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DECLINING BIRTH RATES IN CHILE: THEIR EFFECTS ON OUTPUT, EDUCATION, HEALTH, AND HOUSING

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DECLINING BIRTH RATES IN CHILE: THEIR EFFECTS ON OUTPUT, EDUCATION, HEALTH, AND HOUSING

by

Bruce Herrick and Ricardo Morán

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ABSTRACT

This report explores and quantifies the future impact of fertility rates on socioeconomic variables in Chile, principally GNP, GNP per capita, potential demand for education, health, and housing services, and the resources required to satisfy this potential demand. Also treated are the effects of fertility on population age composition and size of the labor force. To the extent possible, relationships and parameters are modeled on the basis of Chilean empirical evidence.

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SECTION 1
INTRODUCTION

CHILEAN POPULATION TRENDS

The widespread attention currently given to the so-called population problem and the observed decline in Chilean birth rates since the beginning of the 1960s has prompted considerable speculation as to its effects. In this study, the falling birth and death rates observed in Chile are taken as given and their effects on GNP and three social services — education, health, and housing — are explored within the theoretical framework of an economic-demographic model developed by General Electric—TEMPO for the U.S. Agency for International Development.

Basic to an understanding of the ways in which changes in vital rates affect the economy is an appreciation of their impact on the size and composition of the population. As this study will emphasize, the age composition of the population is especially influential in determining economic impacts of falling human fertility. The age distribution, in turn, depends largely on the historical level and subsequent speed of change of birth rate.* The reasons for the greater influence of the birth rate (relative to the death rate) on the age composition of the population may be intuitively grasped. Declines in the death rate usually affect all ages. Changes in sanitary conditions or in economic-well-being improve the health of the population as a whole, and the resulting lessened morbidity and mortality are distributed over all ages. Reduced infant mortality may be the chief result of such improvements, as Chilean mortality changes during the 1960s seem to indicate. Nevertheless, the generalization that the effects are widely distributed throughout the age spectrum still holds.

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*This subject is treated mathematically by Ansley J. Coale (1956).

By contrast, changes in fertility affect only the youngest age group. Births either occur or do not occur at age zero, and a drop in fertility therefore alters only the number entering the youngest age group. As this group becomes older, of course, the overall effects on age composition of declining fertility are even more pronounced, but obviously for the first — say, 40 — years after such a fall, the effects are limited to the population under that age. Thus a combination of declining birth and death rates, such as Chile has experienced, tends to arrest the juvenilization of the population that would occur if only death rates fell.

A second basic set of concepts involves the generation of national product. The national product, or synonymously, the value of total output of a society, is largely determined by the amount of inputs to the production process and by the efficiency with which they are combined. This study emphasizes conceptual and empirical considerations on the amounts of inputs, while eschewing a discussion of how changes in population size and composition affect the efficiency of the productive process, of which admittedly very little is known.

Chile is a promising case study for those interested in the interaction between population and the economy. It has already undergone a surprisingly rapid fertility decline, coupled with the falling death rate typically experienced in all countries. Its population density is relatively low by international standards, so that consideration of the population problem becomes considerably more than a simple calculation of increasing pressures on the man/land ratio. Finally, it is one of the more advanced among the developing countries. At the same time, however, no one considers Chile's level of income satisfactory, and the desire to improve that level is widespread.

STUDY METHOD AND ORGANIZATION

Using a standard model for demographic projections and a high-, aggregated economic model, this study has two objectives:

- Measurement of the impact of fertility change on aggregate and per capita gross national product in Chile
- An appraisal of the probable impact of different levels of fertility and different rates of fertility change on required expenditures for education, health, and housing.

The choice of GNP per capita as an overall index of economic welfare is subject to all the standard criticisms and defenses. While it cannot be claimed that everyone benefits when GNP per capita rises, greater equality in income distribution is easier to achieve with higher and rapidly growing GNP than with lower and slowly increasing GNP.

Education, health, and housing have been chosen as areas for special attention because they attract the strongest social pressures for reform and improvement in developing countries. Furthermore, the responsiveness of these areas to fertility changes is likely to be greater than that of other problem areas such as transport, agrarian reform, monetary policy, or international trade. Education, health, and housing are directly involved with births, deaths, and numbers of children — the essential elements of any analysis relating economic and demographic variables.

Section 2 discusses the demographic and economic models, and Sections 3, 4, and 5 contain projections of population, GNP, and physical and financial requirements for education, health, and housing, respectively. Section 6 discusses the effects of changing fertility on human capital formation, and Section 7 contains the major study conclusions.

SECTION 2

THE ECONOMIC-DEMOGRAPHIC MODEL AND ITS PROJECTIONS

CHILEAN ECONOMIC AND DEMOGRAPHIC TRENDS

The economic factors of primary importance to this study are total national income growth and birth and death rates. The rate of growth of total national income, in real terms, between 1940 and 1962 has been estimated at 3.5 percent per year by the Instituto de Economía y Planificación, University of Chile (1963).* Subsequent economic growth was greater: the period 1960–1968 exhibited an annual growth rate of 4.6 percent (ODEPLAN, 1969).

Chilean birth and death rate movements, together with the resultant natural rate of increase of the total population, are shown for four decades (1929–1969) in Figure 1. Death rates declined with only random variations from the mid-1930s to the early 1950s. Economic uncertainty and the stagnation accompanying unprecedented levels of inflation are usually blamed for the failure of the death rate to continue to fall in the mid-1950s. Finally, a renewal of the process of economic growth in the mid-1960s, appearing unmistakably in the economic statistics of the period, is reflected in the renewed decline in the death rate.

The movements of the crude birth rate are no less interesting. The economic depression of the 1930s in Chile, as in more highly industrialized countries, was marked by a decline in birth rates

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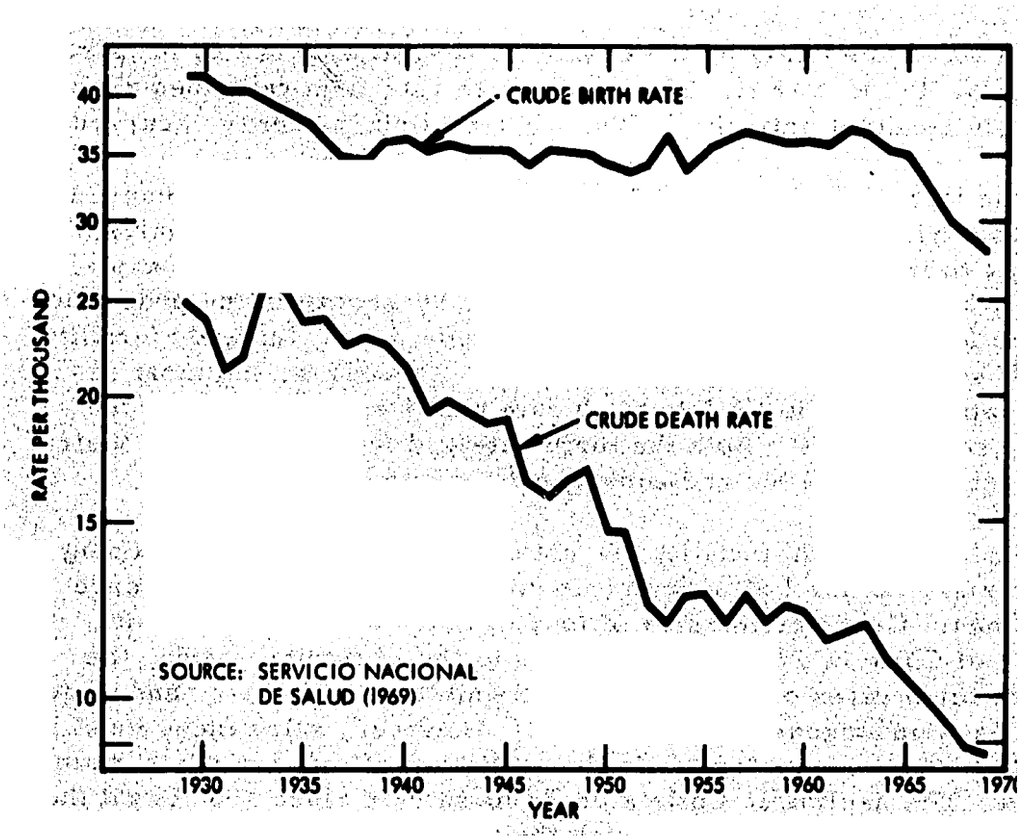
*Readers interested in details of Chile's economic history are referred to this source as well as Pinto (1968), Mamalakis (1965), and the Economic Commission for Latin America (1966).



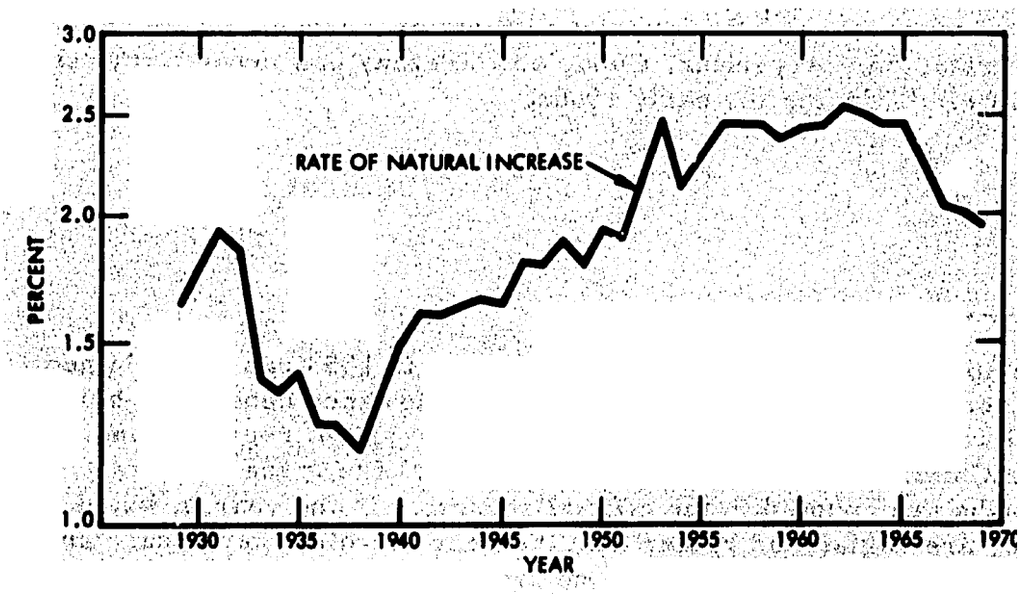


Figure 1. Annual birth rates, death rates, and rates of natural population increase in Chile.

which was halted only by the economic revival spurred by preparations for World War II. The crude birth rate then remained approximately constant until the 1950s, when a slight increase occurred.*

The birth rate increased from about 35 live births per thousand to about 37 in the first years of the 1960s. Preliminary analysis seems to indicate that this increase in the birth rate is not explained solely by age composition effects, i.e., by growth in the proportion of the female population in the most fertile ages. Instead, fertility itself seems to have increased slightly. Of course, the most remarkable change in Chile's birth rate has been registered in the most recent years. Both the birth rate and fertility reached their highest points in 1962 and subsequently declined.

Such declines in fertility are not unknown in today's developing countries. Other Latin American countries have also registered declines. Crude birth rates of four of these are compared with those of Chile in Table 1; in addition to the countries shown, the crude birth rates of the Dominican Republic, Guatemala, and Argentina have undergone lesser declines. However, allowances must be made for underregistration in the statistics of many of these countries. The decline in Chile's crude birth rate since 1962 is all the more interesting since, although the rate is still high by the standards of the industrialized countries, it is considerably lower than that of most other Latin American countries. Indeed, among these countries, only Argentina, Cuba, and Uruguay had lower birth rates than Chile's during the early 1960s.

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*An apparent sharp jump in the birth rate in 1953 can be explained by the extension in that year of family allowance benefits to blue-collar workers. This resulted in an increase of registrations in the Chilean Civil Registry in order to qualify for the benefits. Births are counted in the official statistics in the year in which they are registered rather than the year in which they occur, and it is probable that not only were previously unregistered children registered in 1953, but also that the lag in registrations was reduced so that fewer 1953 births were recorded in 1954.

Table 1. Crude birth rate (CBR) declines in Latin America.

Country	Highest CBR[a]		CBR in 1967
	Year	Amount	
Chile[b]	1962	37.5	30.5
Colombia[c]	1962	44.1	35.7[d]
Costa Rica[c]	1954	50.8	39.2
Peru[c,e]	1959	39.1	30.1
Puerto Rico[c]	1952	36.1	26.2

Notes:

[a]From 1952 to 1967

[b]From Servicio Nacional de Salud (1969)

[c]From UN, Demographic Yearbook (1967)

[d]1966

[e]Incomplete registry. Economic Commission for Latin America (ECLA) estimates for 1963–1965 place the CBR at 44–45

In 1965 Chile's National Health Service (SNS) began its officially sanctioned campaign against induced abortion, one element of which was the provision of contraceptive materials and supplies through the countrywide network of SNS health posts. However, caution must be exercised in ascribing a cause-and-effect relationship to the SNS campaign and the observed drop in fertility. To date, no nationwide study has been completed on the quantitative importance, if any, of the family planning element within the official campaign aimed at reducing induced abortion, although the matter has been assiduously studied at the local level.* The declining birth rate

*See Puga, et al. (1967), Faundes, et al. (1968), and Viel and Lucero (1970).

observed in the 1930s is evidence that fertility can fall without the aid either of spectacular breakthroughs in contraceptive technology, such as the pill and IUD, or of officially sponsored family planning campaigns. Individual decisions on the practice of contraception are made in the light of individual interests, and although official policy can be of influence, it is not a necessary condition for declining fertility.

THE DEMOGRAPHIC MODEL

The demographic model projects future population size and composition by subtracting deaths (disaggregated by age and sex) and adding births to a base-year population. Net international migration is assumed zero. Details on the model and its adaptation to computer calculation are given in McFarland, et al. (1968, No. 23); only modifications that have been made to adapt it more closely to Chilean conditions are described in detail in this report.

Death rates (or more accurately, age-sex specific survival rates) are those used by the United Nations' Latin American Demographic Center (CELADE) and its most recent Chilean population projections, which are, in turn, adapted by CELADE from UN model life tables.*

The study as a whole analyzes the implications of three different assumptions on the future evolution of Chilean fertility. None of these assumptions is meant to be a prediction. Technically speaking, each is a vector of age-specific birth rates whose elements change over time. A description of each follows.

Future Fertility Assumption "A"

The first assumption, identified throughout this study as "A", postulates constant age-specific fertility rates at the levels observed

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*The CELADE projections (Morales, 1969) evolved from earlier CELADE estimates (Alvarez, 1966). These projections have been given official status by the (Chilean) Corporación de Fomento de la Produccion (CORFO) (1970)

in 1960. The gross rate of reproduction (GRR),* a summary measure of fertility levels at a point in time, was 2.5 in that year. This fertility level is compared in Figure 2 with those of the other two assumptions about change.

The 1960 level represents what might be called a "historical" or "postwar" level of fertility whose economic and demographic effects serve as a benchmark for comparison with subsequent lower levels.

Although a fertility decline has been observed since 1963, the conditions posed by assumption "A" still appear important. Fertility declines are not necessarily permanent or irreversible, as demonstrated by the so-called "baby boom" of the United States during the 1950s. They result from varying and imperfectly understood causes. Economic depression is associated with fertility decline, as seen both in Chile and the United States during the 1930s. On the other hand, economic distress did not accompany the falls observed in both countries during the 1960s.

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*The gross rate of reproduction may be variously interpreted. It is the average number of female children born per woman in the fertile ages, generally taken to be 15-45 or 15-49. It may also be viewed as the sum of the age-specific birth rates of females to women in the seven age cohorts from 15-19 through 45-49:

$$GRR = s5 \sum_{i=15-19}^{45-49} \left(\frac{b_i}{P_i}\right)$$

where s = the proportion of female births in total births

b_i = the number of births to women in age-cohort i (i = 15-19, 20-24, . . . , 45-49)

P_i = the number of women in age-cohort i.

