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LIFE CYCLE OF HEALTH, PRODUCTIVITY AND CONSUMPTION

by

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A b s t r a c t

The analysis draws attention to the whole life cycle relationship between health, labor productivity and utility function. Man's health-biological (HB) cycle is inverted U-shaped. It has the obvious growth or upward sloping segment and a declining segment. The peak is considered to be the maximum achievable biological development. The height and slope are determined by nutrition, quality of environment and habits. They vary depending on the degree of deprivation of health inputs. Some evidence from medical research is presented in support of likely HB cycles.

The HB status at each age determines in turn, mental and physical capacity for work. Likewise it determines the utility function or time preference and current demand for goods and leisure. The paper focuses on labor productivity which is a result of the interaction between the capacity supplied by labor and the capacity required by jobs. Poverty is seen to pull down capacity supply and underdeveloped processes to raise capacity requirement. The gap would tend to result in low productivity. Concurrent and life cycle productivity behavior is clarified.

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Human life follows a biological cycle beginning with birth, moving on at a rapid rate of mental and physical development in early childhood, then developing at a slower rate until adulthood is reached at about 18 when full capacity is achieved. We see full capacity as the highest achievable state of physical strength and mental alertness. Full capacity is maintained for a number of years possibly from 18 to 30 after which it begins to decline. From about age 60 onward, physical deterioration hastens. This cyclical pattern generally applies but the cycle itself is not completely homogeneous. The rate of development and the length of each stage of the cycle and therefore the level of physical and mental development attained at each stage may differ between individuals. Height, weight and other health indicators at each age are observed to vary within and between countries. Many factors are known to affect the rate and level of development, among them nutrition, the quality of living conditions, the social environment and even cultural values. Clean air and water, gentle social relations, orderly conduct and self-discipline contribute to health. The influence of any of these variables tends to be prolonged for the health/biological (HB) status achieved at any time t depends not just on the value of health-related variables at this time but on previous health status, in fact on the whole history of a person's health.

A person's health/biological status determines in turn his productivity and his very own utility function, i.e., the intensity of his enjoyment from the consumption of particular goods and from his social relationship, work and other activities, in other words, his total well-being at t. A healthy person is better able to socialize, to enjoy food, sports, etc., and to obtain higher health outputs out of any health input. The utility function itself is viewed to have a biological cycle. As his HB changes over the cycle his taste for goods, services and activities changes. In fact we often hear of mothers being aghast at the amount of food their teen-age sons consume. Infants have their own recommended diet which is rich in protein while older people are advised not to consume rich foods. At the peak of a person's biological development, say ages 15 to 30, utility from physically intense leisure activities such as sports, romance and work appears to be relatively high. At older ages, say 50 onwards, the decline in health status makes the person prefer less energy-consuming activities like bridge games and quiet dinners. Time preference is seen to be partly based on health cycle.

We assume an international standard HB cycle that is defined for the present state of health knowledge. The standard HB cycle is seen as the outcome of the best health conditions for the average person consisting of the recommended diet, clean and safe environment, and wholesome sociocultural relationship and activities. We assume the standard person to be adequately happy so that his psychological state does not impinge on his health

habits such as eating and sleeping. Corresponding to the persons's HB status is his physical and mental capacity for work and living. Physical capacity may be measured by height and weight and manual dexterity while mental capacity by IQ, speed of reflexes, memory, and other forms of intellectual ability. The HB cycle of the average Japanese or Swede or any other group with high life expectancy may be taken as the HB standard for contemporary times. A hypothetical HB standard cycle is drawn below.

