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OUTPUT, CAPITAL, LABOR AND POPULATION: PROJECTIONS FROM THE SUPPLY-SIDE

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In the following, projections are made of output, capital, and labor in the context of future Philippine population growth up to the year 2000. Economists should probably keep out of projections too far out in time. A more complicated analysis should bring in more factors and their interrelationships. A general equilibrium treatment would require much work for which we have no time at the moment. We shall confine ourselves to what we feel are reasonable hypotheses of orders of magnitudes. We hope they are indeed better than mere conjectures.

Projections are not forecasts. Forecasts are predictions from structural equations describing a specified economic system. These equations are based on more sophisticated assumptions about basic interrelationships among certain variables,

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often derived from more direct estimates of certain parameters computed from actual data. In cases of very long run periods into the future, probably the safest figures one could make are simple projections. Very often, forecasts are made only for shorter periods in the future -- one or two years. So, even forecasts will be on foreign ground when dealing with the longer run future.

There are essentially two different approaches that can be used in making very long run projections. One approach is to capitalize on making estimates of requirements on the demand side. This involves making estimates of the orders of magnitudes of, say, output and capital requirements that a growing population requires from period to period. The second approach is to examine the supply side. Estimates are made of how much output results from a growing labor force and a required growth of the capital stock from period to period.

We shall concentrate on the estimation of projected magnitudes from the supply side. To do this, we need an aggregate production function model of the economy. Since the period of the future considered is very long, we shall incorporate the possible effects of technological progress on the growth of output.

Assume that total output is producible under a production function at any time t, described by

$$Q(t) = A(t)\, F\, [K(t),\, L(t)]$$

where Q is total output, A is a time dependent productivity index, and F is the production function having as arguments capital (K) and labor (L).[1] If F is a Cobb-Douglas production function with constant returns to scale, we can write the production function as

$$Q(t) = A(t)\, K(t)^{\alpha}\, L(t)^{1-\alpha}.$$

Transforming into logarithms, we have

$$\ln Q(t) = \ln A(t) + \alpha \ln K(t) + (1-\alpha) \ln L(t),$$

and taking rates of change with respect to time, we have the familiar result

$$\Delta Q_t / Q_t = \Delta A_t / A_t + \alpha\, \Delta K_t / K_t + (1-\alpha)\, \Delta L_t / L_t .$$

Thus, the rate of growth of output ($\Delta Q/Q$) is equal to the growth of technical progress ($\Delta A/A$), the growth of labor ($\Delta L/L$), and of capital ($\Delta K/K$). Technical progress ($\Delta A/A$) is of the neutral (i.e., "disembodied") type, following Solow's early version.[2]

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[1]The productivity index A defines any shift of the production function and this constitutes "technical change" of any kind such as improvements in capital, in labor, and in the general environment.

[2]Neutral technical change or shift in the production function leaves the marginal rate of substitution between factors K and L constant, i.e., with given inputs, output either increases or decreases with technical change. The simplifying assumption of disembodied technical progress means that improvements do not need to be embodied in new capital or do not require

Technical change is estimated as a residual when $\Delta Q/Q$, $\Delta K/K$, $\Delta L/L$ and α are known. In the problem that we shall be considering, a first approximation is to make reasonable limits about α and the rates of growth of labor and of capital.

Given (1) some value of α, (2) an approximate growth of the labor input (even when some assumptions are made regarding non-employment of the total labor force), (3) alternative growth rates of capital, and (4) some notion of the neutral impact of technological change, it is possible to make projections of the total growth of output.

Capital

Let K_t be capital stock at time t. Net additions to capital in time t, is ΔK_t. The growth of capital is given by

$$K_t = K_o e^{rt}$$

where K_o is the initial value of capital, r the rate of growth of the capital stock, and t time in years. The rate of growth of capital, r, may be written as

$$r = \Delta K/K .$$

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new capital. See R. Solow, "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics*, vol. 39, no. 3 (August 1957), pp. 312-320. Solow's method of estimating neutral technical change varies slightly from the one described below.

Multiplying this equation by Y/Y and arranging and eliminating terms, we get

$$r = \Delta K/Y \cdot Y/K.$$

Putting K on the left-hand side of the equation, we have

$$K = \Delta K/Y \cdot Y/r.$$

This equation will be used in arriving at the initial value of the capital stock under varying assumptions. At the initial year t=o, the national income series will give the value of Y_o, the ratio $\Delta K/Y$, and r can be assumed. K_o is therefore easily derivable.

