like 4 to 1 this GNP implies an aggregate wealth of about $4.8 trillion. Given this aggregate and a stationary population in which one seventieth of the population died each year, the yearly inter-generational transfer of property would average (say) 4.9 trillion divided by 70, or $70 billion. Given a population of 200 million, this amounts to $350 per capita. Should this $70 billion be absorbed by inheritance and estate taxes, the overall tax burden of the living population could be reduced slightly, (say) by 12 to 14 per cent.

IV *Age and Productivity*

Productivity varies with age at the overall individual level for two reasons. First, the fraction of a male population cohort that is enrolled in the labour force rises from a low level around ages 16-17 to a peak level in the early or mid-20s, remains at or near this level for perhaps 30 years, and then moves downward, somewhat after 54 and sharply after 64. The labour force participation of non-married females is lower at all age levels than the male rate but describes a somewhat similar pattern over time; that of married females moves down in the late 20s and early 30s from an earlier peak but later returns near the peak level of the early 20s, only to decline after the mid-50s. Labour force participation rates are lower for both sexes than they might be. As a result, gross national product is lower than it might be, though this loss is partly offset by non-commercial production within households. Non-participation in the labour force is attributable mainly to an individual's limitations and to his preference of non-participation to participation, a preference governed in part by the use that can be made of time released by non-participation in the labour force and by the pattern and amount of welfare and unemployment compensation.

Second, the productive capacity of an individual is conditioned by two sets of determinants, *endosomatic* and *exosomatic*. Under the endosomatic determinants may be included human capital in the form of genetic base, knowledge, experience, state of health, work attitudes, sense of responsibility, and other relevant factors inherent in the individual; and under exosomatic, non-human capital in the form of factors external to the individual, such as technological and organizational improvements, quantity and quality of relevant instrumental capital and supervisory personnel per worker, and other relevant factors external to the individual. These two sets of determinants are somewhat complementary to one another, at least in the sense that exosomatic determinants are malleable and hence can be accommodated to the needs and idiosyncrasies of some endosomatic determinants.

Both sets of determinants are subject to depletion as well as to augmentation within

limits. Aging is a physiologically dissipative force, though subject to countervaillance within limits by refresher education, cumulation of experience, improvement and preservation of health, together with home, work, and related environments. Accordingly, the degree to which we can realize what we have called the superior potential productivity per head of a stationary population turns on the degree to which the dissipative force of aging can be counteracted.

As a rule, the demands normally made on a worker fall short of his capacity to meet such demands. Let a value of 100 be assigned to these demands, categorized by the type of labour or professional activity. An individual newly entering a category of employment may be able to meet only (say) 80 per cent of these demands. As a result of experience and learning, however, his capacity to meet these demands will in several years rise above 100 and it may remain above 100 until he is in (say) his 60s or beyond. Moreover, if his excess capacity, say 20 points if his actual capacity is 120, begins to shrink, countervailling measures may prove economically feasible as well as capable of preserving some of this excess. Even should a person's capacity pass below 100 it will pay to keep him employed provided his remuneration can be sufficiently reduced.

The degree to which a worker's capacity matches or exceeds job requirements may be conditioned by exosomatic circumstances. It is essential, therefore, to keep these circumstances optimized, subject, of course, to economic constraints.

Education can contribute in several ways to augmenting and sustaining productivity per worker. First, reducing the number of years spent in primary, secondary, and higher education — say, by one-fourth — can increase a worker's productive life time by one-twelfth or more and release resources for refresher education. Second, because modern economies are dynamic and human capital (i.e., endosomatic determinants) may tend to be dissipated by change and other factors, education, especially refresher education, can contribute to the repletion and augmentation of human capital, at least of some of the endosomatic determinants. Education can also increase the propensity to mobility in an occupation, a propensity of great use in a dynamic economy characterized by great variety in elasticities of demand for products and in the incidence of technological improvement. Education can better adapt the labour force to change in exosomatic determinants as well as accelerate the rate at which newly entering members of the labour force can elevate their performance to parity with job requirements.