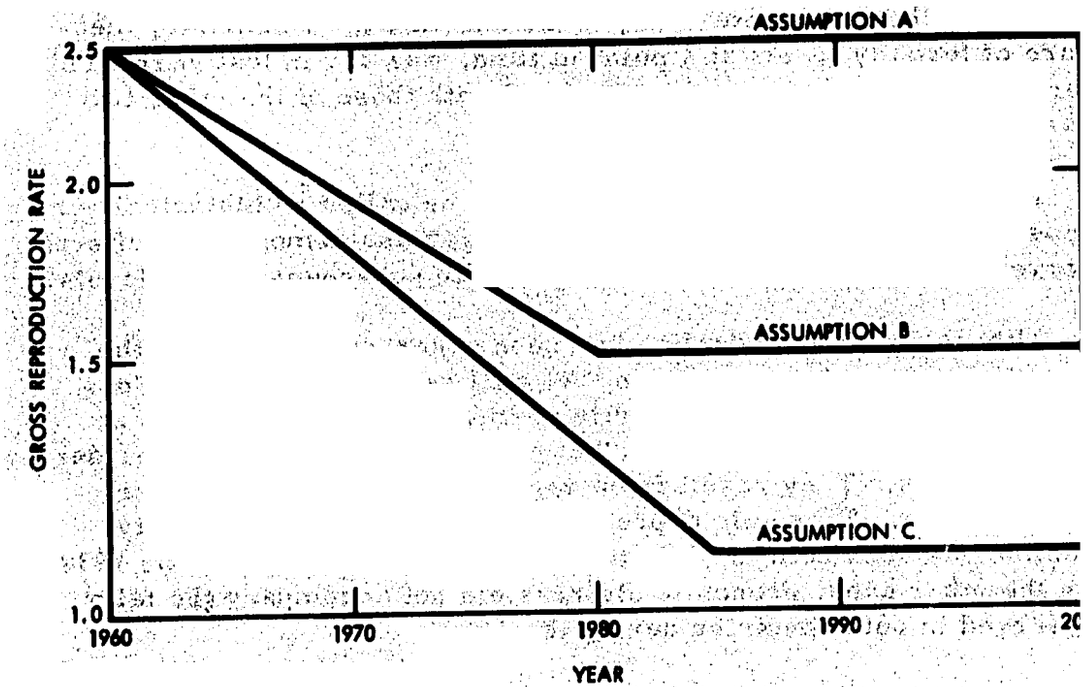

Figure 2. Gross reproduction rate in Chile under three assumptions of fertility, 1960–2000.

Future Fertility Assumption "B"

The second assumption ("B") dealing with fertility changes duplicates one made by Morales (1969) for the Latin American Demographic Center (CELADE). Chilean fertility is already slightly lower than the CELADE estimates labeled "decenso muy rápido de la fecundidad" (very rapidly declining fertility), which were the lowest of three projections made by CELADE. The lowest estimate was adopted because observed fertility declines have already slightly exceeded those postulated. The age-specific birth rates associated with the lowest estimate and their changes over time are compared in Figure 3 with the GRR's empirically observed from 1960 to 1969.

Future Fertility Assumption "C"

Assumption "C" reflects a more dramatic fertility decline, one that might effectively place a lower bound on future Chilean birth rate possibilities. It extrapolates linearly the fall in fertility levels observed during the 1960s until a set of rates is reached that would be consistent with an eventual equilibrium rate of zero population

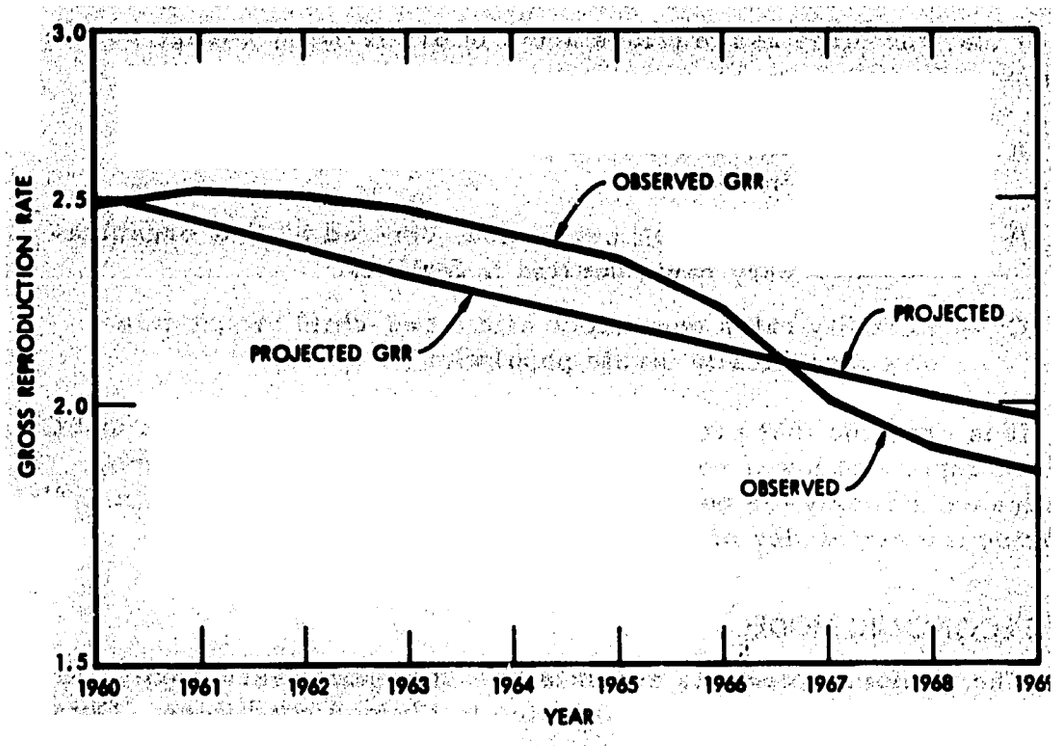

Figure 3. Observed and projected gross reproduction rate in Chile, 1960–1969, using CELADE-based fertility assumption B.

growth and with an average family size of slightly more than two children. Under assumption "C" these birth rates are attained in 1985.

Fertility consistent with the two-child family and a zero rate of population growth do not produce that rate instantaneously. Stable populations need not be stationary populations, and, given Chile's initial age composition, would not be.* Its population would not become stationary until the fourth decade of the 21st century under assumption "C". The GRR implied by this postulated change is compared with assumptions "A" and "B" in Figure 2.

*See, for example, Bogue (1969), Chapter 21 and its references.

Thus, the three assumptions about future fertility change can be summarized as:

A — High fertility at the traditional level, replicating that observed in 1960

B — An official CELADE projection, denoted by that organization as a very rapid decline in fertility

C — Fertility rates consistent with a two-child family in a demographically stable population.

It is probable that projected changes under assumptions A and C place upper and lower bounds on the fertility levels and, hence, influence strongly the population sizes likely to be observed in Chile during the remainder of this century.

THE ECONOMIC MODEL*

The economic model is essentially a straightforward application of a Cobb-Douglas production function to Chilean conditions. Output is generated by inputs to the economic process; these inputs are labor, physical capital, and technological change. Exponential weights were assigned to the labor and capital inputs in the production function on the basis of, and equal to, their estimated partial output elasticities. These elasticities, in turn, were set equal to one, implying constant returns to scale in the production process.†

Labor

The size of the labor input is calculated from the application of age-sex specific participation rates to the population size and composition generated by the demographic model for each future year.

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*The linkage between the economic model and the demographic model described in this report is explored in Enke and Zind (1969). Elaboration and application of the model to computer calculation is described in McFarland, et al (1968, No. 23).

†Some support for such weights appears in Harberger and Selowsky (1966). The weights chosen and the basis for their selection are discussed in Appendix A.

Although the fertility and mortality parameters for the demographic model are exogenously specified on a judgmental basis, their use is reinforced by their similarity to many of the assumptions of the UN's Latin American Demographic Center (CELADE).

Capital Stock

The original model ignored foreign investment and considered only an economy closed to international trade and transfers. Thus capital stock in each period was generated entirely by domestic savings of the previous period, which in turn depended on the level of per capita income and the size of the population in the previous period. Foreign investment, however, is historically an important source of investment in Chile and has probably been more directly motivated by natural resource exploitation than by any other single economic stimulus.

Based on these considerations, the model was modified to add foreign investment—or, more accurately, net capital inflows, including loans, direct investment, and capital transfers. These inflows were given an initial value which was assumed to decline until the end of the century. Interestingly enough, this assumption about the likely decline of foreign capital inflows was built into the model before the socialist victory in the presidential election of September 1970. Events since that election have borne out the likelihood of future declines in foreign capital inflows.

The mathematical form taken by the savings function can be described as follows:

$$Y_t = C_t + S_t$$

$$S_t = S_{c,t} + S_{f,t}$$

$$S_{c,t} = Y_t (1 - c_y) - c_p P_t$$

$$S_{f,t} = S_{f,o} (1 - bt)$$

where

t = subscript, indicating time

Y = GNP

C = consumption, including capital consumption allowances

S = savings

S_c = savings by Chileans

S_f = net savings from abroad

c_y = marginal propensity to consume out of GNP

P = population size

c_p = regression coefficient, linking absolute population size to consumption

b = annual rate of decline of foreign savings, starting with the initial period.

Thus, the explicit recognition of the contribution of foreign savings to eventual capital formation represents a modification of the original model.

Technological Change

Finally, technological change was introduced into the production function. Its contribution to output grows exponentially with time and was set, somewhat arbitrarily, at 1 percent per year. Thus, projected output would grow by 1 percent per year even in the absence of changes in the inputs to the productive process. Technological change of the magnitude used can be inferred, although not rigorously, from sectoral production studies made by Jere Behrman in 1968–1969 for the Chilean National Planning Office (ODEPLAN). However, the choice of this parameter is not critical to the results of the model, as shown in the sensitivity testing results of McFarland, et al. (1969).*

---

*Myrdal in Asian Drama also comments on the whole question of the sensitivity of economic-demographic models to parametric change. There he questions the conceptual robustness of the use of ceteris paribus assumptions in models of a similar class

Output in each year, then, is the product of the amounts of physical capital and the labor force, each weighted by appropriate partial elasticities, the amount contributed by technological change in that year, and a constant term.

THE DEMOGRAPHIC PROJECTIONS

Population

The demographic model generates projections of total population disaggregated by sex and by 5-year age cohorts. Obviously, the overall size of the population is the denominator in the quotient of GNP per capita. One of the goals of this study is to illuminate the relationship between population size and total production. Aggregate GNP is not constant under varying population size partly because the labor force itself is drawn from the population as a whole and varies with fertility levels and, hence, different resultant population sizes. Thus, the demographic model provides the frame of reference to make estimates regarding the labor force by facilitating computation of the size and composition of the population.

Starting from an initial population of 7.683 million in 1960, and using the three different sets of fertility assumptions outlined previously, together with a single set of assumptions concerning mortality throughout the projection period, the demographic model has been used to project the population sizes shown in Table 2. The table shows the increasing force of sustained declines in fertility; the projection based on traditional (1960) fertility yields a population 43 percent and 66 percent larger than those of projections B and C, respectively, by the end of the century. The crude birth rates (CBR) and crude death rates (CDR) that accompany these changes are shown in Table 3.

The calculations of dependency rates, shown in Table 4, are even more revealing. The juvenilization of the population under continued high birth rates is apparent even though the Chilean birth rate at its traditional level is not as high as the rates exhibited by some other Latin American countries. Nevertheless, traditional Chilean fertility levels lead to steady increases in the proportion of the population less than 15 years of age: for each 100 people aged 15-64 in 1960 there are 71 children under 15, and by the year 2000 the number increases to 78.

Table 2. Total population of Chile (thousands).

Year	Fertility Assumptions			Ratio of:	
	A	B	C	A/B	A/C
1960	7,683	7,683	7,683	1.00	1.00
1970	9,932	9,575	9,547	1.04	1.04
1980	13,112	11,591	11,295	1.13	1.16
1990	17,650	14,019	12,853	1.26	1.37
2000	23,983	16,803	14,465	1.43	1.66

Table 3. Crude birth rate (CBR) and crude death rate (CDR) per thousand in the Chilean population

Interval	CBR Under Fertility Assumption			CDR Under Fertility Assumption		
	A	B	C	A	B	C
1960	37	35	35	12	12	11
1970	37	28	27	10	9	9
1980	37	27	21	7	8	7
1990	36	25	19	6	7	7
2000	36	24	18	5	6	7

Table 4. Numbers of youth and old people per hundred persons in the population aged 15-64 under different Chilean fertility assumptions.

Year	Assumption A			Assumption B			Assumption C		
	Total in Dependent Ages	Youth	Old People	Total in Dependent Ages	Youth	Old People	Total in Dependent Ages	Youth	Old People
1960	79	71	8	79	71	8	79	71	8
1970	81	73	8	74	66	8	74	66	8
1980	83	75	8	63	55	8	59	51	8
1990	86	78	8	61	52	9	50	41	9
2000	86	78	8	60	50	10	47	37	10

These movements contrast strikingly with the projections in which fertility falls. In projection B, the officially estimated fertility decline, the number of dependent youths falls from 71 per 100 to 50 per 100 by the year 2000, while the more extreme but nevertheless realizable two-child norm assumption (C) leads to a greater, more abrupt decline.

The lower relative numbers of dependent youths (definitionally, those less than age 15) in the latter projections are offset only slightly by increases in the numbers of those 65 and older. Thus, for example, while the proportion of dependent youths in the two-child-norm projection is falling from 71 (per 100 in the "working ages" of 15-64) to 37 by year 2000, the numbers of old people rise from 8 per 100 to 10.

The potential economic impact of these changes in the age structure of the population is obvious, since the productive labor force is drawn almost exclusively from those aged 15-64. Although some outside those ages do indeed work, especially in rural agriculture and in urban commercial and service occupations, their productivity is very low by any standard. Furthermore, societies attempting to industrialize universally favor long periods of education for youth and social security benefits for the elderly.

Labor Force

The foregoing changes in the age composition of the population translate themselves fairly readily into changes in the labor force. Age-sex specific labor force participation rates are multiplied by the numbers in the work-age population to calculate labor force size.

The results of the labor force projections are shown in absolute numbers in Table 5. Ratios of the projected labor force to total population and the working age population appear in Table 6.*

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*The age-sex specific labor force participation rates were derived as follows: for 1960, census-observed rates were used for both males and females; for 1980, rates were deduced for both males and females from projections given in CORFO (1970); for year 2000, the 1980 rates were used for male age cohorts 25-49, while rates for younger and older men were linearly extrapolated from the 1960 and 1980 rates, and urban female participation rates for 1980 were assigned to the whole female labor force in anticipation of increased urbanization and lower fertility. Values for intermediate years were log-linearly interpolated.

Table 5. Projected Chilean labor force under different fertility assumptions (thousands).

Year	Fertility Assumption		
	A	B	C
1960	2,363	2,363	2,363
1970	3,077	3,077	3,077
1980	4,133	4,096	4,093
1990	5,550	5,119	5,068
2000	7,621	6,219	5,868

Table 6. Chilean labor-force-to-population ratios under different fertility assumptions (percent)

Year	Ratio to Entire Population Under Fertility Assumption			Ratio to Population Aged 15-64 Under Fertility Assumption		
	A	B	C	A	B	C
1960	30.7	30.7	30.7	55.1	55.1	55.1
1970	31.0	32.1	32.2	56.1	56.1	56.1
1980	31.5	35.3	36.2	57.5	57.7	57.7
1990	31.4	36.5	39.4	58.4	58.9	59.0
2000	31.8	37.0	40.6	59.1	59.4	59.8

Absolute labor force size is not affected by fertility decline for 15 years, and even then the subsequent changes proceed only slowly. Thirty years after the onset of falling birth rates the labor force is less than 10 percent smaller under fertility assumption C than under traditional levels of reproduction.