No known capital stock series exists for the Philippines,[3] and therefore it is necessary for us to get a capital stock value at a given year. Since the concern of this paper is to make very long run projections of economic magnitudes, obtaining a benchmark of the capital stock is all that is needed. Anyway, the projections here are not critically dependent on any benchmark figures as much as they are on the rates of change parameters assumed.

Once we start getting the value of the proportion of net product, Y, going to investment, or $\Delta K/Y$, some data limitations

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[3]Richard W. Hooley is presently engaged in this research so that in the future this statistical void will be filled up.

ought to be put to mind. First, the national income series for investment are very poor estimates. Therefore, we cannot fully rely on their value. Second, it is well known that because of estimation peculiarities, even the levels of national product, GNP, may not be good indicators of output levels.[4]

In the estimates of K_o, we shall assume that the output figure used, which is the "net domestic product,"[5] is beyond question. The following demonstrates the manner in which $\Delta K/Y$ and Y/K were computed.

For simplicity, we assume that net saving equals net investment. We use the net investment and net domestic product between 1951 to 1960 as the respective magnitudes for ΔK and Y. Therefore,

$$\sum_{1951}^{1960} \Delta K_t = \Delta K$$

and

$$\sum_{1951}^{1960} NDP_t = Y.$$

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[4]See G.P. Sicat, "On the Accuracy of Philippine National Income Accounts,"*The Philippine Review of Business and Economics*, vol. 1, no. 2 (October 1964), pp. 21-39.

[5]Net domestic product is simply net national product (NNP) minus net factor incomes from abroad.

Using Hooley's net domestic saving[6] and capital consumption figures (see Table 1), the value of $\Delta K/Y$ is .0775.

The value of Y/K will be assumed. But reasons have to be put forward for these assumptions. Suppose we begin with estimates of the net incremental capital-output ratio, or the ICOR. Table 2 are estimates made by the first author of the ICOR, based on different assumptions about the nature of the magnitude of the growth of capital in the Philippines. These assumptions are too complicated to spell out in this paper.[7] Suppose the ICOR is equal to the capital-output ratio, that is,

$$\Delta K/\Delta Y = K/Y.$$

Then, Y/K is the inverse of the ICOR. Corresponding roughly with the estimates shown on Table 2, we shall use the following values of Y/K:

$$(Y/K)_1 = 0.50$$
$$(Y/K)_2 = 0.60$$
$$(Y/K)_3 = 0.75$$

The above assumptions will give three different values of the growth of capital, r, from the equation

$$r = (\Delta K/Y)(Y/K).$$

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[6] This figure does not include transactions in the rest-of-world sector.

[7] See G.P. Sicat, *Some Aspects of Capital Formation in the Philippines*, unpublished Ph.D. Thesis, Massachusetts Institute of Technology, 1963, Chapter 3.

Table 1

DERIVATION OF ΔK/Y VALUE

Year	GDP at current market prices[a] (Million ₱)	Capital consumption allowances[b] (Million ₱)	NDP at current market prices[c] (Million ₱)	Net Savings[d] [= Net Investment (ΔK)] (Million ₱)
1951	7415	380.2	7034.8	331.7
1952	7576	404.5	7171.5	503.5
1953	8111	430.1	7680.9	526.4
1954	8283	470.5	7812.5	350.8
1955	8820	517.4	8302.6	459.1
1956	9537	574.1	8962.9	751.3
1957	10119	629.4	9489.6	947.0
1958	10779	687.2	10091.8	892.8
1959	11506	728.8	10777.2	1009.7
1960	12138	782.1	11355.9	1102.5
			$\sum_{1951}^{1960}$ = ₱ 88679.7	$\sum_{1951}^{1960}$ = ₱ 6874.8

$$\Delta K/Y = \sum_{1951}^{1960} (4) \Big/ \sum_{1951}^{1960} (3) = .0775$$

[a] U.N., *Yearbook of National Accounts Statistics*, 1957, p.185; [illegible], p. 212.

[b] Richard W. Hooley, *Savings in the Philippines, 1951-1960*, Table A-1, p. 74.

[c] Column (1) - Column (2) = Column (3).

[d] Hooley, *op. cit.*

Table 2

SOME ESTIMATES OF INCREMENTAL CAPITAL OUTPUT[a]

(Average, 1949-1958)

$ICOR_i$	Current Price	Inverse	Constant Price	Inverse
$ICOR_1$	1.34	.75	1.06	.94
$ICOR_2$	1.40	.71	1.18	.85
$ICOR_3$	1.66	.66	1.31	.76
$ICOR_4$	1.82	.55	1.43	.70
$ICOR_5$	2.06	.48	1.77	.56

[a]These are estimates of the first author.