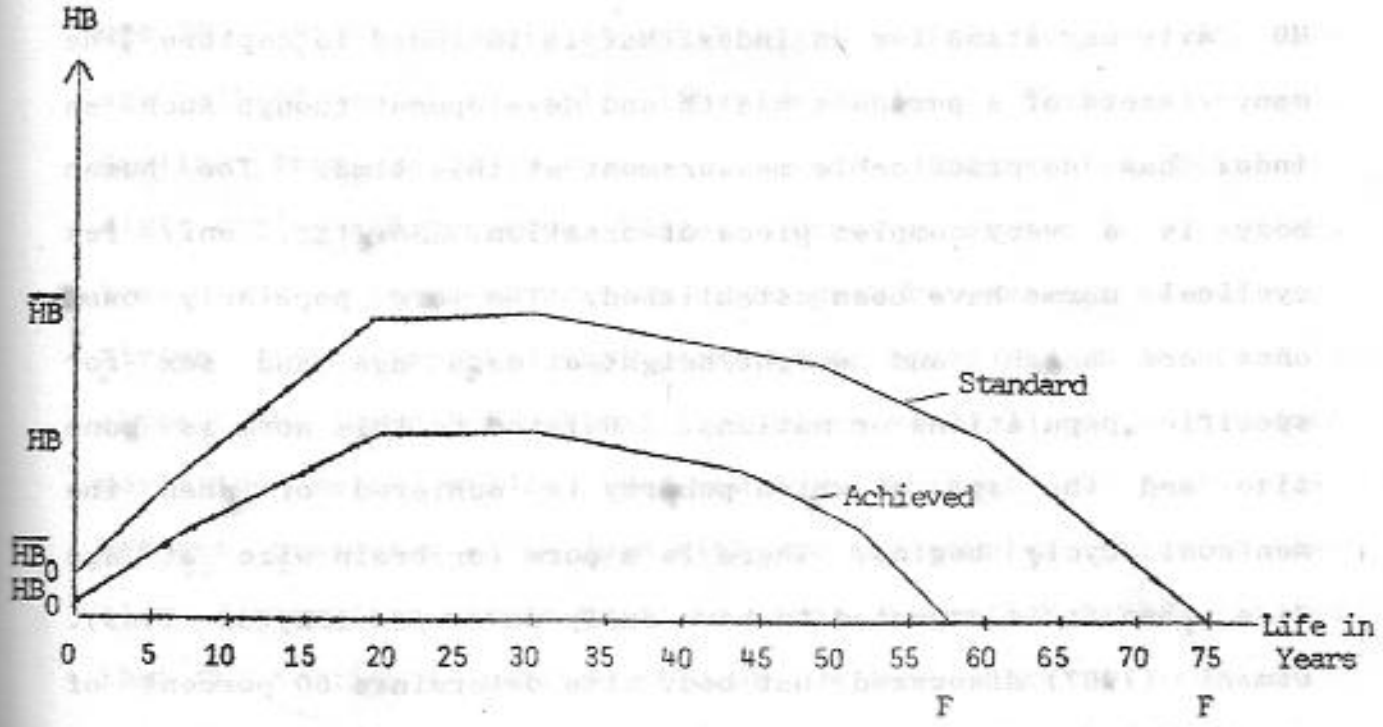

FIGURE 1

The cycle starts at birth for a child of standard health and genetic characteristics. The intercept is a measure of his health status at birth. This is followed by a rapid rate of development up to age 4 to 5, and a slower growth up to age 18 when adulthood and full capacity as well as mental, is achieved. Peak physical capacity is maintained up to 30 after which it begins to decline, very slowly at first and then at increasing rate after age 50 or so. Health deterioration accelerates after this age until death at age 75. (Mental capacities start declining at a later age.)

The graph is a conceptual construct of HB development. The HB axis may stand for an index that is intended to capture the many facets of a person's health and development though such an index has no practicable measurement at this time. The human body is a very complex piece of creation. So far, only few cyclical norms have been established. The more popularly used ones are height and weight/height at each age and sex for specific populations or nations.[1] Related to this norm is bone size and the age at which puberty is achieved or when the mentrual cycle begins. There is a norm for brain size at age five when it is expected to have fully developed (Dayton 1969). Osmani (1987) discussed that body size determines 80 percent of physical strength or capacity. Other norms for various forms of

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[1] Osmani (1987) referred to Martorell study concluding that in general all peoples have similar potential average height. However, country standards are established taking to account their own respective environment and diet. LDC standard height is set lower than Western standards given that the most healthy group in these places are still shorter than in the developed countries.

physical, social and mental abilities during the growing period have also been established. Dr. Spoch has a popular version of some of these.

Medical science has addressed the declining part of the cycle. A few aspects of aging are cited here. Sheila Chown (1986) plotted the age path of selected types of abilities such as forced expiratory volume, loss 4,000 Hz ear, height, grip strength, visual acuity, writing speed, vocabulary size, operations with matrices and images. Forced expiratory volume, loss of 4,000 Hz right ear and visual acruity begin to decline at age 20. Height and grip strength start to fall from age 30. The age path of mental abilities likewise differs. There is an early decline from age 20 in scores in Raven's Progressive Matrices, digit coding and perpetual images. However, scores in vocabulary test, and in tests of writing speed peak between age 40 and 50. Birren (1983) reported that psychomotor speed has an inverted U shape, the mean for retired professors was 1/2 to 1 standard deviation below middle aged and equal that of 17 year olds. Reflect processes slow down with age and complex reaction time slows faster than simple reaction time. L'hayfick (1988) stated that the ability to perform mild or low level physical work does not seem to change significantly up to at least age 60 but the ability to perform heavy work using mascular strength falls significantly with age. This is consistent with Chown's observation of an early decline in forced expiration rate and grip strength. The fall in speed of reflexes explains the weakening of manual dexterity at about age 30. The tests on

memory losses in later life appear not to be conclusive given that knowledge about memory is still rather weak. The mode and depth of remembrance are found to vary depending on the object of memory and the process of its perception. With age, there is a common observation of slower recall of names.

These and other findings do give support to the idea of capacity cycles with the age of peaking and the rate of decline varying according to the physical or mental ability that is involved. Generally, there is an early peaking of physical strength as reflected in the early loss of grip strength and forced expiration rate and a later peaking of the few observed mental abilities.

2. Human Capital Formation and Health

Physical and mental capacities are honed to fit anticipated jobs in the labor market. Jobs require different combinations of physical and mental attributes. Some jobs require more physical strength and manual dexterity, others require more mental ability. Yet a person's health/biological (HB) status determines his rate of human capital accumulation. Generally, the more physically healthy he is, the more mentally alert he is and the faster he learns. Mental capacity, on the other hand, is a constraint on the level and nature of human capital accumulation. Not all have the mental capacity for advanced mathematics, microbiology or musical composition. In turn HB status determines the productivity of human capital that is inputed in the production process. The more healthy the worker,

the higher his productivity in his chosen occupation. His on-the-job training is likewise expected to be faster.

The productivity path in most occupations is inverted U-shaped. The shape is determined by the HB cycle and the opportunities for productivity gains on the job via learning by doing and other forms of training. Productivity in blue-collar jobs which require mainly physical strength, manual dexterity or visual acuity would tend to follow the physical health cycle. The earnings path in these jobs is found to be flatter and to peak earlier or at about the age of prime health. For most white-collar occupations productivity declines at a later age. Within this group, the occupations which require high mental abilities are more complex and take longer to master, hence a later peaking. Moreover, technological changes, scientific discoveries and artistic creation add to the stock of knowledge to be mastered. They therefore increase opportunities for further learning and research so that there is almost no end to learning in these occupations. If there is no HB deterioration, the productivity cycle of people in these occupations would be continuously rising.