V *Horizontal Mobility and Inter-occupational Balance*

Maintenance of something like an optimum inter-occupational balance may prove more difficult in a stationary than in a growing population. It depends upon what may be called an *unattached* mobile reserve and an emerging *detached* potential reserve. By *unattached* mobile reserve I mean those newly entering the labour force and hence without prior ties to any line of activities and therefore free of developed feelings of attachment to particular lines of work except insofar as constrained by training. Members of this reserve constitute a highly elastic supply of labour. By *detached* potential reserve I mean members of the labour force engaged in lines of activity in which surpluses of labour or personnel are emerging, mainly because labour-displacing technical progress and capital investment, together with lowness of income elasticity of demand for the affected product, have reduced the amount of labour input required. Some members of this reserve will be indisposed to move into other lines of activity so long as they expect (without warrant) that they may not have to enter new lines of activity; these are not at the *margin of transference* as are members of the unattached reserve and hence may try to insist on greater remuneration before transferring to a new line of activity. In addition to these reserves a third, the *potentially mobile* members of the labour force, may be identified; while these remain employed and are likely to remain so, they stand ready to

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move into other lines of activity if the level of pay and other attributes of these activities are increased enough in comparison with their current situations. Among these *potential mobiles* younger members of the labour force will predominate even as younger members of the *detached* mobile reserve will be nearest to if not on the *margin of transference* to other lines of activity. For the financial and pain costs of moving tend to be inversely related to age on both economic and socio-psychological grounds.

A growing labour force will be more mobile than a stationary one. First, the relative number of members in the younger age groups is positively associated with the rate of population growth; hence the elasticity of supply of personnel confronting relatively expanding lines of activity will be higher in a growing population. Second, the *unattached* reserve will be relatively larger; if we represent its magnitude by one-half of the male population 15-24 years old in a stable male population and compare this magnitude with the number of members of this population aged 25-59 or 25-64 years, we have a crude index of the relative size of this reserve. Given a stable male population based on a life expectancy at birth of 71.2 years we get the following ratios of the age group 15-24 to that 25-64.

Rate of Growth (per cent)	Ratio
0	0.135
0.5	0.150
1.5	0.189

In a stationary population, therefore, greater dependence must be placed upon the *detached* reserve and young *potential mobiles* who see opportunity in newly developing lines of activity. Consequently, inter-occupational transfer will exercise greater upward pressure against wages *ceteris paribus*. How great this pressure will be depends upon the rate of technical progress and the degree to which it is incident upon industries and occupations the demand for whose product is inelastic to reduction in price and increase in average income. When, on the contrary, technological progress continually gives rise to new and wanted products, labour is continually attracted to their production. This orientation of technology also increases what may be called labour-magnets which in turn exert pull upon all three sources of labour and hence exercise a strong upward pressure against wage levels. In general, therefore, upward pressure against wage levels will tend to be higher in a stationary population, both because the total labour force will not be growing and possibly because there will be greater inter-occupational mobility.

Increase in the transformability of capital and labour reduces the cost of adjustment, for this makes it easier to shift labour and capital from one type of activity to another and thus cushion upward pressures. In other words, more factors are at the margin of transference and ready to change type of activity.

Mobility can be facilitated in two ways. It is essential to dissipate man-made barriers to movement of the sort growing out of efforts by trade unions and professions to bestow small phony monopolies upon not very differentiated segments of the labour force. Second, much more attention needs to be devoted by educational and research institutions to increasing the transformability of capital and labour and to reducing specificity of purpose insofar as possible and thereby making both capital and labour more multipurpose in character.

VI *Vertical Economic Mobility; Earnings Profiles*

Under modern conditions vertical mobility presents problems of little concern as in the past when societies were not very heterogeneous internally, the ratio of the perpendicular of the social pyramid to its base was very low, and ascription, together with mortality and strife, facilitated such vertical mobility as was required. With the advent of modern conditions,

complexity, heterogeneity, and minimization of ascription of roles and status, dimensions of vertical mobility have been multiplied, particularly in long-lived stationary populations.

Upward mobility of a male entering the labour force at (say) age 20 may assume one or both of two forms: (a) He may remain within a general category of jobs or employment but experience improvement in his annual earnings for some of the reasons noted below. (b) He may not only experience improvement along (a) lines but may move out of lower levels of the pyramid of employments into higher levels. This pyramid is largely independent of the rate of population growth, being determined in the main by a population's industrial and organizational structure and by the structure of a population's skills, aptitudes, talent, etc., insofar as these condition the type of industrial and organizational structure that is preferable on economic grounds.

For purposes of exposition we shall use the expression earnings profile to describe both (a) and (b) types of upward economic mobility. For earnings will be the major component of the index of an individual's economic progress through life from his time of entry into the labour force to his time of withdrawal. Monetary earnings will not always be the sole component, however, because, within limits, many an individual may prefer or accept substitutes in place of monetary increments, prestige, political power, etc.