Moreover, three different values of the initial capital stock, K_o, in 1960 will also be found from the equation

$$K_o = (\Delta K/Y)(Y_o/r),$$

when Y_o is known from the income series and the three different values of r derived from the above assumptions are used.

Table 3 shows the computation of the initial value of the capital stock in 1960 prices. Table 4 shows the projected value of capital in the future in terms of 1960 prices. There are changes in the estimates of the capital stock series after 1980 especially for those assumptions where the Y/K is initially higher than 0.50. These latter two assumptions imply that the capital-output ratio is lower than 2. In general, it is not maintainable that over long periodsthe overall capital-intensity of productive processes will not increase. This is especially more untenable with those projections based on low capital-output ratios (i.e., relatively higher Y/K). To correct for this, the series for K_{t2} and K_{t3} were adjusted so that, after 1985, the rate of growth of capital needed to sustain relatively the same amount of output in earlier years had to increase.

Something should be said about the nature of <u>prices</u> used in these projections. We naturally suppose that all prices

Table 3

ALTERNATIVE INITIAL CAPITAL (K_o) VALUES

$(Y/K)_i$	$(\Delta K/K)_i = r_i$	Y_o/r_i	$K_{o_i} = (Y_o/r_i)(\Delta K/Y)$ (Million ₱)
$(Y/K)_1 = .50$	.0388	293,055.5	22711.8
$(Y/K)_2 = .60$	.0465	244,212.9	18926.5
$(Y/K)_3 = .75$	.0581	195,387.1	15142.5

Note:

$Y_o = Y_{1960}$ = NDP at current market prices = ₱11,355.9 million.

Table 4

QUINQUENNIAL CAPITAL SERIES, 1960-2000

(Million ₱)

Year	t	K_{t_1} $(= K_{o_1} e^{r_1 t})$	K_{t_2} $(= K_{o_2} e^{r_2 t})$	K_{t_3} $(= K_{o_3} e^{r_3 t})$
1960	0	22711.8	18926.5	15142.5
1965	5	27567.0	23880.5	20249.2
1970	10	33461.9	30131.9	27078.6
1975	15	40614.4	38019.0	36211.8
1980	20	49299.4	47969.2	48424.5
1985	25	59837.1	60525.4	64757.1[b]
1990	30	72630.6	76369.4[a]	81707.3[c]
1995	35	88159.3	92695.3[a]	99174.3[c]
2000	40	107006.6	112516.9[a]	120381.4[c]

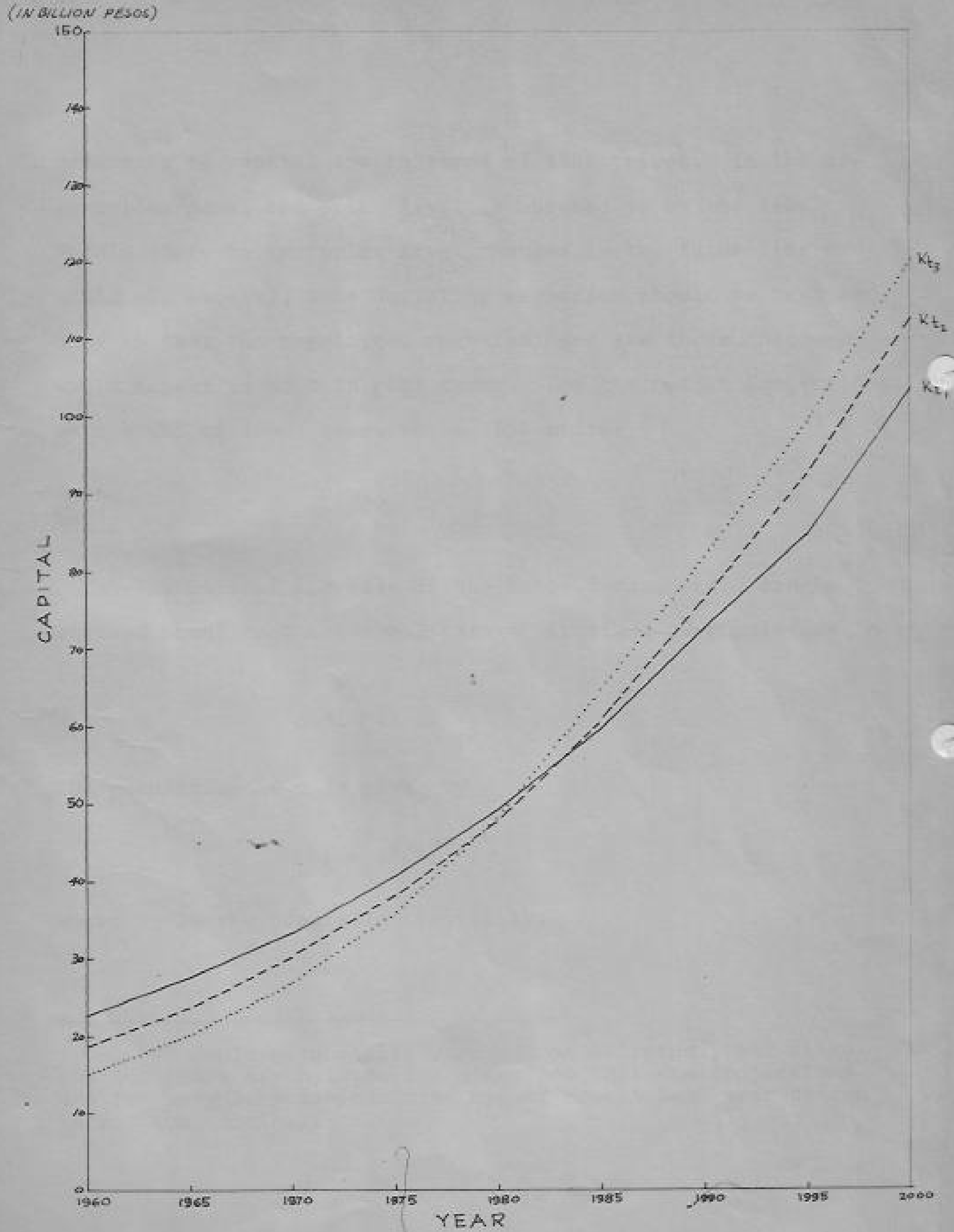
[a] $K_{1985_2} e^{r_1 t}$, t = o for 1985