HB status may not always be a binding constraint on productivity. It is possible and quite likely that in many jobs the worker's physical or mental capacity may exceed the level required by the job. The physical requirement of most jobs in modern factories and construction operations is smaller than the physical capacity of the workers. In this case, the productivity

path will be determined solely by the worker's mastery of his work or by his on-the-job training. For jobs which demand the full capacity of the worker, his productivity path will tend to follow his HB cycle. A ballerina or an opera singer must give her all to her art fully utilizing her capacity at each age. Later on the inevitable HB deterioration will pull down her productivity. Sheer physical strength diminishes, the legs get brittle, the vocal chords stiffen, and/or the memory lapses. At some age, the singer can no longer reach the high notes, the dancer cannot pirouette as many times or stay on her toes as long. In a similar manner, the older manual worker cannot lift as heavy weight or lay as many bricks per day. And athletes reach their prime quite early.

The relationship between HB cycle and productivity cycle is drawn stylistically below. Three cases are discussed: one where the HB requirement of the job equals the HB supplied (possessed) by the worker at all ages, the second is where the HB requirement is below the HB cyclical supply and the third is where the HB requirement exceeds the HB cyclical supply. To simplify, we consider a worker with a given HB or capacity cycle, ABCDF. Retirement age is set at age R and death at age F. The capacity requirement for job 1 is assumed at a constant level OC_1, for job 2 at OC_2 and for job 3 at OC_3. We may say that the worker is just right for job 1, he is underqualified for job 2 and is overqualified for job 3. If the worker chooses to enter job 1, his productivity path will follow the normal gains from experience since his productivity is not

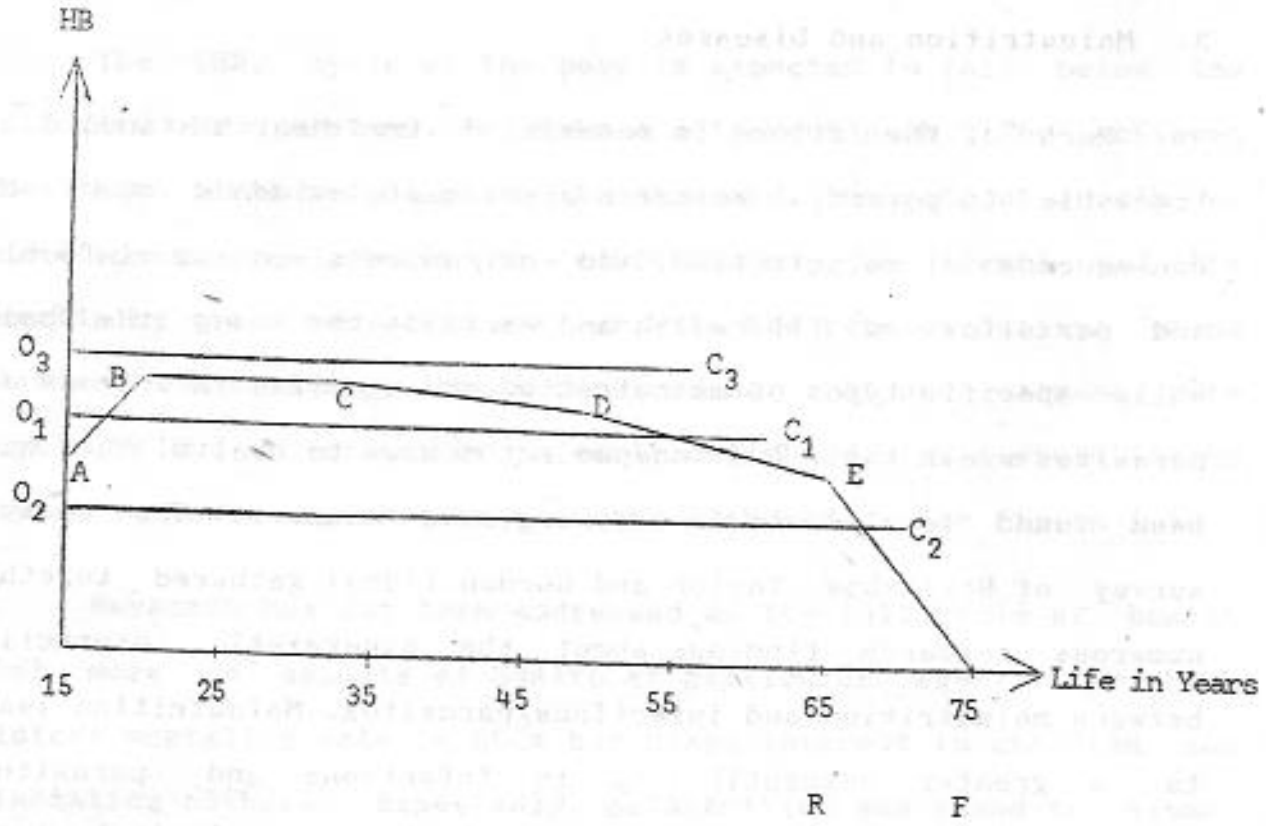

FIGURE 2

constrained by his capacity. In job 2, his capacity will be underutilized and he will be foregoing extra output from a more suitable job. He will be misplaced in job 3. His productivity will be pulled down by his inadequate ability. He might feel harassed or dissatisfied with his performance especially in relation to his peers who are better qualified for the job. Because of his poor qualifications, he might earn less in job 2 than in job 1. An efficient labor market would work towards a good matching of capacities to job requirements so that the workers' lifetime productivity is maximized. Individuals will tend to self-select for the jobs to which they best fit.