The determinants of a representative individual's earnings profile or economic progress from entry into the labour force to the time of his withdrawal, fall within three categories in addition to the role of chance which often is very important. Indeed, the process underlying profile generation is essentially stochastic in character. Two sets of these determinants, the endosomatic and the exosomatic, were discussed in Section IV. Within the third category, economically unjustified discrimination, may be included rules and conventions which confer unearned economic advantages upon the beneficiaries of these rules and conventions. Illustrative may be seniority rules if they fail to produce increments in output that offset increments in compensation under these rules and conventions.

The presence of unjustifiable economic discrimination will intensify problems associated with adjusting the earnings profiles in a stationary population. In a modern stationary population upward mobility, as usually defined, will be slowed down in two ways: (i) by the high life expectancy of adults of working age; and (ii) by the de-pyramiding of the infra-65 age structure of the population. As a result of these two forces, the relative number of older persons in a labour force increases whereas the relative number of higher-order jobs respecting which older workers have preference does not. Accordingly, younger members of the labour force find access to higher-order employments more difficult; relatively more younger persons fail to achieve access to preferred jobs, or, should they prove successful, move up the ladder more slowly. Indeed, as Nathan Keyfitz demonstrates by use of a model different from that employed here, if a population is growing zero per cent instead of two per cent, promotion to the middle levels of hierarchies is delayed about 4.5 years; and so on.[2] In the United States, with increasing reluctance to retire attributable to inflation, the upward progress of younger workers is slowed and conflict situations are developing.

Increase in life expectancy at birth slows upward mobility. On the basis of the U.S. 1971 white male life table, of each 1,000 white males who enter the labour force at age 20, 911 will be, around 30 years later, at age 50, competing for a number of preferred jobs which have not increased in the same measure if at all. Back in 1900, only 750 out of 1,000 survived to age 50, thus reducing competition for these preferred jobs and making possible more rapid advancement. The corresponding number of survivors at age 60 in 1900 was 608; compared with 792 in 1971. Survivors benefit through the departure of their contemporaries be it through death, retirement, or emigration. Thus, if one is a young lieutenant in the army and of an optimistic turn of mind, he will welcome a long war and/or a sickly season, from which

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he, as a survivor, may expect rapid promotion as the upper ranks are emptied by early mortality.

Consider two stable male populations[3] based on a life expectancy of 73.9 years, one annually growing zero per cent and the other 1.5 per cent. Suppose all males 20-64 are in the labour force and that preferred Classes A and B jobs respectively constitute one-eighth and one-fourth of the labour force. With the resulting numbers of these jobs several categories of the members of the labour force may be compared [see lines (5) - (8)], to give rise to results on lines (9) to (13). Access to Classes A and B is more difficult in the stationary than in the growing population especially for older persons and also for those under 35 who must compete with the relatively large number of unplaced older persons aspiring to A and B jobs. The suppositious and inferential data follow.[4]

	0 growth	1.5 per cent annual growth
(1) Per cent aged 20-64	57.42	52.44
(2) Class A jobs	7.18	6.56
(3) Class B jobs	14.36	13.11
(4) Classes A + B jobs	21.54	19.67
(5) Per cent aged 50-64	18.11	12.93
(6) Per cent aged 40-60	25.35	20.26
(7) Per cent aged 40-64	31.07	24.04
(8) Per cent aged 35-64	37.62	30.32
(9) (2) ÷ (5)	0.40	0.51
(10) (2) ÷ (6)	0.28	0.32
(11) (2) ÷ (7)	0.23	0.27
(12) (4) ÷ (7)	0.69	0.82
(13) (4) ÷ (8)	0.57	0.65

As a result of a growing pressure of older persons on the limited number of preferred jobs — a pressure intensified by unwarranted discrimination in favour of older (say, over 35 or 40) members of the labour force — and intensification of difficulties of access to preferred jobs on the part of younger members of the labour force, competition at the top will press down upon upper income levels while a shortage of workers newly entering the labour force, together with resistance to discrimination in favour of older workers, will press up wages at lower levels. There will be some diminution in spread between average incomes at lower levels and those at upper levels.