[b] $K_{1980_3} e^{r_2 t}$, t = o for 1980

[c] $K_{1985_3} e^{r_3 t}$, t = o for 1985

Figure I

QUINQUENNIAL CAPITAL SERIES
(1960 — 2000)



referring to capital are in terms of 1960 prices. In the assumptions made, the price level is assumed to be the same. Should there be any price level changes in the future (as we would all expect), some deflating mechanism should be kept in mind so that the magnitudes revealed here are those that one would expect to hold in <u>real</u> terms. For the output projections, we use GNP of 1960, measured in 1955 prices.[8]

Labor

The rate of increase of the labor force, $\Delta L/L$, can be assumed equal to the natural rate of increase of population, n, i.e.,

$$\Delta L/L = n.$$

The population at t is given by

$$P_t = P_o e^{nt} ,$$

where P_o is the population initially.

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[8]We could have easily used common deflators, but since the two years are not too far apart and that the projections are for very long periods, the use of common base year prices is not too critical.

Our labor projection shall be based on the "modal" population projection (i.e., Hypothesis C) of Lorimer.[9] His three projections have the same assumption of a moderately declining mortality rate. They differ though in the assumption regarding fertility rate. Hypothesis A assumes a constant fertility rate (that of 1960), Hypothesis B assumes a sharp decline of fertility rate through 1970 and a sharper decline from 1975 through 2000, and Hypothesis C assumes an average of the fertility rate assumptions of Hypotheses A and B.

Let us focus our attention on the population projection for Hypothesis C. Due to the nature of the mortality and fertility rates assumptions, the rate of growth of population taken as the difference between the birth rate and the death rate varies quinquennially as shown in column 2, Table 6. Likewise an exponential rate of growth such as n computed from the population projection is shown by column 3 of the same table.

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[9]Dr. Lorimer made population projections based on the 1960 census returns in connection with a monograph that the Population Institute, University of the Philippines intends to publish by the end of 1965.

Table 5

POPULATION PROJECTIONS[a]

(1960-2000)

Year	TOTAL POPULATION (thousand)		
	(Hypothesis A)	(Hypothesis C)	(Hypothesis B)
1960	27087.7	27087.7	27087.7
1965	31846.4	31846.4	31846.4
1970	37671.2	37402.2	37133.6
1975	44776.0	43872.1	43022.9
1980	53414.8	51406.8	48978.1
1985	63905.4	60144.5	55001.1
1990	76654.0	69800.2	61000.9
1995	92169.2	80281.5	66794.1
2000	111138.8	91683.5	72732.7

[a]In these projections of Dr. Frank Lorimer, his 3 hypotheses have the same assumption of a moderately declining mortality rate but differ in the fertility rate assumption: hypothesis A - constant fertility rate as of 1960, hypothesis B - sharp decline of fertility rate through 1970 and a sharper decline from 1975 through 2000, and hypothesis C - average of fertility rate assumptions of hypotheses A and B.