3. Malnutrition and Diseases

Much of the failure in reaching desired health standard is traceable to poverty. Research gives ample evidence about the consequence of malnutrition, and environmental-caused infection and parasites on ill health and early death among the poor. While specific types of malnutrition and specific infections and parasites wreak their own independent damage to health, they have been found to also act in a synergistic manner. The classic survey of Scrimshaw, Taylor and Gordon (1969) gathered together numerous research findings about the synergistic interaction between malnutrition and infections/parasites. Malnutrition leads to a greater susceptibility to infections and parasites. Infection and parasitic attacks tend to be more virulent among badly nourished patients. The diseases, in turn, cause large losses of essential nutrients. In particular, the studies show that the malnourished have a greater vulnerability to diarrhea and the common hookworms; they recover more slowly and in turn suffer a substantial loss of iron; and they absorb food less efficiently. Kwashiorkor symptoms frequently follow onslaught of diarrhea in patients who are initially malnourished. Synergism of malnutrition and tuberculosis, malaria and respiratory infections is also evident. The synergism works worst among infants and children. Equivalently, the treatment of these diseases is hastened by food supplements. This is specially true among malaria and TB patients.

4. Health and Underdevelopment

The (HB) cycle of the poor is expected to fall below the standard HB cycle and to take a different path. The achieved health at birth may be below the standard; the rate of growth or development to puberty or adulthood may be lower; and the declining stage may begin earlier with the rate of decline being faster. Ultimately, death comes sooner. At one extreme, the cycle is cut at infancy or in early childhood. As a whole the HB cycle is lower and shorter than the standard. (See Figure 1.)

Research has not been addressed at the full cycle of health but more on aspects of health at particular ages. The high infant mortality rate in LDCs has drawn interest to children and lactating mothers. Expectedly, malnutrition was found to hinder the first stages of human development. There is a higher incidence of abnormal births and a higher neonatal death rate among malnourished mothers. Diseases occur more frequently among low birth-weighted babies. Among malnourished children brain size is smaller and the onset of the menstrual cycle is later. The studies are focused on points or segments of the health cycle. We know little of the lifetime path of people, especially those in poverty.

Underdevelopment impinges on labor productivity in another way. It generally raises the physical capacity requirement in most jobs. Production processes which use backward technology and little capital per worker require a greater amount of human energy than modern production processes. LDC farmers with few

manual tools exert more effort in hoeing, weeding and watering plants. Construction workers consume much energy in hauling cement and sand by hand. Moreover, LDC work is often done with little protection from the elements. In office jobs where electronics gadgets are not available, relatively more effort is applied to typing, filing, and analyses. And yet the capacity supply due to poor health is lower and could be below capacity requirement. This capacity requirement-capacity supply gap is likely to occur in many unmechanized blue-collar occupations.

How does a worker adjust to this gap? At the prime of his health at ages 18 to 30, he may be able to meet the requirement of the job. But he cannot stretch himself indefinitely. Beyond his prime he will have to work within his capacity by working shorter hour each day, by working irregularly or by working at a slow pace. Tendencies for preserving energy are observed in one form or another in underdeveloped situations. His lifetime productivity will be reflected in a lower effective working hours.

Generally, white-collar occupations require less physical capacity than blue-collar occupations. Within blue-collar jobs, the requirement for sheer physical capacity or energy decreases as the skill level rises. The work assigned to unskilled workers like unmechanized mixing of cement and hauling of debris use up more energy than the more skilled work of furniture making. Paradoxically, wage rises with skill level. Thus the least skilled who receive the lowest wage rate tend to be the most badly nourished. They have less opportunities for acquiring

skills. The poorest are easily trapped in a vicious circle of ill health, low skill and low income.

While it is dismal to realize that a large majority of the world's poor are caught in this circle it is encouraging to find that it will not be difficult to break. Rapid economic development, as has happened in some Asian countries, has resulted in a rapid reduction of poverty incidence and a substantial improvement in the health of their people. Thailand, for instance, was able to reduce its povery rate by half in just one decade, i.e., from 40 percent to 20 percent in 1970 to 1980.

5. Some Empirical Observations about Health and Productivity

Measuring or even simply judging the health status of an individual is a very illusive undertaking. We have for the Philippines a few conventional health indicators such as life expectancy at birth, age specific mortality rates, principal causes of morbidity and mortality, adequacy of nutritional intake and anthropometric measures at early ages. The quality of data varies. It is especially difficult to measure mortality rate since the registration of death and the identification of its cause are not comprehensive for the less developed areas of the country. The Health Department is only in its third health survey began in 1981 while the FOod and Nutrition Research Institute has been conducting nationwide nutritional surveys since 1978 only. We definitely do not have longitudinal data on health and employment that would allow for an empirical testing of the life cycle health-productivity arguments put forward. The

available cross-section data only lend indirect support and provide some insight into the statements. We proceed with a discussion of basic health statistics and then analyze some cross-section data from various surveys.