Such convergence should bring productivity and remuneration into a closer relationship. It will reflect diminution in what we earlier called economically unwarranted age-oriented discrimination. It will thus bring the upward movement of remuneration in closer relationship to endosomatic determinants, especially if the fruits of exosomatic determinants are distributed in close relation with production as determined by endosomatic factors. The slope of the earnings profile is determined after a few years almost entirely by exosomatic factors since increase in the contribution of endosomatic factors becomes exhausted, often after following a logistic-like path. Education can be directed to accelerating the effectiveness and productivity of what we have called endosomatic factors. For this will make more acceptable a flattening of the earnings profile since it will be easily observed then that beyond a point, growth of output per worker is dominated by exosomatic factors.

VII Fluctuating Births

While fluctuation in the inflow of immigrants may give rise to fluctuation in the number of persons newly entering the labour force, such fluctuation is usually the result of an upsurge of births. An upsurge of births, moreover, can give rise to echo effects of diminishing amplitude after the manner of an upsurge in physical capital investment. Of interest here, of course, is whether temporary upsurges are more likely when natural increase is very low as in near stationary populations.

An upsurge in births produces an upsurge 16 to 19 years later in persons newly entering the labour force, with the result that unemployment may tend to rise and, as a result, marriage rates and natality may fall. For the demand for labour is a derived demand and does not materialize until entrepreneurs foresee demands for products warranting a corresponding increase in entrepreneurial activity suited to generate the needed derived demand for labour. Perhaps most striking of these fluctuations was that in births between the 1930s and the late 1960s with births increasing greatly after World War II from low pre-war depression-connected levels, only to return to low levels again in or after the later 1960s.

Even though fluctuation in the number of persons newly entering the labour force is easily foreseen, it tends to give rise to unemployment, until derived demand for labour rises sufficiently to absorb the excess influx. When, on the contrary, the number of persons entering the labour force is constant, as in a stationary population, or not variable even if rising or falling slowly, unemployment of the sort described is not likely to arise.

Fluctuation in the annual number of births is most disturbing to an industry whose activities are closely geared to the number of births or to that of persons of school age. For those engaged in educational activities resemble durable capital, the demand for which is sensitive to the accelerator principle, with the result that a small change in the demand for the services of this capital can occasion a larger demand for the production of additional human or other capital whence the services flow. Let P denote pupils; T personnel serving pupils; $r = P/T$, or $T = P/r$, and R denote the fraction of T annually replaced because of disability, retirement, or withdrawal from teaching. Then, in a stationary population, the amount A of T to be produced per year $= RT$. If P should increase to $P + \Delta P$, A will increase from RT to $RT + \Delta P/r$ —— from $R(P/r)$ to $R(P/r) + \Delta P/r$. Eventually, after the passage of 10 R years, A will gradually approach $R(P + \Delta P)/r$ as echo effects dampen out.

Should the increase ΔP be only temporary, the preferred solution consists not in the production and addition of $R(\Delta P/r)$, but in temporarily increasing r and in drawing on retired and other temporary personnel until $P + \Delta P$ settle back to P. The cost of luring young persons temporarily into teaching is thus averted. Unfortunately, a comparable solution does not exist respecting economy in the use of physical capital in education unless surplus capacity or space had been in existence at the time the upsurge in births got under way. Accordingly, a capital investment cost may be imposed by the upsurge of births — a cost high in per-pupil terms if the upsurge is transitory and the resulting increment in school facilities cannot be diverted to other purposes.

VIII *Genetical and Social Selection*

The educability and quality, genetic and social, of a population depend upon the selective mechanisms operative in a population. Genetic constraints limit investment in human capital and, if relatively more resistant at lower than at higher levels, as the amount of this investment increases, can conduce to greater inequality in the lower half of the population pyramid as investment in human and closely related capital increases. Inasmuch as (observed A. C. Pigou) environments have children, children born into and brought up in culturally and economically poverty-ridden familial environments are unlikely to develop their potential powers in the form of productive and related capacities. Genetic selection is less rigorous today than in the past when mortality was much higher among persons under (say) 30.[5] While socio-economic environmental conditions may be less extremely unfavourable to the poor and underprivileged than formerly, these conditions still exist even as do avoidable health hazards in industry that are still allowed to shorten the work-life and lifetime of hundreds of thousands of workers.