Figure II

POPULATION PROJECTIONS
(1960 - 2000)

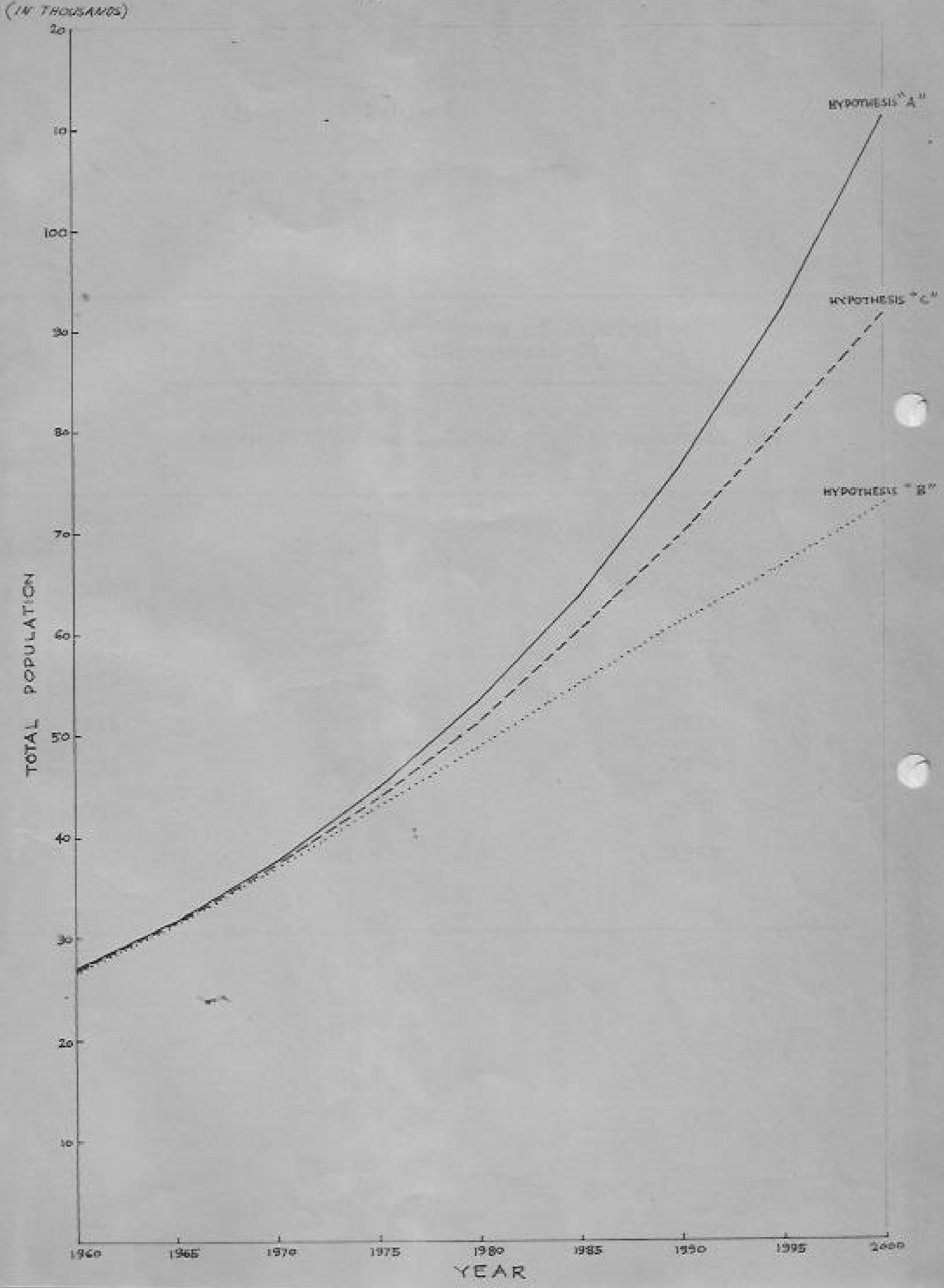

Table 6

RATES OF GROWTH OF POPULATION

(1)	(2)	(3)
	Rate of Growth of Population (Hypothesis C)	
Year	(Birth Rate - Death Rate)	Exponential Rate of Growth
1960-1965	.0340	.0324
1965-1970	.0323	.0322
1970-1975	.0320	.0319
1975-1980	.0318	.0317
1980-1985	.0317	.0314
1985-1990	.0314	.0298
1990-1995	.0297	.0280
1995-2000	.0265	.0266

Labor force in the Philippines is usually defined as the number of persons 10 years and over who are actually at work or seeking work during a specified time. Therefore for each five-year age-grouping (10 years and over) there corresponds a labor force participation rate which indicates the percentage of the total number of persons in that age class that belongs to the labor force. The age specific labor force participation rates for the Philippines based on 1960 Census returns are shown in Table 7. To compute for the labor force at other times these participation rates are applied to the population series by sex-age classes.