3.1 Health Status of Filipinos in the 80s

Increasing income per capita and improvement in education and medical and sanitary facilities helped improve the health status of the nation. In 1970 life expectancy at birth was 55.8 years, infant mortality rate was 93.2 and crude death rate was 10.8. Life expectancy rose to 64 years in 1986 with infant mortality rate at 58 per 1,000 births and overall crude death rate at 8.8 per 1,000 (1980). Yet these indicators are still way below those reached in developed countries and by China or Sri Lanka. To a large extent the average level of health as reflected in these indicators are consequences of great inequality of income and wealth. The Gini ratio has not significantly changed from about 50 percent; the lowest 50 percent of families have been receiving less than 20 percent of personal income. Poverty is prevalent with the families defined as poor reaching 60 percent of the total in mid-80s. The rate rose from about 40 percent in the 70s and now it is estimated to be about 50 percent. The prevalence of poverty has not been mitigated over the last two decades since no comprehensive social welfare program has ever been adopted. Public finance has hardly changed the distribution of income and wealth and the protection

structure of trade and industrialization policies has favored a few leading to a further concentration of wealth.

As in other developing countries, infection and parasites remain the major causes of deaths. Respiratory infections including pneumonia, bronchitis, tuberculosis and influenza, and gastroenteritis, diarrhea and dysentery comprised 29.3 percent of reported death in 1981. Death by unknown causes, possibly those that occurred without a doctor's attendance and post mortem comprised 46.5 percent of the total. These deaths possibly happened to people who are either too poor and/or too far to have access to a doctor For these people infection and parasites are the more likely causes of death. Only 14.1 percent of deaths were by neoplasms and cardio-vascular problems.

Various surveys gave the following information which show the state's failure to provide all its people with sanitary facilities and medical care (Table 1).

While we have no data on the distribution of medical and sanitary facilities among various social classes, it can be reasonably assumed that the distribution is generally regressive and biased against the rural sector. The fact that infections and parasites are the major causes of death is reflective of the inequality of access to health facilities. Among the poor, these unsanitary environment would work synergistically with malnutrition. The more educated and affluent individuals need no longer have to die of these diseases as they have the choice of

TABLE 1

	Percent of Population Serviced		
	National	Urban	Rural
A. Potable water: piped and tube wells (1982)	70.9	91.8	60.5
1. Garbage disposal			
city/municipal collection	13.7	41.3	0.1
burning	50.1	30.4	59.8
other	36.2	28.3	40.1
2. Toilet facilities			
flush/water sealed	64.9	83.1	56.1
closed pit	17.2	7.9	21.7
other	17.9	9.0	22.2
B. Household access to hospitals/ clinics (1981)	31.5		
not aware of government hospital/ clinics	34.5		
10 kms more distant to:			
government hospital/clinic	28.6		
private hospital/clinic	14.6		
C. Population:			
per medical doctor (1987)	3,135		
per nurse (1987)	5,772		
per midwife (1987)	3,926		
per dentist (1987)	10,799		

Source: Panels A, B. Food and Nutrition Research Institute, Second Nationwide Nutrition Survey 1982. Panel C, Edna Reyes and Oscar Picazo, "Health Manpower in the Philippines," Paper presented in International Health Policy Conference, 31 July-4 August 1989, Manila Hotel.

obtaining relatively advanced medical care and of living in sanitary environment.

There is more detailed evidence on malnutrition to lend support to our thesis on the life cycle of health.

A large percentage of the population suffer from undernutrition. According to the 1982 Nutrition Survey from which we get all the data on nutrition used here, 33.6 percent of households have energy intake 80 percent less than the recommended level (RDA) and 25.4 percent are similarly deficient in protein. The proportion of those who are severely mainourished with intake of less than 60 percent of RDA is 6.9 percent in energy and 5.8 percent in protein intake. The severe undernutrition rate in other substances is higher: 19.6 percent in iron, 43.1 percent in calcium, 40.5 percent in Thiamine (Please see Table 2.) One reason for the relatively higher inadequacy level in these nutrients is unbalanced diet. Food consumption is heavily weighted by rice which supplies 56.2 percent of energy and 42.9 percent of protein. It is a poor source of the other nutrients.

Income is a major constraint on food intake as seen in Table 3. Though undernutrition is found among all income groups, the rate of undernutrition decreases quite significantly as income increases, whether measured for the household or per capita. The lowest income group with per annual capita income of less than P 2,000 accounted for almost 75 percent of the undernourished.

TABLE 2

PERCENTAGE DISTRIBUTION OF HOUSEHOLDS
BY LEVEL OF ADEQUACY, BY NUTRIENT, 1982

Adequacy Level	Energy	Protein	Iron	Calcium	Thiamine
< 40%	0.8	0.6	2.7	10.7	11.2
40-49	1.3	1.6	6.5	10.4	13.5
50-59	4.8	3.6	10.4	12.0	15.8
60-59	10.9	8.4	11.2	12.8	12.5
70-79	15.8	11.2	13.5	10.6	12.4
80-89	18.9	14.5	10.7	10.1	9.1
90-99	14.5	14.1	9.5	7.1	6.2
100 & over	32.9	46.0	35.5	26.3	19.3
	100.0	100.0	100.0	100.0	100.0

Source: FNRI, Second Nationwide Nutrition Survey, 1982.