When the focus changes from absolute to relative labor force size, however, the picture is altered as seen in Table 6. The ratio of the labor force — not just those age-eligible for work, but those actually employed or seeking jobs — to the overall population rises by a single percentage point in four decades under conditions of traditional fertility. But with lower fertility, that increase is either 6 or nearly

10 percentage points, depending on the assumptions. The projection associated with a two-child-norm (assumption C) has 40.6 workers per 100 or one-third more in the population by the century's end as compared with only 30.7 in 1960.

The impacts of these prospective changes on total GNP and on GNP per capita are explored subsequently. The degree of latitude given to the developing economy by these changes, otherwise made impossible by the youthful composition of the population, is one of the central mechanisms, if not the central mechanism, by which fertility decline produces its effects.

THE ECONOMIC PROJECTIONS OF OUTPUT

Superficially, it might appear that larger populations would be associated with larger total output, regardless of the relationship between population size and output per capita. But, as shown in Table 7, total Chilean GNP is almost completely unaffected by fertility until after 1990. The labor force after 30 years is only 10 percent lower under conditions of rapid fertility decline than it would be under historic fertility levels and, as seen in Table 8, where the inputs to the production process are detailed, this relatively smaller labor force is almost completely offset by a higher capital stock. itself the result of the process of saving and investment.

The size of output is completely determined by the size of the labor force and capital stock inputs, and by their elasticity coefficients. Like the labor force inputs, the stock of physical capital is influenced by population. At some (presumably low) level of GNP, aggregate savings are zero for any given population, with the absolute size of that GNP associated with zero savings increasing with population size. As GNP exceeds this zero-savings level, savings become increasingly positive.

During the initial decades of the projections, total GNP is notably insensitive to the differences among the three fertility assumptions, while population sizes corresponding to these assumptions increasingly diverge. Since savings flow from the excess of GNP over the zero-savings level in the model, higher fertility increases the zero savings level of GNP and reduces resultant amounts of savings and capital formation. Thus, larger additions to the labor force are offset by smaller additions to the capital stock. The net results of these counteracting forces on GNP are shown in Table 8.

Table 7. Summary of Chilean economic projections, 1960–2000.

Economic Indicator	Year	Fertility Assumption			Ratios	
		A	B	C	B/A	C/A
Total GNP (millions of 1960 escudos)[a]	1960	4,080	4,080	4,080	1.00	1.00
	1970	6,078	6,101	6,102	1.00	1.00
	1980	9,429	9,556	9,569	1.01	1.01
	1990	15,022	14,934	14,951	0.99	1.00
	2000	24,814	23,303	22,847	0.94	0.92
Average Annual Rate of Growth of Total GNP, 1960-2000 (percent)		4.6	4.5	4.4		
GNP/Capita (1960 escudos)[a]	1960	531	531	531	1.00	1.00
	1970	612	637	639	1.04	1.04
	1980	719	824	847	1.15	1.18
	1990	851	1,065	1,163	1.25	1.37
	2000	1,035	1,387	1,579	1.34	1.53
Average Annual Rate of Growth of GNP/Capita (percent)	1960	1.4	1.6	1.6		
	1970	1.7	2.6	2.8		
	1980	1.7	2.7	3.3		
	1990	2.0	2.6	3.2		
	2000	2.1	2.7	3.1		
	1960-2000	1.7	2.4	2.8		

Note:

[a]In 1960, the Chilean escudo was worth about one U.S. dollar. Specifically, E° 1.05 = $1.00.

Table 8. Inputs to the Chilean production process.

Inputs	Year	Fertility Assumption			Ratios	
		A	B	C	B/A	C/A
Labor Force (thousands)	1960	2,363	2,363	2,363	1.00	1.00
	1970	3,077	3,077	3,077	1.00	1.00
	1980	4,133	4,096	4,093	0.99	0.99
	1990	5,550	5,119	5,068	0.92	0.91
	2000	7,621	6,219	5,868	0.82	0.77
Capital Stock (billions of 1960 escudos)	1960	10.3	10.3	10.3	1.00	1.00
	1970	14.4	14.5	14.6	1.01	1.01
	1980	21.2	22.0	22.0	1.04	1.04
	1990	32.8	35.2	35.6	1.07	1.09
	2000	53.5	57.8	58.9	1.08	1.10

Note:

In addition to labor and physical capital, technological progress is included in the aggregate production function, and is assumed to proceed in these projections at a rate of 1 percent per year.

Turning to the evolution of GNP per capita, Table 7 lists the projection results for the three Chilean fertility assumptions. Even under historic fertility conditions, GNP per capita almost doubles over the 1960–2000 period, and nearly triples under the lowest fertility case. The model supplies answers to many other questions bearing on the projected Chilean economy. Table 9 shows, for instance, the years that per capita income reaches given levels under the three fertility assumptions. The table indicates that future contractions in the birth rate would be regarded by a significantly faster rate of growth of per capita output and, hence, a reduction in the period required to attain given levels of this index of economic development. Chile's already moderate rate of population growth, in comparison with that of other developing countries, makes such a conclusion all the more striking. If the strength and growth of the so-called "rising expectations" are as great in Chile as they are commonly thought to be in other developing countries, the possibilities of reaching the indicated levels of GNP per capita a decade or more earlier in the lower fertility cases than in the high should be emphasized.

Table 9. Year in which Chilean GNP per capita reaches a given level.

GNP/Capita (1960 escudos)	Fertility Assumption/Year		
	A	B	C
800	1986	1979	1978
1000	1998	1988	1985
1200	after 2000	1995	1991

Regarding the model's sensitivity to parametric variations, an extensive series of tests conducted earlier on a slightly simpler variant led to the following conclusion:

> "The insensitivity of projected GNP's to changes in the fertility assumptions dominates all of the principal economic conclusions . . . . This important conclusion is independent of the choice of economic parameter values within very broad ranges".*

This conclusion is generally applicable to the present model. It is reinforced by the very small differences — well within the orders of magnitude noted in McFarland, et al. (1969) — that accompanied changes in parameter values introduced while experimenting with the model at earlier stages in this study. The selection of parameter values is discussed in detail in Appendix A.

*McFarland, et al. (1969), page 16. The study further demonstrates that although absolute values of the economic results are sensitive to parametric variation, the relative values achieved through changes in the assumed fertility levels are not similarly sensitive. See p. 18 and passim.

SECTION 3
EDUCATION

PRIMARY AND SECONDARY EDUCATION

This section reviews the impact of the three different fertility assumptions on the resultant school-age population size, on requirements for teachers and schools (given certain educational norms for these items), and on expenditures necessary to provide education.

Among social expenditures, education is affected most strongly by changes in human fertility. Section 2 shows that changes in fertility affect the absolute and relative numbers of young people more quickly and more strongly than other groups in the population, and education concentrates its spending most strongly on the young. By contrast, the age distribution of expenditures both in health and in housing are not so strongly affected by changes in the size of the most youthful cohorts in the population.

Spending on education in this study is calculated by a general method to be applied to all social expenditures, both current and capital. Details on the general framework and its application to computer calculation are contained in McFarland, et al. (1968, No. 23).

Current expenditures include the average expenditure per teacher in the system, an amount comprised not only of salaries, but also of noncapital items of supplies and equipment. The latter amounts are, however, unimportant. Ernesto Schiefelbein (1970, No. 34), former Director of the Chilean Office of Educational Planning, notes that, of the expenditures by the Ministry of Education, "remunerations absorb nearly the whole budget."

tion costs of schools and the costs of providing university training for prospective teachers.*

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*The treatment of teacher training thus differs from that of Bowles (1969), who considers teachers as rented from the economy, their training costs being completely reflected by the rental payments.

The changes in spending necessitated by the three fertility assumptions are each related to the different numbers of school-age population present. Table 10 shows the numbers in the primary school ages, here taken as 7-14, the secondary school ages, 15-18, and university ages, 18-24. In the context of the educational reform, the first group would be those eligible for educación básica, and the second for educación media in its two different variants (scientific-humanistic and vocational).

Table 10. Projected Chilean school-age population

Number of Students and Average Annual Growth	Year	Fertility Assumption		
		A	B	C
Primary School Age (17-14) (thousands)	1960	1,439	1,439	1,439
	1970	1,937	1,902	1,900
	1980	2,523	2,001	1,944
	1990	3,484	2,262	1,874
	2000	4,772	2,704	1,879
Secondary School Age (15-18) (thousands)	1960	590	590	590
	1970	812	812	812
	1980	1,054	976	971
	1990	1,424	1,034	966
	2000	1,376	1,217	909
University Age (18-24) (thousands)	1960	916	916	916
	1970	1,220	1,219	1,219
	1980	1,659	1,641	1,639
	1990	2,160	1,735	1,692
	2000	2,988	1,954	1,640
Average Annual Growth Rates, 1960-2000 (percent)				
Primary School Age		2.97	1.59	0.68
Secondary School Age		2.14	1.82	1.09
University Age		3.00	1.91	1.47

The table points up the pressures on the system by the end of the century. Even if fertility continues to fall as in assumption B, there will be 800 thousand more children in the primary school ages in the year 2000 than there are now; and well over a million more than there were in 1960. The table also shows what would have happened if fertility had not declined during the decade of the 1960s: children of primary school age would more than double by century's end over their present level. That number, 4.772 million, would represent more than three times the number eligible for education in 1960. Further, since the youngest age groups are most strongly and most quickly affected by fertility changes, it would have been possible to make an even more dramatic comparison by including six-year-olds and possibly even five-year-olds among those eligible for primary education. By contrast, fertility levels consistent with the two-child family (assumption C) would result in a number of primary school age children more or less constant in absolute terms between now and the year 2000.

The secondary-school-age and university age groups are less quickly affected by changes in fertility occurring after 1960. The lag of 15 years, in the case of potential secondary students, and 18 years for would-be university entrants, results in both groups remaining unchanged by fertility decline until after 1975. However, once the lags are overcome, both groups are affected almost as strongly as the primary age group.

The other findings of this section are directly related to numbers of potential students. Application of educational standards and norms to these potential students provides figures on desired human resources and physical facilities in education, and calculations of the costs of these yield information on the expenditures implied by the size of the youthful population and the nation's educational standards.

The enrollment ratio is an example of these norms. The Chilean educational reform has a goal of providing the opportunity to all Chilean children to achieve basic literacy. At present, enrollment in primary schools is about 85 percent of those in the primary ages. This study postulates its moving to 95 percent in the next decade. At the same time, social pressures demand expansion of the secondary system. Estimates of possible enrollment ratios appear in Table 11.

Table 11. Projected Chilean enrollment ratios and classroom space.

Year	Enrollment Ratios		Space per Student (Meters^2)[a]	
	Primary	Secondary	Primary	Secondary
1960	0.79	0.26	1.5	2.5
1970	0.95	0.35	1.5	2.5
1980	0.95	0.50	2.0	3.3
1990	0.95	0.60	2.0	3.3
2000	0.95	0.60	2.0	3.3

Note:
[a]Based on Schiefelbein (1970, No. 35) and interviews with education planning officials.

Two more norms allow estimation of the required number of teachers and the necessary physical space to house education programs.

The student-teacher ratio now is about 1:37; this is projected to change to 1:35 on the basis of current planning documents. A teacher attrition factor of 3 percent per year was also estimated on the same basis.

Space in school rooms represents a combination of two estimates: the space per pupil (which varies with education standards) and the extent of shift operations. In calculating school plant additions required by increasing numbers of students, replacement of existing educational plants due to physical deterioration must also be taken into account. On the basis of information from the Sociedad Constructora de Establecimientos Educacionales, 4 percent per year was used as the depreciation rate on physical plant.

The costs to train new teachers vary with grade level to be taught, subject, and so forth, but the average cost to train a teacher in the university, after making appropriate corrections for drop-outs and for students who take longer than the prescribed period to complete their degree requirements, is about E° 2700 (in escudos of 1960).

Costs of constructing and equipping schools have fluctuated over the years, in part because the composition of school construction has varied. An approximate average of E° 98 per square meter (again, in 1960 escudos) was obtained from calculations made by the Sociedad Constructora de Establecimientos Educacionales for constructing and equipping classrooms.

In considering costs to operate these facilities, average expenditures per teacher were calculated using the observation, mentioned above, that salaries comprise the overwhelming bulk of educational spending. Three options were considered for treatment of future i. reases in pay:

1. Treating salaries as constant over time. This approach was discarded since income per capita, and more significantly, income per worker, rises in each projection over time. Thus, constant salaries would amount to relative wage declines which appeared to be an unrealistic assumption.

2. Raising expenditure per teacher by the relative amount, i.e by the percentage, that GNP per worker rises in the variou projections. This approach implicitly assumed that wage differentials between those employed in education and those employed elsewhere remain constant.

3. Recognizing the possibility that increases in relative pay might be necessary to attract the increased number of teachers required in some of the projections and in some periods in the future. Such an approach assumes a labor market initially in equilibrium but requiring a higher pay differential for educators if shifts are to occur toward education in the composition of the labor force.

The second option was adopted, since the model represented by the third is less applicable to Chile than a job vacancy model. The job vacancy model characterized by the second option implies that employment in education is limited not by lack of labor supply but by demand conditions. However, the professional labor market was not studied in detail in order to substantiate this view. Thus, the possibility remains that higher differentials than those presently observed might be necessary in the future.

Using the second option, expenditures per teacher (in escudos of 1960) were estimated to be E° 4900 in 1970, growing to about E° 8100-9650 by the end of the century, depending on the population projections used. These amounts represent not only teachers'

salaries, but the total current account expenditures of the system — including the salaries of all supportive personnel — divided by the number of teachers.

The projected results deriving from the assumptions on, and educational goals of, the Chilean primary and secondary school system are contained in Tables 12 through 14. By century's end, primary enrollment (Table 12) in the event of a continuing fertility decline will be slightly more than half that which would occur for a constant 1960 fertility rate. The difference for secondary enrollment is somewhat less because of the greater lag in impact.

Table 12. Projected total Chilean primary and secondary school enrollment and teacher and classroom space requirements.

Item	Year	Primary Education Under Fertility Assumption			Secondary Education Under Fertility Assumption		
		A	B	C	A	B	C
Enrollment (thousands)	1960	1,137	1,137	1,137	153	153	153
	1970	1,840	1,807	1,805	284	284	284
	1980	2,396	1,901	1,847	527	488	485
	1990	3,310	2,149	1,780	854	620	580
	2000	4,534	2,569	1,785	1,186	730	545
Teachers Required (thousands)	1960	28.4	28.4	28.4	3.8	3.8	3.8
	1970	49.7	48.8	48.7	7.7	7.7	7.7
	1980	69.5	55.1	53.5	15.3	14.2	14.1
	1990	96.0	62.3	51.6	24.8	18.0	16.8
	2000	131.5	74.5	51.8	34.4	21.2	15.8
Classroom Space Required (thousands of meters^2)	1960	1,705	1,705	1,705	383	383	383
	1970	2,760	2,711	2,707	710	710	710
	1980	4,793	3,803	3,693	1,740	1,611	1,602
	1990	6,620	4,298	3,561	2,820	2,048	1,913
	2000	9,068	5,138	3,569	3,913	2,410	1,800

The necessary expansion of primary enrollments between 1970 and 2000 provides further cause for reflection. Even if fertility declines at the officially projected rate of assumption B, more than three-quarters of a million additional children will be in primary school in the year 2000 if the postulated enrollment ratios are maintained. Teaching capacity and classroom space would require expansion by more than one-half their present levels. By contrast, virtually no expansion would be necessary in the event of the accelerated fertility decline of assumption C. The number of students would fall slightly, while the number of teachers and classroom floor space would rise slightly because of higher educational standards.