On the basis of this projection the exponential rates of labor force growth are computed for successive quinquennials.[10] Within the period under consideration the rates of labor force growth are fairly constant, more so than the rates of population growth. This is due to the lag in the influence of changes in fertility on the trend of the adult population, as contrasted with total numbers, including children. So the assumption of a constant labor force growth rate involves relatively small error, and it greatly simplifies the analysis. We then assume that $n = \Delta L/L$ has a constant value, namely .032.

[10]See column 5 of Table 8.

Table 7

AGE SPECIFIC LABOR FORCE PARTICIPATION RATES, 1960 CENSUS

Age Group	Age Specific Labor Force Participation Rate (%)		
	Male	Female	Both
10-14	19.8	10.1	15.2
15-19	59.3	29.6	44.4
20-24	80.8	28.9	54.3
25-29	91.3	26.1	57.9
30-34	94.5	26.3	59.7
35-39	95.5	26.8	79.7
40-44	95.4	27.9	61.2
45-49	95.1	28.9	62.4
50-54	93.6	29.0	61.8
55-59	91.7	28.3	60.7
60-64	86.4	25.5	58.5
65 and over	66.8	21.2	43.7
TOTAL	71.1	24.4	47.8

Source: 1960 Census returns used for computation by the Population Institute, University of the Philippines.

Table 8

LABOR FORCE PROJECTION

(1960-2000)

(1)	(2)	(3)	(4)	(5)
Year	'Labor Force (thousand)			Exponential Rate of Growth of Labor Force
	Male	Female	Both	
1960	6421.2	2178.2	8599.4	
1965	7582.9	2561.0	10143.9	.0330
1970	8978.2	3021.7	11999.9	.0336
1975	10647.1	3574.2	14221.3	.0340
1980	12622.1	4227.9	16850.0	.0339
1985	14933.8	4986.2	19920.0	.0335
1990	17622.0	5865.5	23487.5	.0329
1995	20733.3	6885.6	27618.9	.0324
2000	24291.8	8043.9	32335.7	.0315

Output

Output Q_t shall be defined by the equation

$$Q_t = Q_o e^{mt}$$

where Q_o is the initial value of output, m is $\Delta Q/Q$, and t time in years.

The initial value of output (Q_o) is GNP (at 1955 prices) for year 1960. As for the rate of growth of output (m), an upper and lower value of .05 and .04 are assumed.[11] On the basis of these assumptions we have two output projections shown in Table 9.

α-Value

The elasticity of output with respect to capital, α, in the Cobb-Douglas production function implies the distribution of output in general. In an earlier study of the projection function for manufacturing in the Philippines the value of α = 0.70. In the US, the value of α = 0.35 has often been mentioned.

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[11]Using the formula

$$m = \Delta Q/Q = \sum_{1951}^{1960} (Q_{t+1} - Q_t) \Big/ \sum_{1951}^{1960} Q_t$$

Considering the very long run nature of the projections and our ignorance of the future, we shall just make three assumptions about α, which appear reasonable for the Philippines. These three values are:

$$\alpha_1 = 0.60$$

$$\alpha_2 = 0.50$$

$$\alpha_3 = 0.45$$

These values of α give relatively more weight to the share of capital than to labor. Capital will be a relatively more scarce factor than labor in the Philippines. The demographic factors determining the growth of the labor force are pretty well set by noneconomic forces. The more important variable for the growth of output, aside from technical progress, is the growth of the capital stock. Economic forces will determine the distribution of output between the two major inputs in the production function, capital and labor.

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where Q is GNP at 1955 prices, m = .0487.

The value of m is .0505 when it is computed according to

$$Q_t = Q_o e^{mt}$$

where Q is also GNP at 1955 prices from 1951 to 1960.

So on the basis of these historical m's our assumed values for m cover the range well enough.