TABLE 3

ENERGY ADEQUACY RATE BY HOUSEHOLD AND PER CAPITA INCOME 1982

			Adequacy Level Within each Class		
A. Annual Household Income	% HH	% of <80% Adequacy	<80%	80-109%	110% & over
< P= 1,500	6.6	2.8	42.3	33.2	24.5
1,500- 2,999	11.5	4.6	40.2	34.1	25.7
3,000- 5,999	19.6	6.7	34.1	48.0	17.9
6,000- 9,999	20.2	6.8	33.9	44.9	21.2
10,000-16,999	19.6	6.6	33.7	46.8	19.4
17,000-29,999	13.3	3.6	26.7	49.1	24.2
30,000 & over	9.2	2.5	27.7	43.0	29.3
	100.0	33.6			
B. Annual per Capita Income					
<P= 250	4.9	2.5	50.7	36.9	12.4
250- 499	10.2	4.9	47.5	35.3	17.3
500- 999	21.7	7.8	35.8	48.2	16.0
1,000-1,999	28.0	9.4	33.6	44.4	22.1
2,000-3,499	19.3	5.7	29.4	48.1	22.5
3,500-6,999	11.3	2.6	23.0	43.8	33.2
7,000 & over	4.6	0.9	19.4	37.9	42.7
	100.0	33.8			

Source: FNRI, Second Nationwide Nutrition Survey. 1982.

TABLE 4

ENERGY ADEQUACY LEVEL BY OCCUPATION, 1982

Occupation of Head	% HH	Adequacy Level in Energy Intake <80%	80-109%	110% & over	Total
1. Professional, technical, entrepreneurs, skilled	17.0	30.6	44.7	24.7	100.0
2. Farm owners, managers	14.2	31.5	31.6	29.5	100.0
3. Farm workers	19.7	34.1	46.1	19.8	100.0
4. Fishermen (mostly small and hired)	8.6	36.4	49.0	14.6	100.0
5. Semi-skilled	28.3	36.4	44.9	18.7	100.0
6. Common laborers	1.1	40.0	42.0	18.0	100.0
7. Other	6.5	26.6	44.2	29.0	100.0
8. No occupation	4.7	36.1	38.6	25.2	100.0
Total	100.0				

Source: FNRI, Second Nationwide Nutrition Survey, 1982.

Of direct interest to the paper is the nutritional distribution across occupations (Table 4).

Considering that the first two occupations earn higher incomes, their rate of nutritional adequacy is higher as compared to the blue-collar groups: farm workers, fishermen, semi-skilled and unskilled workers. For these groups, more than one-third of their households are 20 percent undernourished in energy. Note, however, that the estimates are based on a uniform age-specific RDA standards, not adjusted for nature of activity. The RDA for persons engaged in heavy manualwork is higher. If in addition these workers suffer from parasites or infections, they would incur additional losses from their nutritional intake. On both counts the FNRI rate of inadequacy for the low income and blue-collar workers is likely to be underestimated.

The degree of undernutrition has been serious enough as to retard children's growth. In Table 5, we see that at least 20 percent of children from infancy to age 14 do not attain standard height and weight. Assuming that the cross-section data on height per age reflect the path of their development, the rate of retardation starts at infancy at about 20 percent and continues on at slightly increasing rate till adulthood. The table only gives data up to age 14 but Table 6 shows that the rate of undernutrition worsens during adolescence. This may mean that the rate of retardation continues and possibly worsens during the rest of the growth period or up to age 18.

Additional data on nutritional intake during the growth period are obtained from three surveys. The FNRI survey shows that within the family, children's intake is more inadequate than adults. Babies' energy intake is only 30.6 percent of RDA, and children from age 1 to 14 is on average less than 80 percent of their RDA. As RDA peaks during adolescence, intake appears not to rise commensurately. Consequently the rate of adequacy falls to about 76 percent among adolescents. As RDA declines in later ages, the adequacy rate rises reaching 91 percent, at age 50-59. For men it falls in old age despite lower RDA possibly because their relative value to the family as a source of income drops. In two small surveys, one in Metro Manila and one of rice farmers in Laguna, fathers generally have the highest adequacy rate, 83 percent and 88 percent, respectively. These surveys also show that adolescents of both sexes have the lowest adequacy rate, only 60 percent. Adult offsprings who might be working and contributing to family income have higher adequacy rate than practically all other offsprings. The pattern for protein intake is similar though the adequacy rate, on average for all groups is higher than for energy.[2]

Anthropometric measures were obtained from a rather small subsample of the FNRI sample and do not permit empirical analysis of the processes and determinants of retardation. We do know that the rate of undernutrition is higher among lower income and

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[2] For individuals who suffer from energy undernutrition, some of the protein consumed is used up as energy. The effective rate of adequacy for protein is therefore not directly indicatedby protein intake.

lower occupational classes. Moreover, sanitary facilities and medical care are not available to all, meaning they are less available to the poor. A consequence of the lack of sanitary facilities is the high incidence of parasites. The 1982 FNRI survey found that as much as 69.3 percent of the population has at least one kind of parasites; 51.6 percent has ascaris and 39.3 percent trichuris. Interacting with or working independently of undernutrition, they cause anemia and other nutritional health effects. Anemia incidence is 26.6 percent. It is higher for rural areas--28.1 percent versus 23.6 percent for urban--possibly because they have less sanitary facilities, be it water, toilets or garbage collection. Consistent with their relative adequacy infants and children up to age 12 have higher anemia incidence. 51.3 percent and 31.0 percent.