Although the expansion of secondary enrollments during the 1960s was remarkable, even under the lowest official fertility assumption, B, enrollment must continue to accelerate during the 1970s. Given the goals for secondary enrollment ratios shown in Table 11, by the year 2000 almost 450 thousand more secondary students will be enrolled than in 1970. Such an increase will require growth to more than two and one-half times its present size in order to service adequately what seems likely to be sustained social demand.

Table 13 projects the numbers of new teachers and the amounts of floor space required for expansions in enrollment for the first year of each decade from 1970 through 2000. The table shows that by the year 2000 the numbers of new primary teachers required annually under fertility assumption A would be more than four times those of assumption C. At the secondary level, educational planners would have to face in the highest fertility case a teacher training program about six times the magnitude of that required by the lowest fertility projection. Similarly, annual requirements for additional classroom space would be nearly four times as great for primary education under assumption A as they would be for assumption C, and nearly five times as great for secondary education.

The foregoing comments on projections for training new teachers and adding new classroom space apply equally to the projections of investment costs given in Table 14 for teacher training and for classroom construction. The system operating costs of Table 14, which disregard (definitionally) the substantial investment expenditures implied by the projections, provide a less dramatic comparison among fertility assumptions than do the teacher training

Table 13. Projected annual Chilean primary and secondary school new teacher and new classroom space requirements.

Item	Year	Primary Education Under Fertility Assumption			Secondary Education Under Fertility Assumption		
		A	B	C	A	B	C
New Teachers Required (thousands)	1970	3.6	3.4	3.3	0.6	0.6	0.6
	1980	4.1	2.1	1.9	1.2	1.0	0.9
	1990	5.4	2.6	1.2	1.7	0.9	0.7
	2000	7.2	3.2	1.7	1.9	1.0	0.3
New Classroom Space Required (thousands of meters^2)	1970	203.0	191.4	190.4	59.6	59.6	59.6
	1980	397.8	247.0	227.6	171.6	144.0	142.0
	1990	426.4	214.6	113.2	215.0	121.8	98.6
	2000	570.6	264.8	149.2	251.0	129.0	53.8

costs, but in absolute terms rise considerably. For the last projected year, 2000, the necessary primary level total investment and operating expenditures of 479 million escudos in the lowest fertility assumption can be compared with those of 1,016 million escudos for the highest. Similar relative magnitudes obtain for secondary level system expenditures. Although the educational system grew swiftly and steadily during the latter half of the 1960s, the continuation of that expansion at the rates made necessary by these projections will clearly intensify pressures on already strained public budgets.

Although the results of the projections reviewed in the preceding paragraphs are highly aggregated, include some coefficients that are constant over time, or at best, grow at constant rates, and disregard many details of concern to planners, they do deal with the most important features of the system. At the same time the analytical scheme underlying these projections provides the skeleton for future, more detailed models of the system.

Table 14. Projected annual investment and operating costs of Chilean primary and secondary schools (millions of 1960 escudos).

Item	Year	Primary Education Under Fertility Assumption			Secondary Education Under Fertility Assumption		
		A	B	C	A	B	C
Investment for Training New Teachers	1970	9.6	9.0	9.0	1.7	1.7	1.7
	1980	11.0	5.7	5.0	3.2	2.6	2.5
	1990	14.5	6.9	3.2	4.6	2.5	1.9
	2000	19.4	8.6	4.6	5.2	2.6	.9
Investment Costs for New Classroom Space	1970	19.8	18.6	18.6	5.8	5.8	5.8
	1980	38.8	24.2	22.2	16.8	14.0	13.8
	1990	41.6	21.0	11.0	21.0	11.8	9.6
	2000	55.8	25.8	14.6	24.6	12.6	5.2
System Operating Costs	1970	211.8	210.4	210.2	31.6	31.6	31.6
	1980	358.6	302.6	297.4	73.4	71.4	71.4
	1990	570.6	410.6	360.8	142.0	115.4	111.2
	2000	941.4	625.0	460.2	245.4	176.6	145.4
Total Investment and Operating Costs	1970	241.2	238.0	237.8	39.1	39.1	39.1
	1980	408.4	332.5	324.6	93.4	88.0	87.7
	1990	626.7	438.5	375.0	167.6	129.7	122.7
	2000	1,016.6	659.4	479.4	275.2	191.8	151.5

While the projections consider quantitative improvements in the student/teacher ratio, in the classroom space per student, and in teachers' (and others') salaries, equally important qualitative improvements have been proposed for the system. Higher rates of retention of skilled employees; an orientation of education toward more meaningful general education, on the one hand, and more immediately useful vocational training, on the other; a better way of evaluating educational progress; and a greater emphasis on in-service training all fall within this context. Merely naming these improvements makes clear the difficulty of their inclusion as quantitative parametric changes in the present model. But it is equally clear that higher quality education is likely to be more expensive education. Therefore, not accounting for these improvements explicitly in the projections means, in turn, that the projections understate differences in the economic implications of the different fertility levels.

UNIVERSITY EDUCATION

University education in the development process is frequently regarded as qualitatively different from primary and secondary education. It is viewed as having a special role in the formation of high level manpower required to introduce and manage the changes associated with the transition into a technologically advanced society. These qualitative differences are of particular relevance to the projections of this study and, thus, separate treatment of tertiary education is warranted.

While a certain degree of diversity may be found in the product mix of Chile's lower educational system, its students have been treated as homogeneous and have been differentiated only by primary and secondary levels in this analysis. In the case of higher education, however, these differences, e.g., widely divergent lengths of the various programs offered at the university level and huge differences in the costs of providing equipment and facilities for different types of training, are too great to ignore. Consequently, certain methodological problems must be dealt with in the treatment of this part of the educational system. Basically, these consist of problems of aggregation and compositional change, which can be illustrated by differences in the per-student costs for law and medical training.

Composition of Student Population

Schiefelbein (1969) has estimated the annual cost per law student attending the University of Chile at E° 160 during the mid-1960s. For medical students, the corresponding amount was E° 1,280, or roughly eight times greater. Concomitantly, law students were about 66 percent more numerous than medical students. Suppose for simplicity's sake that the Chilean higher educational system contained a single university consisting only of a law school and a medical school, and that the stated conditions prevailed in some base period.

From this information, one may readily compute the "average cost per university student" which turns out to be E° 580.* This value, however, is neither representative nor "typical" of the annual cost of providing university training to any single student or to any easily identifiable group of tertiary level students. Thus, the statement that "the average annual cost of university training is E° 580 per student" is far less meaningful in terms of describing the "typical" cost of providing university training than in the case of lower education because of the widely divergent cost distributions of the former. Its reliability as a parametric coefficient in the projection of the financial requirements needed to provide university level instruction in the forthcoming decades suffers from an inherent weakness: the potential impact of changes in the career composition of higher education upon the cost of training any given number of university students. For example, a change in the composition of university students between law and medicine from the historically observed 1.66 to 1.00 ratio to 1.00 to 1.00 would, in the absence of any change in the average training cost within each field, result in an increase of the average cost per university student from the previous E° 580 to E° 720. This 24 percent increase would, by itself, cause those projections in which such a shift is not taken into account to underestimate university training costs to a comparable degree.

Although this additional potential source of error exists in the <u>absolute</u> orders of magnitude of the projected input requirements and their total cost, it does not interfere with the validity of the main thrust of the projection exercises if it is assumed that the career

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*The calculations appear in Appendix B.

composition of university students at any point in time is essentially independent of the fertility regimes, past or present. Under this assumption it can be asserted that the relative differences in input requirements to meet future demands for university education associated with each fertility assumption are uniquely attributable to the differences among these fertility assumptions.

The foregoing point, although made in the context of the educational sector, is equally relevant to all the other social services treated in this study. It may be stated more generally as follows: the greater the degree of heterogeneity and compositional instability of the service (e.g., medical care, housing) to be rendered, the less reliable are projected absolute magnitudes (and corresponding absolute differences) associated with each fertility assumption. Since proportional differences among these magnitudes are less sensitive to compositional changes that may independently occur in the interim, correspondingly greater importance should be attached to proportional differences in assessing the impact of differential fertility regimes upon the relative future demands for the service in question.*

Enrollment Ratios

A second difference between lower and higher education involves the choice of assumptions on the number of students to be enrolled at each level of the educational system throughout the next three decades.

While a set of official and apparently undisputed enrollment goals for lower education was found for at least the near future, no such goals could be readily identified for tertiary enrollment. Thus, the projections of absolute input and related outlay requirements associated with university level instructions are even more speculative than the degree implied by the previous discussion on shifts in the composition of student populations.

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*McFarland, et al. (1968, No. 23, p. 11), argues that even if the parametric coefficients chosen diverge widely from their actual o future values, it is still generally true that the validity of the projected relative differences in input requirements to satisfy future demands for any given service will be essentially unaffected by any such error.

The spectrum of influential views on university enrollment appears extremely wide and lacks any clearly distinguishable modal points. One extreme of this spectrum holds that Chilean universities should be abolished in their present form or, at least, their enrollment should be rendered highly selective and, correspondingly drastically reduced. The other extreme may be capsuled by its well-known slogan: "universidad para todos" (university for everyone).

Focusing on more constructive evidence, a vector of enrollment ratios was chosen on the basis of historical trends and future goals proposed in Schiefelbein (1970, No. 36). The derivation of these parameters is explained and discussed in Appendix B. Their assumed values, as well as those for the other relevant parameters used in the projections associated with university education, are shown in Table 15.

Table 15. Parametric coefficients assumed for projections relating to university education.

Year	Enrollment Ratio	Teacher-Student Ratio	Annual Attrition Rate (%)	Teacher Training Unit Costs (E° of 1960)	Annual Operating Cost per Teacher (E° of 1960) Under Fertility Assumption		
					A	B	C
1960	0.03	0.12	3.0	4,590	8,425	8,425	8,425
1970	0.06	0.10	3.0	4,590	9,640	9,660	9,660
1980	0.10	0.08	3.0	4,590	11,135	11,325	11,350
1990	0.18	0.06	3.0	4,590	13,210	14,115	14,275
2000	0.30	0.05	3.0	4,590	15,890	18,095	18,810

Student-Teacher Ratio

While a substantial number of estimates of this ratio's historical value (particularly for the University of Chile) are available, they lack reliability because until very recently Chilean universities failed to record the number of their teaching personnel. The Instituto de Investigaciones Estadísticas de la Universidad de Chile has attempted on several occasions to secure this information, as well as other related data for its parent institution. To this end

questionnaires were sent to each individual on the University's payroll records, but about 50 percent of the recipients of the questionnaires failed to return them.

To the extent that these "sample" results, taken from the Institute's Boletín Estadístico (Reference 20), reflect true universe parameters, they indicate that the student-teacher ratio obtaining in the University of Chile for the year 1959 was 7.4 students per equivalent full-time instructor. Corresponding estimates found in Schiefelbein (1968, p 3), for seven other Chilean universities in 1968–1969 yield a weighted average student-teacher ratio just slightly under 10 to 1. On the basis of these admittedly questionable estimates, the ratio was set at 8.3 to 1 in 1960 and 10 to 1 in 1970 for the purpose of the projections.

The remaining values were chosen on the basis of a discussion on "optimal university size" in Schiefelbein (1968, p. 3), which notes that large U.S. universities show a 20 to 1 teacher-student ratio and implies that this proportion could be taken as a goal for Chilean institutions of higher education. The ratio was set at this level for the year 2000 and interpolated log-linearly between the assumed 10 to 1 ratio for 1970 to obtain the desired coefficients for the years 1980 and 1990.

Attrition Rates

Since neither historical records nor wholly reliable estimates of past numbers of teaching personnel in Chilean universities exist, neither does the data base required to compute average attrition rates of tertiary level teachers. Several university administrators and specialists of Chilean higher education were asked to estimate the current rate of attrition and hypothesize its future evolution. Estimates on current attrition clustered around the value of 3 percent per year. Because of general unwillingness to predict whether these would undergo significant increase or decrease in the future an invariant 3 percent per year attrition rate was assumed.

Teacher Training Cost

Available data in Schiefelbein (1968, p 60), on the cost of training students, from entrance through graduation, in 15 fields of

specialization at the University of Chile for the years 1961, 1962, and 1963 provided the principal basis for the estimation of tertiary teacher training costs.* In view of the substantial variance present in the distribution of these costs, a weighted average cost per graduate was computed, using pertinent enrollment data from the University of Chile's Instituto de Investigaciones Estadísticas on the composition of countrywide university enrollment among the 15 fields as the basis of the vector of weights. The resulting weighted average cost per university graduate came to E° 4600.

Exploratory calculations indicated that the previously postulated schedule of the increasing student-teacher ratio in higher education throughout the projection period tended to decrease the training cost per graduate by comparable amounts to those by which the assumed increases in current costs (i.e., increases in university employees' salaries based on increased GNP per capita) tended to increase it under fertility assumption B. Under this assumption, then, average cost per university graduate would remain roughly constant through the projection period, decreasing slightly under fertility assumption A and increasing slightly under the two-child family assumption, C. The differences resulting from the alternative fertility regimes were small enough to disregard, and hence a constant average tertiary teacher training cost was postulated.

Operating Costs

The assumptions and methods used in projecting current expenditures at the lower educational sectors apply equally to tertiary education projections, i.e.: (1) wage and salary payments exhaust the sector's operating budget, (2) the composition of the educational work force remains stable over time, (3) relative wages among the various personnel categories are constant from period to period, and (4) wage rates increase over time in proportion to GNP per worker.

The estimate of the ratio of total current expenditures to the number of teachers in the base period required by the computational

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*A brief discussion of the concept of "teacher training cost" is included in Appendix B.

procedure was based on data pertaining to the University of Chile, from Schiefelbein (1968, pp 43 and 51), since these were the only data available. The University's operating budget for 1965 was divided by the estimated number of full-time equivalent teachers t arrive at an annual figure of E° 8700 of current expenditures per teacher.

Because remuneration of personnel employed in the educational sector is assumed to change over time in proportion to changes in economy-wide income per worker, this (1965) estimate was adjusted to a 1960 level of E° 8400 on the basis of historical income per worker data. For the successive projection years, expenditures per teacher were increased proportionally to the increases in income per worker generated by the model itself under each of the three fertility assumptions.

In estimating tertiary education investment costs (as opposed to the lower levels), only the cost of training new teachers was taken into account. No reliable estimate of other types of investment costs, such as construction costs associated with the replacement of depreciated physical plant and equipment or with net increments to these stocks was obtained. While this omission tends to underestimate the future costs of providing tertiary education to an increasing number of university entrants, the understatement is probably not very serious proportionally.

Such an assumption is supported by two considerations. First, available data from Schiefelbein (1968, p. 51) show that nonoperating expenditures during the early 1960s were but a small fraction of the total budget of the university establishment in Chile — specifically, only 14 percent in 1964 for all Chilean universities. Secondly, the already established assumption that future building costs will remain at their 1960 level, together with the assumption that teachers' salaries increase over time, imply that this 14 percent proportion of total expenditures going to nonoperating outlays will tend to diminish with time. Since 18 years elapse after each fertility assumption before demands on tertiary education are affected, this allows a considerable amount of time for the share of nonoperating costs in the total university budget to shrink well below the initial 14 percent proportion.

Results of University Education Projections

Projected tertiary enrollment and the corresponding number of teachers required for the first year of each decade, from 1960 to 2000, are shown in Table 16.

Table 16. University enrollment and teachers required 1960-2000 (thousands).

Item	Year	Fertility Assumption		
		A	B	C
Enrollment	1960	27.5	27.5	27.5
	1970	73.2	73.2	73.2
	1980	165.9	164.1	163.9
	1990	388.8	312.2	304.6
	2000	896.0	586.2	492.0
Teachers Required	1960	3.3	3.3	3.3
	1970	7.3	7.3	7.3
	1980	13.3	13.1	13.1
	1990	23.3	18.7	18.3
	2000	44.8	29.3	24.6

University enrollment, and consequently the number of teachers required, remains unaffected by the changing fertility assumptions until 1980 because of the lag between the introduction of alternative fertility assumptions in 1960 and the movement of corresponding cohorts into university-eligible ages. Indeed, the differences in each of these variables under the three regimes is still relatively small in 1990. It is not until century's end that they become substantial. Specifically, year 2000 enrollment and teachers required under assumption A, traditional fertility, turn out to be 82 percent greater than under assumption C, the two-child family.