Table 9

OUTPUT PROJECTIONS

(1960-2000)

Year	OUTPUT (Million ₱)	
	m_1 = .05	m_2 = .04
1960	10804.0	10804.0
1965	13872.3	13196.0
1970	17812.6	16117.4
1975	22872.1	19686.0
1980	29368.5	24044.3
1985	37709.2	29368.5
1990	48420.3	35870.4
1995	62172.7	43812.4
2000	79831.8	53512.2

Synthesis

The original equation

$$\Delta Q/Q = \Delta A/A + \ \Delta K/K + (1 - \alpha)\ \Delta L/L$$

can be simplified to look as follows:

$$m = X_T + \ \alpha r + (1-\alpha)n.$$

The only term which has not been discussed at length is X_T (= $\Delta A/A$), which stands for the rate of disembodied technical progress. It is easily derived as a residual given the estimates or assumptions about m, α, r, and n. Therefore,

$$X_T = m - \alpha r - (1-\alpha)n.$$

Summarizing, the following are the alternative assumptions about rate of growth of income (m), elasticity of output with respect to capital (α), rate of growth of capital (r), and rate of growth of labor (n):

m_i	s	r_t	n
m_1 = .05	α_1 = .60	r_1 = .058	.032
m_2 = .04	α_2 = .50	r_2 = .046	
	α_3 = .45	r_3 = .039	

Their different combinations will yield different X_T's as shown in Table 10. The X_T values range from .0148 to zero.[12]

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[12]It is plausible to assume that $X_T \geq 0$. A negative value of X_T implies a degenerate technical change. Total output falls because of adopting new technology. This is a situation which is hardly economically rational.

Table 10

RATE OF TECHNICAL PROGRESS ($X_{m_i \alpha_s r_t n}$) MATRIX

$[\alpha_s r_t + (1-\alpha_s)n]$ \ m_i	$m_1 = .05$	$m_2 = .04$
$[\alpha_1 r_1 + (1-\alpha_1)n]$ = .0476	.0024	(.0076)*
$[\alpha_1 r_2 + (1-\alpha_1)n]$ = .0404	.0096	(.0004)*
$[\alpha_1 r_3 + (1-\alpha_1)n]$ = .0362	.0138	.0038
$[\alpha_2 r_1 + (1-\alpha_2)n]$ = .0450	.0050	(.0050)*
$[\alpha_2 r_2 + (1-\alpha_2)n]$ = .0390	.0110	.0010
$[\alpha_2 r_3 + (1-\alpha_2)n]$ = .0355	.0145	.0045
$[\alpha_3 r_1 + (1-\alpha_3)n]$ = .0437	.0063	(.0037)*
$[\alpha_3 r_2 + (1-\alpha_3)n]$ = .0383	.0117	.0017
$[\alpha_3 r_3 + (1-\alpha_3)n]$ = .0352	.0148	.0048

*Equal to zero by assumption.

Instead of working at the problem as if we know m, or how total output will grow, let us assume that the rate of technical progress, X_T, is known. Depending on the value of α assumed, we may get different values of X_T. In the US, the rate of technical progress (X_T) has been estimated to be from 1.7 to 2.5 per cent per year, depending on the assumptions about the elasticity of output with respect to capital (α) and the rate of growth of output (m).[13] Let us just assume that, given our earlier assumptions about α, r, and n, the rate of technical progress (X_T) takes on different values, which we label with adjectives designed to convey our guesses:

optimistic:	X_1	=	.020
"modal" :	X_2	=	.015
	X_3	=	.010
pessimistic:	X_4	=	.000.

These assumptions about X_T are independent of the way the values of α, n, and r are determined.

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[13]See R. Nelson, "Aggregate Production Functions and Medium-Range Growth Projections," *American Economic Review*, vol. 54, no. 5 (September 1960), p. 589.

Our alternative assumptions then are the following:

X_T	α_s	r_t	n
X_T = .020	α_1 = .60	r_1 = .058	.032
X_T = .015	α_2 = .50	r_2 = .046	
X_T = .010	α_3 = .45	r_3 = .039	
X_T = .000			

Table 11 shows the rate of growth of output (m) matrix. For positive X_T's, m values range from .0676 to .0452. When there is no technical change (X_T = 0) and the elasticity of output with respect to capital (α) and the rate of growth of capital (r) are lowest, the rate of growth of output (m) reaches its lowest value of .035. It may well be that this already very low growth rate of 3.5 per cent per annum is too low. In relative terms, this is slightly higher than the natural growth rate of the population. In short, the most pessimistic result still makes it possible to have a positive, but very small growth of per capita income. However, judged from the said magnitude, this is almost equivalent to economic stagnation.