6. Health and Productivity

Evidence on health and productivity relation is weak (Baldwin and Weisbrod 1974, Popkin 1978, Gwatkin 1983). The data used in most studies are concurrent, i.e., health status now as determinant of productivity now. The latter is measured by work hours or output per unit time. Concurrent relationship is not likely to be conclusive since work time and leisure can be intertemporally substituted. If discrete work hours are set, those currently employed will work equal number of hours. But over time, the malnourished will tend to work less hours. During planting and harvesting seasons everybody works long hours. In other seasons, most farmers work less possibly to allow them to

ECONOMICS 11
Exercise 8
Theory of Comparative Advantage

Consider the following production possibilities for RP and Japan:

	RP		Japan	
	Rice	Robots	Rice	Robots
A	600	0	440	0
B	450	10	330	14
C	240	24	210	30
D	120	32	120	56
E	0	40	0	80

1. Which country has the absolute advantage in the production of both products? _____ Why? _____

_____

2. What is the comparative cost of Rice (RI) and Robots (RO) in both countries?

RP	Japan
1 unit RI = ____ units of RO	1 unit RI = ____ units of RO
1 unit RO = ____ units of RI	1 unit RO = ____ units of RI

3. Which country has the comparative advantage in rice? _____
in robot production? _____

4. Assume that prior to trade, both countries are producing at alternative C. What is the total gain in rice and robot output if the two nations decide to specialize and trade with each other?
Rice output gain _____ Robot output gain _____

5. What is the range of prices (in terms of $^{RI}/_{RO}$) where both nations will find trade beneficial?

lower occupational classes. Moreover, sanitary facilities and medical care are not available to all, meaning they are less available to the poor. A consequence of the lack of sanitary facilities is the high incidence of parasites. The 1982 FNRI survey found that as much as 69.3 percent of the population has at least one kind of parasites; 51.6 percent has ascaris and 39.3 percent trichuris. Interacting with or working independently of undernutrition, they cause anemia and other nutritional health effects. Anemia incidence is 26.6 percent. It is higher for rural areas--28.1 percent versus 23.6 percent for urban--possibly because they have less sanitary facilities, be it water, toilets or garbage collection. Consistent with their relative adequacy infants and children up to age 12 have higher anemia incidence, 51.3 percent and 31.0 percent.

6. Health and Productivity

Evidence on health and productivity relation is weak (Baldwin and Weisbrod 1974, Popkin 1978, Gwatkin 1983). The data used in most studies are concurrent, i.e., health status now as determinant of productivity now. The latter is measured by work hours or output per unit time. Concurrent relationship is not likely to be conclusive since work time and leisure can be intertemporally substituted. If discrete work hours are set, those currently employed will work equal number of hours. But over time, the mainourished will tend to work less hours. During planting and harvesting seasons everybody works long hours. In other seasons, most farmers work less possibly to allow them to

TABLE 5

PERCENTAGE OF POPULATION BELOW STANDARD HEIGHT PER AGE AND WEIGHT PER AGE 1982

		% Below Standard Weight per Age			
	% Below 90% Standard Height per Age 1982	1 9 7 6		1 9 8 2	
		Mild	Moderate & Severe	76-90%	<75%
< 1	20.0	30.5	17.9	34.3	11.3
1	23.7	41.8	38.0	53.6	30.3
2	21.1	49.7	25.8	52.3	21.1
3	20.2	50.2	22.6	54.5	16.2
4	18.1	55.7	13.6	54.4	12.9
5	21.8	56.4	15.9	56.8	13.2
6	19.3	42.4	22.1	52.8	14.4
				<80%	<70%
7	22.0			33.2	10.1
8	23.2			36.1	9.8
9	20.7			41.6	12.5
10	23.6			50.5	16.7
11	26.3			57.3	22.3
12	29.0			57.4	25.1
13	27.8			50.8	26.3
14	23.8			46.2	24.6

Source: Food and Nutrition Research Institute, Nationwide Nutrition Survey, 1978, 1982.

TABLE 6

RDA (ENERGY) AND RATIO OF INTAKE TO RDA
BY AGE AND SEX, 1982

Age Group	RDA (Energy) Male	RDA (Energy) Female	Intake as of RDA-Energy (%) Male	Intake as of RDA-Energy (%) Female
6-11 months	970		30.2	
1- 3 years	1,310		65.3	
4- 6 years	1,640		78.3	
7- 9 years	1,870		78.7	
10-12 years	2,270	2,170	76.1	68.0
13-15 years	2.510	2,200	75.1	75.9
16-19 years	2,700	2,060	76.6	74.5
20-39 years	2,580	1,920	82.3	81.9
40-49 years	2,450	1,820	79.0	87.8
50-59 years	2,320	1,730	91.4	87.6
60-69 years	2,060	1,540	84.4	91.2

Source: Gracia M. Villavieja et al., "Intrafamily Distribution of Dietary Intake in Luzon," FNRI Research Seminar, July 1983.

recoup energy losses in the former seasons. Productivity losses due to ill health may only be observable longitudinally and not concurrently.

It is also argued that the strength of the health-productivity relation will depend on the nature of work and its capacity requirement. In jobs whose capacity requirement exceeds the capacity of the worker, lifetime work hours and work intensity will tend to be lower than in the opposite cases where the capacity requirement is relatively low. In the present context, manual or blue-collar occupations likely include more jobs where the capacity requirement exceeds capacity supply. We obtained data of hours worked by wage workers for three occupations: professionals, blue-collar, agricultural from the Bicol Multipurpose survey[3] during the reference week. professional labor generally worked longer than the other two groups of labor. Agricultural labor worked about two-thirds the professionals at every age range. And they worked fewer days or about 4 days versus 5 days. Of the blue-collar workers, 63 percent worked less than the professional labor. Note, however, that the data are for those who worked for wage and form only a small proportion of the Bicol sample or 9 percent. The observed short hours worked by the manual workers could be demand determined. They could also be a response to a low wage rate. Alternatively, the data might be supportive of the argument that

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[3] This is an accompanying study of the Bicol River Basin Integrated Development Program.

ill health and nutrition-caused HB underdevelopment may have caused the shorter hours worked by manual workers. To the extent their capacity is below the standard. Their productivity also falls below standard.