Of concern in the present context is whether selective forces are less favourable in a

stationary than in a growing population. In all populations not the whole but only a major fraction of a cohort of females accounts for its offspring. For example, in the United States as of 1970, of the five married cohorts born in 1931-35, 18.5 per cent had produced five or more children, 65 per cent had produced two to four children, and 19.5 per cent had produced one child or more. Moreover, the members of these cohorts represented only 94.6 per cent of the females born in 1931-35, since 5.4 per cent had never married.[6] If, as may be presumed, time and other costs of childbearing, together with skill at regulating family size and sense of responsibility for fully developing the potential of children, are less evenly diffused in a population already stationary than in one that is growing, a larger fraction of children born in a stationary population will grow up in inferior environments. Genetic selection will be more adverse as well, if, as supposed, those with superior genetic endowments contribute relatively fewer children than formerly.

Should these inferences be tenable, the role of education, as countervaillant to initially unequal starts for children, will become even greater than at present. Relatively more resources will be available, however. For, as indicated earlier, some of the resources formerly invested in growth may be devoted to improvement of child population. Moreover, output of goods and services per capita may be higher provided that older workers are not denied employment opportunities, and that the work-lives of workers in industries subject to health hazards are extended through elimination of industrial causes of disability and death.

IX Entrepreneurial Expectations; Dynamics

Will stationarity of population make an economy less dynamic and entrepreneurial confidence and expectations less conducive to progress in production?[7] Two sets of concomitants of stationarity, it is said, will produce such an effect: age-structure conditions; incentives to investment.

1. The age structure of a stationary population, it is said, is less conducive to invention and innovation and to the acceptance of change.

(a) It is said that the relative number of persons of inventive and innovative age will be lower. Let us put this age at 25-35, 25-39, or 30-49. Then in stable male populations growing 0, 1, and 1.5 per cent per year, we find those 25-34, 25-39, and 30-49 constituting the following fractions of the total male stable population and of males aged 18-64.[8]

Age Groups as Fraction of Population	0	1.0	1.5
	per cent	per cent	per cent
(25-34) / total population	0.132	0.140	0.142
(25-39) / total population	0.197	0.205	0.205
(30-49) / total population	0.261	0.251	0.242
(25-34)/(18-64)	0.220	0.243	0.255
(25-39)/(18-64)	0.328	0.355	0.368
(30-49)/(18-64)	0.435	0.451	0.434

Growing populations have a slight advantage when the fractions 25-34 and 25-39 are compared with the total population, but not if the fraction 30-49 serves as indicator of innovative potential. Comparison of the same fractions with the population 18-64 is not relevant unless it is a better index of the power of age groups to exercise innovative leadership.

(b) It is said that when a population is growing, the rate of qualitative improvement per worker tends to be higher than when a population is stationary, because in the former case, if educational resources are available, the average education of the population rises[9] much as the average quality or productivity of a country's physical capital improves when it increases at a higher than normal rate. For increments to the labour force are both larger and better

educated than increments withdrawing. This proposition, insofar as it is empirically valid under actual conditions, is much more descriptive of an underdeveloped than of a developed country.

In a developed country the level of education is high and is maintained or elevated by self-education, refresher education, training programmes, etc., all designed to keep individuals abreast of new findings. In a stationary population resources per capita for education tend to be higher than in a growing population.

It is possible that a growing population will be more congenial to change than will a stationary population for there will be relatively more persons in lower age groups. For example, in a stationary population only 26.35 per cent of the male population will be in the 20-39 group compared with 28.04 to 28.40 in stable male populations growing 1 to 1.5 per cent. Presumably, cultural conditions have more to do with dynamics than do small differences in age structure.

(c) It is feared that too much power will gravitate into the hands of older persons (e.g., boards of directors) whose decision-governing time horizon supposedly tends to be short and whose propensity to take and bear risk therefore is less than that of younger persons. Accordingly, since in a stationary population there are likely to be fewer young decision-makers than in a stable population growing (say) 1.5 per cent annually gerontocratic rule could become ascendant. This threat may be overcome, however. It may be stipulated, for example, that not over a third of a board's membership be over 60, with a second third in the 50s, and the remaining third under 50.

2. It is feared that the significance of the growth prospect as perceived will be less conducive to salutary change and investment. In other words, it is supposed that expectation respecting the future will be dominated by relatively short time horizons and, therefore, less favourable to the entrepreneurial assumption of risk and uncertainty and the undertaking of investment long in gestation and time horizon. It is also feared that the aggregate rate of growth will be lower and that, therefore, it will be more difficult to liquidate over-investment. A larger fraction of output will be characterized by a low overall elasticity of demand. Moreover, there will be relatively more consumers, especially among older persons, indisposed to modify their consumption patterns or to continue consumption making heavy physical demands upon the consumer.