Table 17 shows the number of new teachers who must be trained during selected years in order to meet requirements imposed by projected enrollments. These figures were obtained, as in the cases of lower education, from aggregating the number of new teachers required to replace those who drop out of the system with the number of additional teachers needed to meet growing enrollment. The estimated training costs and the costs of operating the higher educational establishment for the same years are also shown in this table.

Table 17. Tertiary education new teacher requirements, teacher training costs, and system operating costs.

Item	Year	Fertility Assumption		
		A	B	C
New Teachers Required (thousands)	1970	0.6	0.6	0.6
	1980	0.9	0.9	0.9
	1990	1.6	0.9	0.8
	2000	3.3	1.8	1.1
Teacher Training Costs (millions of 1960 escudos)	1970	2.8	2.8	2.8
	1980	4.1	4.0	4.0
	1990	7.1	4.0	3.7
	2000	15.3	8.2	5.1
System Operation Costs (millions of 1960 escudos)	1970	56.0	56.0	56.0
	1980	120.6	121.9	122.0
	1990	247.0	222.1	220.2
	2000	570.7	439.6	397.2
Total Training and Operation Costs (millions of 1960 escudos)	1970	58.8	58.8	58.8
	1980	124.7	125.9	126.0
	1990	254.1	226.1	223.9
	2000	586.0	447.8	402.3

While the differences in the number of new teachers required and the cost of training them among the alternative assumptions are quite large by the last period considered, the differences in operating costs are comparatively much smaller. Teacher requirements and teacher training show a threefold difference between assumptions A and C, while the corresponding system operation costs differ by only 43 percent because of the more rapidly rising salaries of university personnel under assumption C.

The substantially greater magnitude of operating costs vis-à-vis teacher training cause the relative divergence in total costs between say, assumptions A and C to be dominated by operating costs, and thus, for the last period, total costs of A exceed those of C by less than 50 percent despite the 300 percent difference in training costs.

SECTION 4
HEALTH

BACKGROUND INFORMATION

Demands for health care are less dramatically affected by fertility changes than are demands for education. Fertility changes affect the youngest first, altering their relative and absolute numbers in the population, and the fertility changes are quickly translated into changes in demand for education. Demands for health care are much more evenly spread out, covering all age groups in a population.

As with education, the main expenditure items in the health sector, both now and in the future, can be specified. Requirements for medical personnel, from the highly skilled to the considerably less skilled, are well known or can be readily determined. In addition, two basic types of physical facilities can be distinguished: hospital beds and consulting rooms (called "boxes" in this study). These categories of medical personnel and physical facilities do not cover all the requirements for the provision of health services; also necessary are administrators, inspectors, and clerical and janitorial personnel, on the one hand; and all the physical instruments of the great metropolitan research hospitals, on the other. The categories do, however, allow quantification of ratios of availability of health services to the user population.

Initial numbers of physicians, dentists, pharmacists, nurses, midwives, medical technicians, and nurses' auxiliaries are shown in Table 18. Historically, the last four categories have been almost exclusively women. The costs of personnel training were deduced from data originating at the universities, with the derived estimates adjusted for dropouts and repeated years. Surprisingly, the cost of training pharmacists, whose university curriculum lasts 5 years, exceeds that of physicians, who are subject to a 7-year program. This is because pharmacy students have higher dropout and repetition rates than medical students. In the absence of authoritative cost estimates for training nurses' auxiliaries, the amount shown was approximated by assuming that one nurse can train 17 auxiliaries in a year. Thus their training cost was taken as one-seventeenth the annual salary of a nurse.

Table 18. Numbers and costs of Chilean health personnel.

Type of Personnel	Number[a] (1968)	Average Training Cost (Escudos of 1960)	Average Annual Salaries and Benefits (Escudos of 1960)[b]	Annual Attrition Rate (%)[a]	Average Annual per Capita Increase in Numbers (%)[a]
Physicians	5,559	13,000[c]	7,300	1.5	1.0
Dentists	3,250	8,700[c]	7,300	1.5	1.0
Pharmacists	1,975	13,600[c]	7,300	1.5	1.0
Nurses	2,428	4,400[c]	3,400	2.0	4.0
Midwives	1,371	1,600[c]	3,300	2.0	2.0
Medical Technicians	512	3,300[c]	3,200	2.0	2.0
Nurses' Auxiliaries	11,000	200	1,200	2.0	1.0

Notes:

[a]Ministry of Public Health (1970)

[b]Ruderman (1968)

[c]Schiefelbein (1968), p 60

The salary data in Table 18 represent a combination of salaries and fringe benefits for each of the specified personnel categories. Unlike the treatment of education, the costs of other supporting personnel have not been included. Total salary costs, and hence their divergence under the different fertility assumptions, are thus understated.

The attrition rates were deduced from empirical studies of the Research Section of the Health Sector Planning Office of the Ministry of Public Health and corrected for increasing numbers (and hence, increasing youthfulness, given the customary age of entry into the profession) of medical personnel.

The assumptions shown in Table 18 for projected per capita improvements in service ratios are also based on studies made by the Planning Office of the National Health Service (SNS).

Construction and operating costs for beds and boxes (Table 19) were taken from a series of studies done in 1967 and 1968 by the Sub-Department of Architecture of the SNS. Operating costs include physical inputs on current account, i.e., those whose expected life is less than a year. All salaries of medical personnel are excluded to avoid double counting.

Table 19. Construction costs, annual operating costs, and coverage improvement of Chilean health facilities.

Type Facility	Average Unit Construction Cost[a] (Escudos of 1960)	Average Unit Operating Cost[a] (Escudos of 1960)	Percent of Improvement in Ratio/Population from 1960–2000
Hospital Beds	9,900[b]	1,700	20[d]
Examination Rooms (Boxes)	9,700[c]	8,700	100

Notes:
[a] Ministry of Public Health (1970)
[b] 1967 data
[c] 1968 data
[d] Ten percent by 1988

RESULTS OF THE PROJECTIONS

Projected increases in the base population and medical service goals allow quantitative estimates to be made of the numbers of health personnel needed in the future. Table 20 shows that to meet the goals postulated, even the lowest fertility assumption calls for over twice as many doctors in 2000 as in 1970. Fertility levels of 1960 imply the need for almost four times the 1970 number of physicians by the end of the century. Similar or greater increases are required for other types of health specialists shown in Table 20.

Table 20. Projected Chilean health personnel requirements.

Type Specialist	Year	Fertility Assumption		
		A	B	C
Physicians	1960	4,100	4,100	4,100
	1970	5,860	5,650	5,630
	1980	8,540	7,550	7,350
	1990	12,710	10,090	9,250
	2000	19,070	13,360	11,500
Dentists	1960	2,420	2,420	2,420
	1970	3,460	3,330	3,320
	1980	5,030	4,450	4,340
	1990	7,500	5,960	5,460
	2000	11,250	7,880	6,780
Pharmacists	1960	1,470	1,470	1,470
	1970	2,100	2,020	2,010
	1980	3,050	2,700	2,630
	1990	4,540	3,600	3,300
	2000	6,810	4,770	4,110
Nurses	1960	1,350	1,350	1,350
	1970	2,580	2,490	2,480
	1980	5,050	4,460	4,350
	1990	10,060	7,990	7,330
	2000	20,220	14,160	12,190
Midwives	1960	930	930	930
	1970	1,460	1,410	1,400
	1980	2,350	2,070	2,020
	1990	3,850	3,060	2,800
	2000	6,380	4,500	3,850
Medical Technicians	1960	350	350	350
	1970	550	530	520
	1980	880	780	760
	1990	1,450	1,150	1,050
	2000	2,400	1,680	1,450
Nurses' Auxiliaries	1960	8,180	8,170	8,180
	1970	11,680	11,260	11,230
	1980	17,020	15,040	14,660
	1990	25,330	20,120	18,440
	2000	38,010	26,630	22,930

The Ministry of Public Health has estimated that in 1970 almost 40,000 beds (both public and private facilities) and 1,650 boxes (public facilities only) existed in the country. As shown in assumption A of Table 21, population growth would require bed facilities by the year 2000 of almost four times the 1970 number if fertility were to return to its traditional (1960) level. Declining fertility, on the other hand, would increase requirements to roughly two and one-half times their current levels.

Table 21. Projected Chilean health physical facility requirements.

Type Facility	Year	Fertility Assumption		
		A	B	C
Beds (thousands)	1960	30.1	30.1	30.1
	1970	40.9	39.4	39.3
	1980	56.8	50.2	48.9
	1990	80.0	63.5	58.2
	2000	116.6	81.7	70.3
Boxes, Public Sector (thousands)	1960	1.5	1.5	1.5
	1970	2.4	2.3	2.3
	1980	4.2	3.7	2.6
	1990	7.1	5.6	5.2
	2000	11.6	8.1	7.0

The costs associated with providing health services to a growing number of individuals can be broken down into two parts: the investment outlays necessary to train the additional personnel and construct the facilities required to service this expanding population, and the operating costs that must be incurred in the form of staff salaries and fringe benefits and operations of supportive physical facilities. The magnitude of the divergence of required annual outlays attributable to the different fertility assumptions is shown in Tables 22 and 23.

Even under the lowest fertility assumption, C, the training costs for various categories of medical personnel (assuming increases in their current proportions to population) nearly double between 1970 and 2000. As in the case of education, the impact of the population-induced investment accelerator becomes readily apparent from the

Table 22. Projected Chilean health investment costs (millions of 1960 escudos).

Item	Year	Fertility Assumption		
		A	B	C
Training of New Health Personnel				
Physicians, Dentists, and Pharmacists	1970	6.3	5.5	5.5
	1980	9.6	7.1	6.5
	1990	14.6	9.5	7.5
	2000	22.2	12.3	9.1
Nurses, Midwives, Technicians, and Auxiliaries	1970	1.0	.9	.9
	1980	1.6	1.2	1.1
	1990	2.7	1.8	1.5
	2000	4.5	2.7	2.1
Construction of New Physical Facilities	1970	24.0	21.4	21.2
	1980	35.4	27.2	25.2
	1990	51.6	35.0	28.6
	2000	76.4	44.2	34.0
Total Investment Costs	1970	31.3	27.8	27.6
	1980	46.6	35.5	32.8
	1990	68.9	46.3	37.6
	2000	103.1	59.2	45.2

results tabulated in Table 22. Comparison of training costs associated with fertility assumptions A and C for the year 2000 reveals that E° 11 million would be required for this purpose under fertility assumption C versus E° 27 million under A. In other words, a difference in the respective population of about 66 percent under the two assumptions generates a relative difference of 145 percent of corresponding training costs.

Table 23. Projected Chilean health operating costs (millions of 1960 escudos).

Item[a]	Year	Fertility Assumption		
		A	B	C
Salaries of Health Personnel				
Physicians, Dentists, and Pharmacists	1970	76.2	74.6	74.6
	1980	127.4	117.0	115.0
	1990	222.4	192.6	180.8
	2000	399.4	327.2	294.8
Nurses, Midwives, Technicians, and Auxiliaries	1970	27.4	26.8	26.8
	1980	48.8	44.8	44.2
	1990	92.2	79.8	75.0
	2000	182.0	149.0	134.2
Facility Operating Costs	1970	85.4	83.4	83.2
	1980	120.0	108.6	106.6
	1990	171.6	139.8	130.2
	2000	249.0	179.8	157.2
Total Operating Costs	1970	189.0	184.8	184.6
	1980	296.2	270.4	265.8
	1990	486.2	412.2	386.0
	2000	830.4	656.0	586.2

Note:

[a]Administrative and other nonspecified support personnel not included in tabulation.

Operating costs show less striking contrasts between assumptions A and C because of the faster increase in GNP per worker, and, hence, medical personnel salaries, associated with assumption C. Consider, for example, that in the year 2000 the required number of medical personnel in the low fertility assumption is about two-thirds the corresponding number under the high fertility assumption. On the other hand, low fertility operating total costs are three quarters of the high fertility costs as a result of the factor growth of individual salaries in the low fertility case.

FUTURE GOVERNMENT HEALTH EXPENDITURES

Survey data of the Ministry of Public Health show that about 73 percent of the population is covered by some sort of public health service, of which SNS is the most prominent. The degree of coverage* (cobertura) provided by the SNS does not reflect with any degree of accuracy the size of the population receiving health care in the country. Among those not covered by the SNS, some avail themselves of health services privately; others do use SNS facilities simply because no private facilities are available or because the individuals are medical indigents, or both. This is particularly common outside the large metropolitan centers. Finally, some who are entitled to SNS services do not use them, but obtain private health care. These partially offsetting factors tend to weaken the accuracy of SNS coverage as an index of effective population-wide coverage.

The historical trend has been one of expanding government-provided health services, although even if this process continues, it is unlikely to encompass the entire population in the foreseeable future. Some people will continue to buy private health care. Rural areas, especially in the far north and far south, may remain medically isolated. However, future extension of coverage seems inevitable. An estimate of its future extent and the numbers of people covered under the three fertility assumptions appears in Table 24.

Table 25 shows the impact of these numbers on public spending in terms of aggregate operating and capital expenditures. These

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*"Coverage" refers to the approximate proportion of the population which depends primarily on the government for most of its health care.

Table 24. Projected extent of coverage of government-provided health services.

Year	Extent of Coverage (%)	Millions of People Covered, Under Fertility Assumption		
		A	B	C
1960	73	5.61	5.61	5.61
1970	73	7.25	6.99	6.97
1980	76	9.97	8.81	8.58
1990	80	14.12	11.22	10.28
2000	85	20.39	14.28	12.30

Table 25. Projected government health costs (millions of 1960 escudos).

Item	Year	Fertility Assumption		
		A	B	C
Operating Expenditures	1970	138.0	134.8	134.8
	1980	225.0	205.6	202.0
	1990	389.0	329.6	308.8
	2000	705.8	557.6	498.2
Capital Expenditures	1970	31.4	27.8	27.6
	1980	26.6	55.6	32.8
	1990	68.8	46.4	37.6
	2000	103.0	59.2	45.2
Total Expenditures	1970	169.4	162.6	162.4
	1980	271.6	241.2	234.8
	1990	457.8	376.0	346.4
	2000	809.0	616.8	543.4

expenditures reflect the assumptions that the government pays for varying amounts of current expenditures, as shown by the data in Table 24, and pays for all expenses and capital costs involved in human capital formation and in construction of physical facilities.

With traditional (1960) fertility levels, a fivefold increase in government expenditures between 1970 and 2000 must occur, if the postulated medical standards are maintained and improved. Even under fertility assumption C, the least demanding from the standpoint of the provision of health care, more than a threefold increase is required.

The projections made in this section are highly aggregated, tend toward an artifically stable growth rate, and deliberately exclude many details. No doubt Chilean health experts, particularly those professionally involved in providing health service to Chile's expanding population, could develop a more detailed and realistic analytical framework for assessing the impact of diverse fertility schedules in the years to come. Although the scope of the present study precluded such refinements, we feel confident that such an exercise, in addition to being valuable for national resource allocation, would reinforce the basic conclusions of this section.

In summary, the faster the population grows, the higher are the costs that society must sustain (and the greater, accordingly, is the diversion from other ends) in order to finance the expansion and operation of an adequate public health system. The validity of this conclusion is strengthened by the assumptions used, since these tend to minimize the cost differentials associated with varying fertility levels.