TABLE 7

AVERAGE NUMBER OF HOURS WORKED IN REFERENCE WEEK
BY PRIMARY OCCUPATION

	White		Blue		Agriculture		Ratio: Hours Worked	
	Hours	Days	Hours	Days	Hours	Days	Blue White	Agri. White
15-20	41.44	6.10	35.43	5.15	21.08	3.02	85.5	50.9
21-25	42.03	5.86	35.39	5.26	26.47	4.10	84.2	13.0
26-30	44.06	5.52	45.10	5.44	30.51	4.38	102.4	69.3
31-35	42.90	4.85	36.53	5.00	27.25	4.08	85.2	63.9
36-40	52.75	6.10	39.26	5.07	31.48	4.13	74.4	59.7
41-45	39.93	5.73	45.33	5.94	36.00	4.34	113.5	90.2
46-50	34.46	5.46	50.12	5.88	28.18	4.43	145.5	81.8
51-55	37.28	5.19	30.33	5.50	21.17	3.35	81.4	56.8
56-60	35.71	4.57	38.10	4.60	24.70	3.23	106.7	69.2
61-65	22.0	4.67	42.80	5.00	30.17	4.17	194.6	137.1

Source: File of Bicol Multipurpose Survey, 1978.

7. Concluding Remarks

When we think about the future we inescapably think of the changes in our health and biological make-up for it determines our earning capacity and our needs. By needs we mean the utility function. The preference ordering among goods, services and activities at each time period t, and the time preference for each good or activity (leisure-work) do change as HB status in the future changes. Changing health therefore implies changing taste and thanging demand structure. A healthy population with a longer life span would have a different saving rate, demand for health care and leisure activities from a population of poorer health.

Productivity definitely follows the cyclical path of HB. The paper argued that achieved HB is determined by health inputs which in many LDC situations fall below standard requirements. Generally an inferior HB implies or results in lower capacity for work. It will result in a reduced labor productivity when the capacity requirement of a job exceeds the worker's capacity. A worker of below standard HB may be as productive as a very health one in an unstraneous job. An underdeveloped worker or one of short height and small body size can be as productive as a six footer weighing 200 pounds in highly mechanized jobs which require little physical exertion. This expiains why Filipino workers in American military construction work do very well. We therefore need to look at both capacity requirement and capacity supply in analyzing health effects on productivity.

The paper also argued that concurrent health productivity relation may not be observable since intertemporal substitution of energy intake and expenditure may be made. A worker may decide to bunch his work activity for a period of time incurring energy deficits which he intends to replenish in a later period.

Data collection of nutritional intake health and productivity has not been oriented to lend support to life cycle or even a short intertemporal relationship. The data presented merely point out to features of HB underdevelopment in the Philippines. There is evidence that Filipinos, on average, attain at most 80 percent of standard height per age and even lower standard weight per age. The latter means that those of below standard height are also undernourished for that height. Their physical capacity is impaired and they would show relatively low productivity in heavy manual jobs such as agriculture. We did find out that on the whole hours worked in this sector was much lower than in white-collar occupation. The data are, however, still very inadequate.

References

Baldwin, R. and B. Weisbrod, 1974. "Disease and Labor Productivity." EDCC, 22/3.

Birren, James E., M. A. Josep, H. T. Munnicks and M. Marois, 1986. Aging: A Challenge to Science and Society. Oxford University Press, Oxford, New York, Toronto.

Chown, Sheila M, 1986. "Profiles of Abilities" In Birren, et al.

Dayton, D., 1969. "Early Malnutrition and Human Development." Children 16, November-December.

Florencio, Cecilia A. "Where Lies the Value in Nutrition: Conceptual and Contextual Difficulties" In Policy Issues on Nutrition and Welfare.

Gwatkin, Davidson R., 1987. "Does Better Health Produce Greater Wealth: A Review of the Evidence Concerning Health, Nutrition and Output." Manuscript.

Habicht, J. et al., 1974. "Height and Weight Standards for Preschool Children, How Relevant are Ethnic Differences." Lancet. April.

L'hayfich, 1988,

S. R. Osmani, 1987. "Controversies in Nutrition and their Implications for the Economics of Food." WIDER WP 16, July

Policy Issues on Nutrition and Welfare, 1987. University of the Philippines, Los Banos. Policy Working Group, Center for Policy and Development Studies, UPLB, College, Laguna.

Popkin, Barry M., 1978. "Nutrition and Labor Productivity." Social Science and Medicine, Vol. XIIC No. 3/4.

Reyes, Edna A. and Oscar Picazo, 1989. "Health Manpower in the Philippines." Paper presented in International Health Policy Conference, 31 July-4 August, Manila Hotel.

Scrimshaw, Nevin, Carl E. Taylor, John E. Gordon, 1968. Interactions of Nutrition and Infections. Geneva: WHO.

Svedberg, Peter. "A Model of Nutrition, Health and Productivity."

Villavieja, Gracia et al., 1983. "Intrafamily Distribution of Dietary Intake in Luzon," FNRI Research Seminar, July.

Data Sources

Food and Nutrition Research Institute, 1978, 1982. Nationwide Nutrition Survey.

The Ministry of Health, 1981. National Health Survey.

National Economic and Development Authority, 1987. Philippine Statistical Yearbook.

1977 Bicol Multipurpose Survey Computer File.