Countervailling conditions will be present as well, even though an older population may be less responsive as consumers and lenders to forces of change sponsored by entrepreneurs. As noted earlier, with a large fraction of entrepreneurs required to be below 60 and 50, age bias at the decision level will be minimized. There will also be elements in the environment that can favour longer-run expectations. There should be more financial resources available per capita for underwriting risky investment and reducing its cost, for per capita income not only may be higher but will not be absorbed in so great a measure by population growth and population-oriented widening investment which (e.g., housing) yields relatively low long-run social returns. Trade cycle-connected losses should be less if cycle-prone durable investment declines in importance. Should technological change continue at former levels, new products should enter consumption as in the past, describing logistic-like curves until use of these products is dominated by growth of per capita income and the approach of satiety.

Production is much more likely to be consumer- than producer-oriented, since a larger fraction of the population will be older and more resistant to product differentiation and purposeful obsolescence. Should this prove to be the case, inputs currently wasted in forms of production and salesmanship that add little to the per capita flow of satisfaction and utility, would be available for increasing real output per head.

Should entrepreneurial expectations prove less favourable in a stationary population, analysis of the psychological factors contributing to this effect will need to be analyzed. For,

insofar as these factors are modifiable, educators may prove equal to reducing the capacity of these factors to produce adverse effects.

X *Conclusion*

Accommodation of an economy to population change, in the present case the coming of zero population growth and a stationary population, requires that economic inputs or factors of production be quite substitutable for one another, perhaps after partial transformation of some of the factors which initially are not highly substitutable for others. Substitutability may be directly realizable at the producer level or indirectly realizable through substitution of some goods and services for others at the producer level. Accordingly, the overall objective is countervaillance of the high degree of specificity of capacity currently built into manpower and instruments of production and supported by both trade unionism and barriers to competition at the levels at which goods and services are produced and marketed. Indeed, gains associated with specificity may be more than offset by sacrifice of adaptability in an economy dynamic at both consumer and producer levels.[10]

The contribution of education to the adjustment of an economy to the advent of a stationary population is five-fold: (1) It can contribute to an economy's flexibility by increasing the substitutability of factors of production for one another. (2) It can slow down the dissipation of human capital in general. (3) It can accommodate affected members of the labour force to the impact of technical change. (4) It can help to keep expectations in line with relevant future probabilities. (5) It can play a continuing role in making possible realization of man's maximum potential.

Footnotes

1 See A. J. Coale, 1972. Alternative Paths to a Stationary Population. Pages 591-603 in C. F. Westoff and Robert Parke, Jr. (eds.), Commission on Population Growth and the American Future, Vol. I, Demographic and Social Aspects of Population Growth, Washington, D. C.: U. S. Government Printing Office. Also Papers by Norman B. Ryder and Thomas Frejka, ibid., pp. 607-643. See also Thomas Frejka, 1973. The Future of Population Growth: Alternative Paths to Equilibrium. New York: John Wiley and Sons.

2 Nathan Keyfitz, 1973. Individual Mobility in a Stationary Population. Population Studies 27: 339, 348.

3 A. J. Coale and Paul Demeny, 1966. Regional Model Life Tables and Stable Populations. Princeton: Princeton University Press.

4 Based on Coale and Demeny, op. cit.

5 Philip Handler (ed.), 1970. Biology and the Future of Man, chapter 20. New York: Oxford University Press. See also Harvey Leibenstein, 1971. The Impact of Population Growth on Economic Welfare—Nontraditional Elements. Chapter four (especially pages 181-188) in National Academy of Sciences, Rapid Population Growth. Baltimore: Johns Hopkins Press.

6 U. S. Bureau of the Census, 1974. Population of the United States, Trends and Prospects: 1950-1990. Current Population Reports, Series P-23, No. 49. Washington, D. C.: U. S. Government Printing Office.

7 E. g., see Alfred Sauvy, 1969. General Theory of Population. Translated by Christophe Campos. New York: Basic Books, pp. 303-319.

8 Computed from Coale and Demeny, op. cit., p. 168.

9 Leibenstein, op. cit., pp. 188-195.

10 See George J. Stigler, 1939. Production and Distribution in the Short Run. Journal of Political Economy 47: 305-327.