SECTION 5
HOUSING

HISTORICAL PERSPECTIVE

Official concern with the problems of inadequate housing for large numbers of Chilean families dates to 1939 when a public agency, the Caja de Habitación Popular, was created and charged with the construction of low cost housing. The government has since played an increasingly important role in the housing sector by providing tax exemptions on certain kinds of housing, subsidizing credit for residential construction and purchase, and taking more direct forms of action such as administering construction and distribution of large housing projects. The extent of the State's growing involvement in housing since 1939 can be gauged from Servicio de Cooperación Técnica statistics showing that from 1960 to 1968 the State's average intervention in all residential construction was 51 percent, reaching 62 percent in 1968.

This expanded effort to supplement the private sector's housing output has placed a considerable financial burden on the government. Ministry of Housing and Urbanization statistics show that capital budgets for 1966 through 1969 have averaged 12 percent for residential construction and related facilities.

Oficina Nacional de Planificación data show that for the economy as a whole, the amount of resources allocated to the housing sector have been equally significant. For the period 1960–1968, the average investment in residential construction was:

- 3.0 percent of gross domestic product
- 15.9 percent of gross domestic saving
- 18.0 percent of gross domestic investment in fixed capital
- 48.0 percent of net domestic saving
- 55.8 percent of net domestic saving from Chilean sources.

Despite the government's massive budgetary and economic effort, many Chilean families continue to live in dilapidated shacks assembled from discarded material such as wooden and cardboard boxes and sheet metal.

In the context of the quantitative analysis of housing requirements contained in the remainder of this section, all households are considered to require a dwelling of acceptable physical characteristics and conditions as determined by census standards. Thus, the term "housing unit" is reserved only for those dwellings meeting the official (census) minimal standards. Dwelling units meeting minimal conditions of acceptability and those regarded as substandard or deficient are distinguished by the corresponding categories in the official 1952 and 1960 censuses, from which all the basic housing data have been taken. This criterion has the advantages of being both official and operational.

Normative housing requirements, measured in terms of number of households, and availability, measured by the number of existing housing units, are shown for the years 1960 and 1968 in Table 26. Both of these measures are, in turn, disaggregated into certain of their component elements to permit the analysis of intertemporal changes in residential requirements and availabilities. Since the number of households depends on both population size and average household size, changes in these component factors determine changes in housing requirements.*

The number of available housing units changes over time by the difference between the numbers of housing units built and housing units lost through deterioration, demolition, and catastrophe.

Table 26 reveals that the substantial housing deficit of 1960 had worsened greatly by 1968 despite massive public and private outlays for residential construction during this interval. The yearly growth rates for each of the listed variables allow assessment of each component's contribution to the observed changes in housing

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*"Household size" is defined here, as in the census, as the number of individuals living together, regardless of their familial relationship.

Table 26. Housing requirements, availability, and deficits by component elements.

Element	Year 1960	Year 1968	Annual Growth Rate (%)	Changes in Availability 1960–1968
1. Population (thousands)	7,683[a]	9,351[a]	2.4	
2. Average household size	5.39	5.03[c]	-0.9	
3. Total households requiring housing	1,425[b]	1,859	3.3	
4. Total housing units available (thousands)	940	1,110	2.1	170
5. Absolute deficit (3) - (4) (thousands)	485	749	5.6	
6. Relative deficit (3) - (4) (thousands)	1.52	1.67	1.3	
7. Housing units built (thousands)				302.1[d]
8. Housing units lost (thousands)				132.5[d]
9. Average annual ratio of houses built to midyear stock				0.036
10. Average annual ratio of houses lost to midyear stock				0.016

Sources:

[a]Dirección de Estadística y Censos (1969, No. 10)

[b]Dirección de Estadística y Censos (n.d., No. 11)

[c]Dirección de Estadística y Censos (1969, No. 12)

[d]Servicio de Cooperacion (1969)

requirements, availability, and corresponding deficit. The inter-period increase recorded for the relative deficit, equivalent to a 1.3 percent yearly rate, is decomposable into the algebraic sum of the rates of change (or contributions) of the relevant components, as shown in Table 27. The third column of Table 27 distributes the 4.9 percentage points contributed by the three deficit-augmenting components on the base of 100 percent, indicating that population growth was approximately equal to the combination of smaller households and housing losses as a source of increase in the relative deficit for this period.

Table 27. Sources of housing deficit increases.

Sources of Annual Change	Contribution (percentage points per year)	Percentage Distribution
Population Growth	2.4	49
Smaller Households	0.9	18
Housing Losses	1.6	33
Total Deficit Augmenting Contributions	4.9	100
Less Housing Construction	-3.6	
Rate of Deficit Increase	1.3	

PROJECTIONS: 1968–2000

Normative Housing Requirements

The basic analytical framework developed in the previous section on historical perspectives was brought to bear on projections of normative housing requirements to the year 2000. Thus, the variables identified as "sources of change" during the period 1960–1968 were also taken into account in the estimation of future needs. With the exception of the alternative population time profiles, which are supplied by the demographic model, a unique set of hypothetical values was provided for the remaining structural parameters.

Decennial projections were made for the following dimensions of normative housing requirements:

1. Number of individuals requiring housing which, in accordance with the established definition of "normative housing requirements," is identical to total population
2. The corresponding number of households, by definition equal to normative housing requirements at any given point in time
3. Interperiod increments in normative housing requirements due to:
   a. Increases in the number of households, and
   b. Housing losses
4. The cost of providing the additional units to meet these incremental requirements.

Item 1 is simply the projection of total population on the basis of the three alternative fertility assumptions used throughout this study as described in Section 2. Item 2 calls for a hypothetical estimate of family size, subsequently divided into the total population to obtain the number of households and, hence, the required housing units. Item 3a is simply the decennial differences with respect to Item 2, and Item 3b corresponds to the interperiod housing losses assumed to occur. Item 4 results from multiplying the sum of 3a plus 3b for each period by the assumed cost per housing unit. It follows that quantitative estimates must be made for average household size, housing losses, and housing unit costs.

The diversity and multiplicity of household size determinants make any projection of this significant dimension of housing requirements rather hazardous, as may be judged from the following sample of determining factors: (1) the degree of "family extendedness," (2) marriage and its age structure, (3) annulments, separations, and the not unrelated incidence of extramartial relationships, (4) urban-rural distribution of the population and related migration, (5) fertility changes, and (6) housing availability itself.

Despite these difficulties, two considerations afford rough guideposts in estimating household size. One is that some of the most powerful determinants of average household size, such as rural-urban migration and family extendedness, have been moving in the direction of reducing family size in Chile for the past few decades, and there is no indication that this trend will cease in the foreseeable future; the other is that fertility is positively related to family

size. To the extent that fertility declines may accentuate the tendency toward smaller households (and hence toward increased housing requirements for any given population size), this effect should be considered when projecting future housing needs under alternative fertility assumptions.

These considerations lead to an assumption of decreasing household size throughout the projection period for all three fertility assumptions.* However, rapidity and extent by which household size was assumed to decrease is slowest and smallest for assumption A and fastest and greatest for assumption C, as shown in Table 28.

Table 28. Total population (thousands) and average household size, 1960–2000.

Year	Fertility Assumption					
	A		B		C	
	Population	Size	Population	Size	Population	Size
1960	7,683	5.4	7,683	5.4	7,683	5.4
1970	9,932	5.2	9,575	4.9	9,547	4.9
1980	13,112	5.0	11,591	4.6	11,295	4.4
1990	17,650	4.8	14,019	4.3	12,853	4.0
2000	23,983	4.6	16,803	4.0	14,465	3.6

This table reveals an interesting difference in the way in which the alternative fertility and average household size assumptions operate. Household size under assumption C is almost 6 percent smaller than under assumption A by 1970, while population is only approximately 4 percent lower. By contrast, in the year 2000, while the difference in family size is about 22 percent, the corresponding difference with respect to population is approximately 38 percent. These comparisons indicate that, initially, the "household size effect" will tend to predominate over the "population

*Appendix C describes the procedure used for specifying household size schedules for each fertility assumption.

effect" in determining the differences between housing requirements under the alternative fertility assumptions; and vice versa toward the end of the projection period.

The effects of the family size hypotheses on numbers of households are tabulated in Table 29. First, under all three fertility assumptions, the number of families increases proportionally faster than total population. For example, while the population (Table 28) grows 2.2 times during the entire period under fertility assumption B, households (Table 29) increase 2.8 times.

Table 29. Differences in number of households attributable to alternative fertility and household size assumptions, 1960–2000 (thousands).

Year	Fertility Assumption			Difference	
	A	B	C	A–C	% of C
1960	1,423	1,423	1,423		
1970	1,910	1,954	1,948	-38	-2.0
1980	2,622	2,520	2,567	55	2.1
1990	3,677	3,260	3,213	464	14.4
2000	5,214	4,201	4,018	1,196	29.8

Secondly, the faster rate of household size decrease under fertility assumption C causes the corresponding number of households to be greater than under assumption A during the first 17 years. Thereafter, the population growth differentials between the two assumptions increasingly predominate, and the number of households under A relative to C becomes both absolutely and proportionally greater over time. This trend is reflected in the last two columns of Table 29, which show how the divergence in the number of households between these two assumptions evolves from a minus 2.0 percent in 1970 to a plus 29.8 percent by the end of the century. Equivalently, the assumptions underlying these calculations imply that 5.214 million housing units would be required by the end of the century under fertility assumption A, 4.201 million under B, and 4.018 million under C – the difference between the two extreme numbers being 1.196 million.

The number of housing units assumed lost by destruction and depreciation during the period 1970–1978 has been taken directly from estimates contained in the SCT (1970) study.* These figures were generated from a dynamic vintage model dating back to 1930 and anchored on censual data for 1952 and 1960. Annual estimates for 1960–1969, in the same source, were pooled with the 1970–1978 projections. Values for the years remaining between 1978 and 2000 were projected by extrapolating from a log-linear fit to this entire set of observations. While the divergence between this latter projection and one resulting from the extended application of the vintage model would undoubtedly be appreciable on a yearly basis, this variance tends to wash out within the decennial periods which were chosen as temporal units. Consequently, the simpler projection procedure was used.

Although analytically less problematic than family size, unit costs for housing depend on so many factors that they are also difficult to project. Whereas substantial productivity gains might be expected in the future from further technological advances and expanded mass production, it is just as plausible that wages will rise sufficiently to counter the cost reduction effect of increasing productivity. In addition, as population grows, the cost of the land taken up by additional housing will rise. Finally, as living standards rise there will be a tendency to demand bigger, better, and consequently, costlier housing

Since there is no justifiable basis to establish which of these sets of opposing forces is more likely to predominate in the future, the estimated average housing unit cost of E° 6519 for the period 1960–1968 was assumed to prevail without change throughout the projection interval.†

The incremental differences attributable to the three fertility assumptions in the number of additional housing units needed to meet the additional housing requirements resulting from the increasing number of households are given in Table 30. Table 31 adds to

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*Ch. V, p. 3.

†This estimate was derived by dividing the total number of housing units built during the period 1960–1968 (source: Servicio de Cooperación Técnica study, 1970) into gross investment in residential construction (source: ODEPLAN, 1969) for those years.

these amounts the number of housing units lost throughout the corresponding period to obtain the projections of total incremental housing requirements. The last two columns in Tables 30 and 31 show, respectively, the absolute and relative differences between the results obtained under assumptions A and C.

Table 30. Incremental normative housing unit annual requirements resulting from additional households, 1970–2000 (thousands).

Year	Fertility Assumption			Difference	
	A	B	C	A-C	% of C
1970	53	56	55	- 2	- 4
1980	78	60	64	14	22
1990	115	79	67	48	72
2000	168	99	85	83	98

Table 31. Total incremental normative housing unit annual requirements, 1970–2000 (thousands)

Year	Housing Losses	Total Additional Requirements Under Fertility Assumption			Difference	
		A	B	C	A-C	% of C
1970	20	73	76	75	- 2	- 3
1980	33	111	93	97	15	15
1990	52	167	131	119	48	40
2000	83	251	182	168	83	49

Again, the household size assumption predominates over the fertility effect during the initial decade (1960-1970), causing incremental requirements in 1970 resulting from additional households to be

greater under B and C than under A, but thereafter the fertility effect predominates and the additional housing requirements of A relative to C become increasingly divergent.

Calculations underlying Table 31 show that for the entire 1960-2000 period almost 1.2 million housing units would be "saved" under assumption C relative to A. It is evident from the tabulation that housing losses comprise a substantial and increasing proportion of total housing requirements. In fact, in the final decade, incremental requirements due to housing losses account for nearly one-half of the total under the lowest fertility assumption, C.

Projected Housing Expenditures

Assessment of the implications of housing projections in terms of total and public outlays for residential construction requires first the resolution of certain other questions: (1) the fraction of the incremental housing requirements to be fulfilled during each period, (2) the percentage, if any, of the base year's normative housing deficit to be absorbed in each decade, and (3) how the cost of residential construction will be distributed between the private and public sectors. The answers to these questions in turn depend heavily on assumptions about future housing policy and its implementation.

Examination of official and semi-official documents relating to housing policy, together with public and private statements of officials concerned with housing policy, revealed a wide spectrum of housing goals for the coming decades.

On the basis of this research, it is possible to identify a "minimal policy goal" shared by all concerned policy-makers and politicians. That is, while most housing targets were more ambitious, to varying degrees, than those implied by the "minimal policy goal," none of them aimed for less. The minimal target consists of providing additional housing to the extent required to freeze the 1965 proportion (the last year for which empirical estimates are available) of the population living under unacceptable housing conditions.

Table 32 shows projected expenditures required to meet the minimal policy goal during each indicated year to the end of the century. The expenditures were derived on the basis of projected population and household size schedules associated with the three fertility assump-

tions, housing losses, and housing cost. The computational procedure underlying Table 32 is described in Appendix C.

Table 32. Total public and private annual outlays required to meet minimal housing policy goal, 1970-2000 (millions of 1960 escudos).

Year	Fertility Assumption			Difference	
	A	B	C	A-C	% of C
1970	339	352	345	- 6	- 2
1980	522	450	463	59	13
1990	789	645	600	189	31
2000	1,199	926	874	325	37

Note: See Appendix C for method of computation.

The impact of declining fertility upon future housing expenditures tends to be offset by decreased household size, requiring relatively more housing units. Despite this, and despite the addition to each of the three incremental requirements projections of an identical number of housing losses, the outlays required under each fertility assumption continue to show substantial differences in the final decades. As indicated in the last two columns of the table, the outlay excess of assumption A over C increases monotonically from E°59 million (or 13 percent of C's outlays) in the year 1980 to more than E°300 million (or 37 percent of C's outlays) in the year 2000. For all years during the four decades 1960-2000, the difference between the two totals is nearly E° 4.7 billion.

Table 33 shows the public portion of the total investment that would be required to meet minimal policy goals under the assumption of a fixed share of 57 percent of total outlays in residential construction, which represents the average proportion of public to total investment in housing for the period 1960-1968. (This projection should be regarded as merely illustrative, however, since the ratio in question has varied widely in the past and may continue to vary in the future.)

Table 33. Annual public outlays required to meet minimal housing policy goal, 1970–2000 (millions of 1960 escudos).

Year	Fertility Assumption			Difference	
	A	B	C	A–C	% of C
1970	193	201	197	- 4	- 2
1980	298	257	264	34	13
1990	450	368	342	108	31
2000	683	528	498	185	37

The feasibility of attaining the minimal housing policy goal in any given period will depend on both the cost of building the required number of housing units and the amount of investible resources available for this purpose. Thus, feasibility can be assessed by computing the ratio of projected target expenditures for housing to investible resources.

Net domestic savings (NDS) is one measure of the amount of available resources allottable to the expansion of the economy's stock of reproducible capital. Housing units, however, are only one of the many types of goods that compose this stock. NDS excludes that part of the total savings generated by the economic system required to replace capital goods consumed, destroyed, or deteriorated over the course of time, i.e., it excludes "depreciation" and the cost of replacing housing units lost during the projection period. Consequently, the projections of Table 32 require adjustment to allow legitimate comparison with NDS.

Empirical estimates for 1960–1968, as well as the entire set of projections of the cost of providing the additional housing units required to meet the policy target (or, equivalently, "net" investment in residential construction), can be readily obtained from the same

set of data used to compute the total ("gross") investment requirements shown in Table 32.*

Table 34 presents the ratios of the resultant net projected expenditure requirements and projected NDS (derived by the same methods as the capital stock of Table 8) for the three fertility assumptions. The ratios represent the relative share of investible resources remaining for net additions to the aggregate capital stock that would have to be devoted to the construction of additional dwellings to achieve the minimal policy target. Since only 8.7 percent of net domestic savings was used for residential construction during the period 1960-

Table 34. Percentage of net domestic savings required for additional residential construction to meet minimal housing goal, 1970–2000.

Year	Fertility Assumption (percent)		
	A	B	C
1970	39	40	38
1980	34	23	24
1990	29	17	14
2000	23	13	11

*The formula used to generate the total projections is specified in Appendix C as

$$C\ (\text{"gross"}) = E^{o}\ 6,519\ \left(0.6\ \frac{\Delta P}{s} + L\right),$$

where ΔP is the net population change in any given period, s is the average household size, and L is housing losses during the period. To obtain the adjusted, or C ("net"), set of values, exclusive of the cost of replacing lost housing units, requires only dropping L from this expression and making the necessary computations for each projected period.

1968, Table 34 offers no reasonable basis for hope of meeting the minimal policy target within this century unless fertility falls. This depressing finding has even more impact in view of the modesty of the minimal policy target: to halt further deterioration of the proportion of Chilean households lacking decent housing. In the context of a country whose population is increasing, and in all likelihood will continue to increase during the next few decades at a substantial rate, even if the minimal target could be met the number of Chilean families living under unacceptable housing conditions would continue to rise. The failure to meet this target, as predicted, means that this number will grow at an even faster rate than the population itself.

SECTION 6

FERTILITY, HUMAN CAPITAL FORMATION, AND FUTURE ECONOMIC GROWTH

This section discusses some initial attempts to extend the model, allowing for the effects of fertility change on educational attainment and, in turn, on the productivity of the labor force

With decreased fertility lowering the number of young people in the population, for any given educational budget the resulting reduction in enrollments allows either a greater number of years of school attendance for each student or higher quality (more costly) education, or both. In either case low fertility may provide the opportunity to upgrade stocks of human capital, both in total and, as a result, on a per capita basis as well.

Within this frame of reference, the model's initial assumption of a homogeneous labor force can be modified by weighting the productivity of members of the labor force on the basis of their educational attainment.

While it is easy to assert that more education and higher productivity will raise incomes, the magnitude of these effects under different fertility assumptions can be derived only through the application of an integrated conceptual and computational model. Thus, given an educational budget as a certain percentage of GNP, the capabilities of society to provide education under different fertility conditions and productivity changes in the labor force can be examined.

EDUCATION-WEIGHTED LABOR FORCE MODEL

Changing fertility eventually affects the size of the labor force. Under the two-factor neoclassical production function used to this point in the study, the smaller labor force that would eventually result from lower fertility implies, all other conditions being equal, correspondingly lower levels of gross output. Of course, other conditions may not be equal.

Section 2 discusses how greater savings out of per capita income may offset the effect of the smaller labor force for a fairly extended period, but considers the effect only in terms of absolute numbers in a group of purportedly homogeneous population. Thus, that discussion considers only physical capital formation, while, in fact, the possibility exists that when population is smaller and per capita product higher, the economy also may be able to produce human capital faster. If more human capital can be formed, the greater productivity of workers may offset their smaller numbers. Then, even in the restrictive case in which physical capital formation has not changed, output will be higher. If, in addition, savings and resultant investment rise, the combined effects of lower fertility, smaller population, higher per capita output, greater human capital formation, and higher labor force productivity will be reinforced by relatively greater amounts of physical capital.

To explore these effects, four levels of educational attainment were first posited and weights representing the elasticity of output with respect to the input of labor of each level were attached to them. The weights represent the percentage by which output changes when the labor force in a given educational category grows by 1 percent. Appendix A describes the development of the weights in some detail and Table A-2 shows their amounts, which reflect the productivity of the individual worker and the relative importance of each educational category in the total labor force.

In this study, human capital formation was assumed to occur exclusively as a result of formal education. While inclusion of the effects of on-the-job-training in the model would have been desirable, no life cycle earnings data existed.

Weighting the labor force involved some considerations that should be made clear. If the weights are constant over time, this implies that the relative elasticities of output with respect to labor inputs in the various educational categories are themselves constant. Alternatively, an initial set of weights using observed relative wage differentials among the educational classes, and a final set reflecting the narrower wage structure (and presumed underlying productivity differentials) observed in the industrialized countries can be postulated. The computer model can then be programmed to interpolate between these two sets of weights as time passes. Because of the limited time available for exploring the education-weighted model, only the constant weights case was treated. The weights used were the following:

Education	Weights
• None	0.03
• Primary (1-8)	0.23
• Secondary (9-12)	0.11
• University	0.13
• Total Labor Force	0.50

The economic capacity of the nation to provide education while maintaining other necessary expenditures was next considered. Both that portion of GNP which Chile has devoted to education in the recent past and amounts spent by other South American countries in a comparable period were examined. Available UNESCO data indicated that 3 percent of GNP is a reasonable estimate for Chile.*

This educational "budget," derived as a simple percentage of GNP, was allocated among the various classes of education in two stages by the computational model. First, the existing educational plant — square meters of school rooms after depreciation, teachers after attrition — was operated to determine current spending.

The second stage involved investing in new educational capacity in terms of both teachers and buildings. Here a variety of alternatives was open. As a preliminary treatment of the allocation problem for new investment expenditures, the model expands the various levels of the system (primary, secondary, and university) by equal proportional amounts to the extent allowed by educational budgets.

The amount of expansion desired, in turn, depends on the age-eligible population, taken from the basic population projections, and on transition matrices describing the passage of students through the three educational levels. These transition matrices, derived from the 1960 census and from single-year transition matrices for 1967–1970 provided by the Planning Office of the Ministry of Education, allow the calculation of potential educational "demand" in each year. Students pass through the system according to the matrices, essentially a Markov chain process at each year of age and each

*This estimate was derived from UNESCO's statistical yearbooks covering the decade of the 1950s and the early years of the 1960s. Data for selected Latin American countries during the first half of the 1960s show public spending for education ranging from about 1.5 to 3.5 percent of GNP.

calendar year. Students continuing at the same level as the previous year or passing on to a higher level are the potential demanders for education. Dropouts and graduates pass into the nonstudent population and become eligible for labor force participation. Thus, the model tallies the numbers in the population by age, sex, and educational attainment for each calendar year and disaggregates student and nonstudent populations on the basis of budget capabilities to provide education. The resultant numbers in the labor force, disaggregated according to the same variables, are also calculated. The projected numbers in the labor force for 1970–2000, by educational attainment, appear in Table 35.

Table 35. Projected numbers and educational attainment of the Chilean labor force, 1970–2000 (thousands).

Education	Year	Fertility Assumption		
		A	B	C
None	1970	330	330	330
	1980	255	255	255
	1990	170	170	170
	2000	85	85	85
Elementary (Grades 1-8)	1970	1,940	1,940	1,940
	1980	2,605	2,590	2,590
	1990	3,465	3,185	3,150
	2000	4,740	3,635	3,530
Secondary (Grades 9-12)	1970	600	600	600
	1980	840	840	840
	1990	1,130	1,150	1,150
	2000	1,510	1,560	1,555
University	1970	100	100	100
	1980	160	160	160
	1990	230	240	240
	2000	320	365	375
Total Labor Force	1970	2,970	2,970	2,970
	1980	3,865	3,855	3,850
	1990	4,995	4,750	4,725
	2000	6,655	5,695	5,540

Results

The economic impact of the education-weighted labor force on GNP and on GNP per capita is reflected in Table 36. The gross national product of the smaller labor force associated with lower fertility is almost exactly offset by the productivity increases attributable to greater educational attainment. As a result of the essential invariance of total output among the three fertility assumptions in any given year, GNP per capita rises rapidly, more rapidly in fact than under the assumption of a homogeneous labor force, as indicated by the comparisons of projected average annual growth in the table.

Table 36. Projected Chilean GNP and GNP per capita with labor force weighted by educational attainment, 1960-2000.

Output/Growth	Year	Fertility Assumption			Ratios	
		A	B	C	B/A	C/A
GNP (millions of 1960 escudos)	1960	4,080	4,080	4,080	1.00	1.00
	1970	6,695	6,710	6,710	1.00	1.00
	1980	10,770	10,885	10,900	1.01	1.01
	1990	17,250	17,550	17,610	1.02	1.02
	2000	27,775	27,905	28,010	1.00	1.01
GNP per Capita (1960 escudos)	1960	530	530	530	1.00	1.00
	1970	675	700	705	1.04	1.04
	1980	820	940	965	1.14	1.18
	1990	980	1,250	1,370	1.28	1.40
	2000	1,160	1,660	1,935	1.43	1.67
Average Annual Growth Rates, 1960-2000 (%)						
Weighted Labor Force Model						
GNP		4.91	4.93	4.94		
GNP per Capita		1.97	2.39	3.28		
Unweighted Labor Force Model						
GNP		4.61	4.45	4.40		
GNP per Capita		1.68	2.43	2.76		

EXTENSIONS OF THE WEIGHTED MODEL

Several extensions could be made to the education-weighted labor force model to improve its sensitivity and accuracy. These are:

1. Transition matrices. A single set of transition matrices, one for each year of age, was used. Each matrix was assumed constant over the 40-year period and included elements describing the probability of entering the system, remaining at the previous level, advancing to a higher level, and dropping out into the nonstudent population. Such an assumption of constancy over a long period of time, while simplifying greatly the computations, is artificial at best. Since entrance, promotion, and retention rates seem likely to improve over time, a set of transition matrices reflecting projected improvements would be conceptually superior to the present, less dynamic treatment.

2. Sensitivity to budget proportions. The model's educational budget proportion, a constant 3 percent of GNP, was chosen on the basis of information for a limited span of years. At least two questions on this figure arise:

   a. The effects of decreasing or increasing budgets by 10 or 20 percent, say, to 2.7 percent or to 3.3 percent of GNP. Some partial results of these preliminary experiments with changes are noted in Table 37.

   b. The effects of increases in aggregate demand for education, especially at the university level, which are likely to accompany higher incomes and their economic impact under varying fertility assumptions.

3. Investment priorities. For computational simplicity an equal proportional expansion of the different levels of the educational system was assumed. Other allocational decisions might reflect more adequately the aspirations of a developing country. For example, greater weight might be given to expansion of the primary system when funds allowed, with correspondingly slower rates of increase at the other levels. Alternatively, because of the crucial dependence of industrialization on scientific and technical manpower, university training in those fields might be given priority at the expense of growth at the lower levels.

Table 37. Economic effect in year 2000 of varying Chilean educational budget.

Fertility Assumption	Educational Budget as a Percent of GNP			
	2.7%	3.0%	3.3%	3.6%
GNP (billions of 1960 escudos)				
A		27.8		
B	27.1	27.9	28.6	29.1
C		28.0		
GNP per Capita (1960 escudos)				
A		1,158		
B	1,611	1,661	1,700	1,734
C		1,936		

4. Elasticity of demand. This section has treated demand elasticity for educated workers at all levels as infinite, i.e. changes in the numbers, both relative and absolute, of workers with varying levels of education does not alter the relative productivity and the relative wage of those workers. Allowing wage differentials to change over time, as discussed earlier, would improve the projection accuracy of the model.

5. Education expenditures. It was assumed, more for ease of calculation than for realism, that the public treasury was the source of all educational expenditures. Since the students educated receive some private benefit it could be argued that such a treatment underestimates the amounts of human capital formation possible. A more detailed treatment could disaggregate these educational expenditures between private and public ones.

6. Considerations of efficiency versus equity. The treatment of this issue was essentially neutral. Although elementary notions of equity imply mass education, more controversial notions of efficiency may imply more selective educational programs in the future.

Further investigation of the complex economic and demographic interrelationships suggested by the foregoing considerations could prove to be exceptionally fruitful in obtaining a better understanding of Chile's potential for human capital formation and economic growth.

SECTION 7
CONCLUSIONS

Individual sections of this report treat the effects of fertility decline on the age composition of the population, the size of the labor force, the aggregate and per capita output of the economy, and three areas of spending on social services—health, education, and housing. They show the extent to which fertility decline arrests the trend toward higher dependency rates, allows greater proportions of the population to participate in productive activities, leaves the growth of total GNP largely unaffected through increasing GNP per capita, and leads to substantial savings in the provision of social services or the alternate possibility of substantial increases in their quality. While this study has focused on the economy of Chile, the approach used and the consequences of differing rates of population growth are equally applicable to other developing countries, capitalist and socialist alike.*

Since a major portion of the study was devoted to consideration of fertility impacts on social services, some combined projections for annual expenditures are shown in Table 38. The differences in the proportions of GNP required for public support of these social services are striking by the century's end. Table 38 shows that 13.5 percent of Chile's GNP would have to be devoted to the support of the subset of social services considered if fertility remained at its 1960, or traditional, level. By contrast, two-thirds of this proportion would maintain the same standards of quality in the distribution of these services to the smaller population of assumption C.

Because of population differences the projection model generates higher per-capita expenditures by year 2000 under assumptions B

*In a major address quoted in the Cuban newspaper Granma, Fidel Castro expressed considerable concern over the economic problems accompanying population growth in Cuba. Yet, Cuba's annual rate of population increase (2.02 percent from 1958-1970) was less than Chile's (2.4 percent from 1960-1965 and 2.1 percent from 1966-1970).

Table 38. Projected annual public expenditures associated with different fertility rates for education, health, and housing at decade intervals 1970–2000, in absolute terms and as a percentage of total GNP (millions of 1960 escudos).

Year	Type Service	Fertility Assumpton		
		A	B	C
1970	Education	341	337	337
	Health	169	163	163
	Housing	193	201	197
	Total	703	701	697
	Total GNP	6,078	6,101	6,102
	Education, Health, and Housing as % of GNP	11.5	11.5	11.4
1980	Education	622	547	538
	Health	272	241	235
	Housing	298	257	264
	Total	1,192	1,045	1,037
	Total GNP	9,429	9,556	9,569
	Education, Health, and Housing as % of GNP	12.6	10.9	10.8
1990	Education	1,050	794	722
	Health	458	376	346
	Housing	450	368	342
	Total	1,958	1,538	1,410
	Total GNP	15,022	14,934	14,951
	Education, Health, and Housing as % of GNP	13.0	10.3	9.4
2000	Education	1,857	1,301	1,033
	Health	809	617	543
	Housing	683	528	498
	Total	3,349	2,446	2,074
	Total GNP	24,814	23,303	22,847
	Education, Health, and Housing as % of GNP	13.5	10.5	9.1

Sources: Tables 7, 14, 25, and 33.

and C than under A.* Nevertheless, since lowered fertility allows a smaller proportion of aggregate GNP, in addition to smaller absolute amounts, to be spent in these service areas in order to maintain the same quality of services, more funds could be allocated for increasing the quality of health care, education, or housing; more people could be served by extending coverage; or other social goals could be set and met.

The projections presented in this study should not be regarded as forecasts or predictions of the likely evolution of the pertinent variables in the future. Each set of three projections reflects alternative and widely diverging assumptions regarding the future course of Chilean fertility, e.g., the gross reproduction rate will be roughly 2.5 times greater under assumption A than under C in the year 2000. Such divergence in the fertility assumptions and consequent divergences of comparable magnitudes in the projected variables encompass too broad a range to allow them to be regarded as predictions. Furthermore, the considerable distance into the future for which these variables are projected and the commensurate uncertainty are additional justification for not interpreting them as predictions.

In any event, the models used, especially in the social service areas, are sufficiently simple that their projections can easily be recalculated using different parameters. This would be a productive exercise for investigators especially interested in the workings of a single social service sector.

In their present form, the economic model and the models of the three social service sectors are highly aggregated and largely exogenously specified. Regional and functional details necessary to the planner in his day-to-day work are glossed over. But, although the projections and the models underlying them should in no sense be considered planning models, they do serve to evaluate expenditures for each social service sector within the context of the economy as a whole, to show the effects of fertility decline on aggregate economic variables, and to indicate demands that might be faced by the economic system in future decades. The orders of magnitude projected for school enrollments, health care, and housing should both stimulate the reformulation of the models in greater detail and lead to an appreciation for the long-term impact of demographic variables on these and other social services.

*These amount to $E^{o}139$, $E^{o}146$, and $E^{o}143$ per capita per year for assumptions A, B, and C respectively.

APPENDIX A

NUMERICAL VALUES FOR PARTIAL ELASTICITIES OF OUTPUT WITH RESPECT TO FACTOR INPUTS

BASIC HOMOGENEOUS LABOR FORCE MODEL

The values under consideration in this appendix correspond to the exponential coefficients α, β in this model's production function:

$$Y = Z\,(1 + \tau)^t\, K^{\alpha} L^{\beta} \qquad (1)$$

where

Y = gross national product

τ = annual rate of technological change

t = years elapsed since base period

K = capital

L = labor

Z = a constant.

Currently available Chilean data on aggregate production function variables were not deemed adequate to justify econometric estimation of these α, β parameters for recent years. Consequently, the approximate α, β values were established through other less direct routes; notably, through available factor income data.*

While it cannot be claimed that the restrictive neoclassical conditions required to equate factor shares to corresponding output

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*See Correa (1970) for a discussion of Latin American factor income data.

elasticities are approximated in fact, the following considerations led to the choice of α, β values based in part on observed factor prices and factor shares:

1. Drastic discrepancies between a neoclassical model and the real world are by no means confined to Chile. Indeed, such discrepancies are pervasive in virtually any country one may choose to consider. Nevertheless, economists continue to use theoretical results deduced from neoclassical assumptions to arrive at estimates of certain variables which defy more direct methods of evaluation. The estimation of partial elasticities of output for Cobb-Douglas production functions using factor income data to derive the elasticities is a case in point. In the context and scope of the present study, these considerations appear to provide sufficient justification to proceed similarly.

2. In a study by Harberger and Selowsky (1966) completed almost four years before income distribution data could be obtained from national accounting statistics, the authors' ingenious analysis of indirect evidence and their seasoned judgment led them to conclude that Chilean income is distributed in approximately equal shares between labor and capital.

3. The most current available edition of officially published Chilean national accounts statistics contains, for the first time, functional income distribution data in the form of annual observations from 1960 to 1968.* This source shows "labor's share" (defined as the sum of aggregate wages, salaries and employer's contributions to workers' social security funds) fluctuating between 46.8 and 51.6 percent of national income throughout that period, averaging almost exactly 50 percent. The remaining half of national income is attributed to payments to "other factors of production."

4. Undoubtedly, a significant share of this latter half is imputable to work performed by the relatively large number of self-employed workers in Chile. In fact, James Gavan (1968-1969) estimates that no less than 15 percent of Chile's national

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*ODEPLAN (1969), Cuentas Nacionales 1960-1968.

income may be accounted for by this group. Thus, if his estimates are sound — and the methodological care and thoroughness shown in his work suggest that they are — relative shares during recent years would be in the neighborhood of 35 percent and 65 percent to capital and labor, respectively.

On the basis of the preceding considerations projections were computed using an alternative pair of α, β values of(0.50, 0.50) and (0.35, 0.65). Differences resulting from these alternative specifications of the production function tended to be relative small. A representative sample of the corresponding projection values is tabulated in Table A-1.

Table A-1. Comparative output projections under two assumptions about relative shares for year 2000.

Fertility Assumption	(α, β)	
	(0.50, 0.50)	(0.35, 0.65)
A - Constant 1960 Fertility		
Total Output[a]	24,814	22,617
Output per Capita[b]	1,035	943
B - Present Decline Continues		
Total Output[a]	23,303	20,232
Output per Capita[b]	1,387	1,204
C - Two-Child Norm		
Total Output[a]	22,848	19,594
Output per Capita[b]	1,580	1,355

Notes:

[a]Millions of 1960 escudos

[b]1960 escudos

Finally, the set of projections associated with $\alpha = \beta = 0.50$ was chosen in accordance with the following rationale. The available evidence indicates that the overwhelming majority of self-employed workers in Chile bring to bear pitifully small amounts of physical or human capital in their work. The typical member of this category is the street vendor, bootblack, or subsistence farmer. It appears fairly certain that, at the margin, the output contribution of this labor category is nil for all practical purposes.* Consequently, labor's output elasticity was assessed as the share of employed labor (estimated at 50 percent) and that of "capital" as the residual 50 percent. Note that the Gavan estimate of relative shares was, in effect, modified to allow for the low output elasticity attributed to self-employed workers as a whole.

EDUCATION-WEIGHTED LABOR FORCE MODEL

Section 6 deals with a refinement of the basic model in which tl parts of the labor force, rather than being homogeneous, were weighted according to their educational attainment and correspondingly disparate productivities. In this variant of the model, the production function is given as

$$Y' = Z'(1+\tau)^t K^{\alpha'} L_1^{\beta_1} L_2^{\beta_2} L_3^{\beta_3} L_4^{\beta_4} \qquad (2)$$

where the L_is refer to the labor input from workers in each of the four educational attainment categories considered and the remaining symbols are defined as in Equation 1.

There was no apparent reason to alter the validity of the previous considerations leading to an assumed value of 0.05 for the output elasticity of "labor" as a whole. Thus, it was assumed that $\sum_{i=1}^{4} \beta_i = 0.50$, and α' was again taken as the residual 0.50. The problem, then, consisted of distributing the 0.50 aggregate labor elasticity of output into the β_i elasticities corresponding to the

*The observation that members of this category receive positive income for their activities does not contradict this view, which allows for a correspondingly positive average product to which they have claim.

four educational attainment categories (L_i) by which the employed labor force (L) was disaggregated (i.e., $\sum_1^4 L_i = L$).

The possibility of arriving at the required estimates econometrically was barred, a fortiori, by the same data limitations preventing such a procedure for α and β in the basic model. Available data from Blitz (1963) and Dirección de Estadística y Censos (1966) did, however, allow for estimates of relative labor income shares of the educational attainment categories. On the basis of considerations analogous to those leading to the numberical specification of α and β, the L_i values were chosen such that their ratios would equal the corresponding average labor income ratios, $\overline{W}_i$, subject to the restriction that their sum equal 0.50. Symbolically, if:

$\overline{W}_i$ = the average labor income received by workers belonging to category i, i = 1, 2, 3, 4;

L_i = the number of workers in the ith category,

β_i values can be chosen to satisfy the set of equations consisting of the system:

$$\frac{\beta_i}{\beta_j} = \frac{\overline{W}_i L_i}{\overline{W}_j L_j} \; ; \quad i, j = 1, 2, 3, 4; \; i \neq j \tag{3}$$

and

$$\sum_i \beta_i = 0.50. \tag{4}$$

Given estimates for $\overline{W}_i$, L_i, the preceding set of equations can be solved uniquely for the β_i. Estimates for the $\overline{W}_i$ were obtained for the year 1962 from a labor force survey over the metropolitan areas of Santiago, Valparaiso, and Viña del Mar (Blitz, 1963). Nationwide L_i for 1962 were calculated by log-linear interpolation between observations resulting from the 1960 census and a nationwide household survey taken by the Dirección de Estadística y Censos (1966).

Table A-2 shows the $\overline{W}_i$, L_i estimates used in the calculation of of the i as well as the i values themselves.

Table A-2. Income, labor force, and output elasticity.

Educational Attainment	$\overline{W}_i$ (escudos)	L_i (thousands of workers)	$\overline{W}_i L_i$ (millions of escudos)	β_i (output elasticity)[a]
None	55	350	19.3	0.03
Elementary	92	1,716	157.9	0.23
Secondary	191	408	77.9	0.11
University	1,231	76	93.6	0.13
All Categories			348.7	0.50

Source: Blitz (1963) and Oficina de Planificación Nacional (1969)

Note:

[a] $\beta_i = \dfrac{0.5\,\overline{W}_i L_i}{348.7}$

APPENDIX B

UNIVERSITY EDUCATION COST CALCULATIONS

AVERAGE COST PER UNIVERSITY STUDENT

Let C stand for total (annual) university costs and N for the total number of students, with

C_l, C_m = the total (annual) costs assignable to the law and medical schools, respectively

N_l, N_m = the numbers of law and medical students, respectively

$$N = N_l + N_m \quad .$$

The average cost per student, C/N, may be written

$$\frac{C}{N} = \frac{C_l}{N_l} \cdot \frac{N_l}{N} + \frac{C_m}{N_m} \cdot \frac{N_m}{N} \qquad (1)$$

or more simply,

$$\bar{c} = \bar{c}_l \cdot n_l + \bar{c}_m \cdot n_m \quad . \qquad (2)$$

It is known that $n_l = 1.66\, n_m$; definitionally $n_l + n_m = 1$, or $n_l = 1 - n_m$. Thus, $n_m = \frac{1}{2.66} = 0.374$, and $n_l = 0.626$. Inserting all known values into Fquation 2,

$$c = \underbrace{161 \times 0.626}_{100.8} + \underbrace{1{,}280 \times 0.374}_{478.7} = E^{o}.\ 580 \qquad (3)$$

IMPACT OF COMPOSITIONAL SHIFTS ON AVERAGE COSTS

In general, the relative impact of compositional change on average cost per student may be estimated from the formula

$$\frac{\Delta \bar{c}}{\bar{c}} = \sum_{i=1}^{n} \frac{\bar{c}_i}{\bar{c}} \Delta n_i \tag{4}$$

where the subscript i indexes the n fields. In the present example, n = 2, this expression simplifies to

$$\frac{\Delta \bar{c}}{\bar{c}} = \left(\frac{\bar{c}_m - \bar{c}_1}{\bar{c}}\right) \Delta n_m , \tag{5}$$

and, hence

$$\frac{\Delta \bar{c}}{\bar{c}} = \frac{1,121}{580} \times 0.126 \approx 0.24, \text{ or 24 percent}$$

DERIVATION OF UNIVERSITY ENROLLMENT RATIOS

University enrollment was approximately 24,700 students in 1960 and 73,600 in 1969.* Dividing each of these quantities by the estimated number of individuals aged 18-24 years in 1960 and 1969 yielded enrollment ratios, so defined, slightly under 3 percent for 1960 and 6 percent for 1970.

Dr. Ernesto Schiefelbein (1968), when Director of the Office of Educational Planning of the Ministry of Education, suggested that to meet future requirements for university level personnel, tertiary enrollment should expand in the future at about 6 to 7 percent per year. This rate of enrollment expansion was used to project university enrollment in 1980, 1990, and 2000. Each of these projected enrollments was divided by the chronologically corresponding estimates of the 18-24 year old population on the basis of the "official" (CELADE/CORFO) projections. The resulting coefficients were rounded off to two significant digits and taken as the assumed enrollment ratios for each of these years. The complete vectors of enrollment ratios used in the three sets of projections are shown in Table 16.

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*For 1960, Schiefelbein (1968), p 32, Anexo 10. For 1969, Schiefelbein (1970), pp 22-25.

The enrollment ratio of 30 percent derived for 2000 by this procedure closely approximates the current U.S. ratio. Because Chilean socioeconomic goals for 2000 are often set in terms of current U.S. magnitudes, this coincidence may lend additional intuitive appeal to the chosen values.

TEACHER TRAINING COST

While in certain countries graduate curricular programs may justifiably be regarded as university-teacher training programs having readily identifiable costs (e.g., the Ph.D in a majority of disciplines in the U.S), such is not the case in Chile. The vast majority of Chilean university instructors has no greater formal education than the typical university graduate. This gives rise to some ambiguity in the concept of university "teacher training cost."

The source of ambiguity lies in the alternative ways in which the term "cost" may be defined in the context of an economic good. These alternatives can be illustrated by the different ways in which a firm's accountant and the social statistician define, and compute, the cost of producing a given quantity of the firm's product. While the firm's accountant uses a cost equation which includes the value of all the required inputs, independently of whether they were purchased from other firms (e.g., "raw material") or whether they were "added" by the firm itself (e.g., labor), the social statistician includes in his corresponding cost equation only the values of those inputs "added" by the firm, leaving out the firm's expenditures on "raw material" purchases.

Analogously, one could take this latter point of view on the cost of training a university instructor and argue that since nothing has been "added" in "producing" him out of common university graduate "raw material," the cost of training a university instructor is nil. On the other hand, one could argue from a firm accountant's point of view that "producing" a university instructor requires providing him with higher education, which is hardly costless and that, consequently, the cost of training a tertiary level instructor should very definitely include the cost of putting him through the university. Specifically, if fewer university instructors were required, resources would be liberated for other purposes and their (alternative use) value represents the opportunity cost imputable to tertiary teacher training.

This latter view of the cost of university teacher training appears far more pertinent to the context of this study and, thus, is the one adopted.

APPENDIX C

COMPUTATION OF HOUSEHOLD SIZES AND HOUSING OUTLAYS

DERIVATION OF HOUSEHOLD SIZE CHANGES

Time-series data on household size and gross reproduction rates (GRR) were examined, for the few countries for which they were available, in search of systematic relationships linking these two variables over time. This suggested the functional form

$$s_t = s_o (1 - r)^t \frac{g_t}{\alpha} \tag{1}$$

where

- s is household size
- g is the GRR
- t is the yearly time index, with $t = 0$ corresponding to a "base" year
- r, α are constants.

Taking the log-derivative of Equation 1 with respect to time yields

$$\frac{d \ln s_t}{dt} = \ln(1 - r) + \frac{d \ln g_t}{dt} \quad ; \tag{2}$$

the finite approximation to Equation 2 can be written as

$$\frac{\Delta s}{s} = \frac{\Delta g}{g} - r \tag{3}$$

Available empirical estimates of s and g for Chile for the years 1960 and 1968 allow the computation of $\Delta s/s$ and $\Delta g/g$, and, thus, r in Equation 3. Knowing r and s_o, the g_t value available for each fertility assumption can be used in Equation 3 to generate the s_t schedules associated with each of these assumptions. The s_t values appearing in Table 28 approximate the result of the indicated calculations.

COMPUTATION OF OUTLAYS TO MEET MINIMAL HOUSING GOAL

The estimates of Table 32 covering total public and private outlays required to meet the minimal housing policy goal for Chile were developed from the population and household data of Table 28, housing stock for 1965 from Servicio Nacional de Salud (1969), and population data for 1965 from Dirección de Estadística y Censos (1969). The procedure was to let

P = the number of individuals requiring new housing during the period (for each fertility and family size assumption)

ΔP = the net population increment (Table 28) in a given period associated with any one of the three fertility assumptions

s = the associated household size (Table 28)

L = housing losses during the period

α = fraction of the population in acceptable housing in the year 1965, estimated to be 0.6 by the relationship

$$\alpha = \frac{s_o H_o}{P_o}$$

where

H_o = the 1965 stock of housing units (= 1.004 million; from Reference 38)

s_o = average household size (= 5.17; interpolated from Table 28)

P_o = total population in the year 1965 (= 8.708 million; from Reference 10);

therefore,

$$\alpha = \frac{5.17 \times 1.004}{8.708} \approx 0.6$$

Solving for the number of individuals, p, requiring new housing during the period,

$$p = 0.6\,\Delta P + sL \quad . \qquad (4)$$

$$C = \bar{c}p/s \tag{5}$$

where $\bar{c}$, the estimated parametric unit cost, was found to be E° 6,519, according to the calculations and sources described in Section 5. Substituting the expression in Equation 4 for p in Equation 5 gives the formula used to generate each cell value in the first three columns of Table 32; namely,

$$C = 6,519 \left[0.6 \left(\frac{\Delta P}{s}\right) + L\right] \tag{6}$$

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