Potential Output

The preceding discussion was on output of the economy without indication as to whether the level is that of full-

Table 11

RATE OF GROWTH OF OUTPUT ($m_{X_T a_s r_t n}$) MATRIX

$[a_s r_t + (1-a_s)n]$ \ X_T	$X_1 = .020$	$X_2 = .015$	$X_3 = .010$	$X_4 = .000$
$[a_1 r_1 + (1-a_1)n] = .0476$	.0676	.0626	.0576	.0476
$[a_1 r_2 + (1-a_1)n] = .0404$	.0604	.0554	.0504	.0404
$[a_1 r_3 + (1-a_1)n] = .0362$	.0562	.0512	.0462	.0362
$[a_2 r_1 + (1-a_2)n] = .0450$	.065	.060	.055	.045
$[a_2 r_2 + (1-a_2)n] = .0390$	.059	.054	.049	.039
$[a_2 r_3 + (1-a_2)n] = .0355$	.0555	.0505	.0455	.0355
$[a_3 r_1 + (1-a_3)n] = .0437$	.0637	.0587	.0537	.0437
$[a_3 r_2 + (1-a_3)n] = .0383$	.0583	.0533	.0483	.0383
$[a_3 r_3 + (1-a_3)n] = .0352$	.0552	.0502	.0452	.0352

employment or not. In other words, the projections of output referred to are actual output. The concept of output at productive capacity, i.e., potential output, is helpful for policy considerations. The potential output projections are related to an employment concept, which is deemed desirable as a policy objective.

Okun has devised a method of measuring potential output.[14] Full-employment in terms of labor is defined as an acceptable or "desired" level of unemployment (set at 4 per cent per year). His approach assumes that the unemployment rate variable incorporates all the ways in which idle resources affect output such as the effect of the level of economic activity on average hours worked, labor force participation and manhour productivity.

We shall use Okun's method as a first approximation of potential output in the Philippines. How good such an approximation would be depends on how close the "desired" unemployment rate of labor assumed approaches capital full-employment. This is determined by the substitutability of labor for capital.

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[14]A. Okun, "Potential GNP: Its Measurement and Significance," American Statistical Association Proceedings Business and Economic Statistical Section, 1962, pp. 98-104.

Given the capital stock, the greater the extent of this substitutability the more it is possible to assume a higher rate of employment of the labor force.

Due to the extreme paucity of useful data, we shall be much more imprecise in applying Okun's method of measuring potential output. Whereas Okun's guesses were based on actual computations, the guesses offered here are largely subjective a priori guesses of the first author.

Following Okun (but altering his notation to suit ours), let

Q_A actual output

Q_P potential output

η employment rate

η_F potential employment rate where $\eta_F = 100 - U^*$

U^* being the rate of unemployment which is considered a desirable minimum

μ rate of growth of Q_P

Okun shows that

$$\log \eta_t = \log (\eta_{Ft}/Q_{Po}) + \beta \log Q_{At} - (\beta\mu)t$$

can be derived as a regression equation and yields parameters Q_{Po} (given η_F) and β, which is the elasticity of output with respect to the employment rate. Given data about employment rate (η) and actual output (Q_A), β can be estimated. We have data on Q_A (NNP or GNP), but the series for η is not reliable. In view of this, we shall not estimate β but make assumptions about its value.

Okun reports a "subjectively weighted average" value of β = 3.2 per cent (i.e., in pure number, 0.032). In his model where "desired unemployment" is equal to 4 per cent (for the U.S.), he shows that given his estimate,

$$Q_P = Q_A [1 + 0.032 (U - 4)]$$

where U is the existing unemployment rate.

In our case, let U* be the tolerable unemployment rate of the labor force, so that U - U* is the actual unemployment rate of the economy. Thus we have the equation

$$Q_P = Q_A [1 + \beta (U - U^*)]$$

If $U = U^*$, then $Q_P = Q_A$, i.e., potential output is equal to actual output at the unemployment rate U. If $U > U^*$, potential output will be larger than actual output, or $Q_P > Q_A$. If $U < U^*$, then $Q_P < Q_A$. All the above is evident from the equation.

Since what we need is employed labor, our labor force projection is not sufficient. This is where the major difficulty lies; the employment series in the Philippines is highly unreliable and it does not begin until 1956. Because of changes in sample size and other difficulties traceable to concepts used, the series (which is based on sample surveys of the labor force) reflects a very highly irregular pattern of unemployment. However, making an assumption about the level of employment is better than giving up entirely. This assumption can be based on an average unemployment figure taken from the available series.

Let

η_1 = employment rate with underemployed not considered employed

η_2 = employment rate, with the underemployed given a weight of 1/2 compared to the employed.

Philippine labor force statistics in Table 12 yield some light on the reasonable magnitude of U.

A rough interpretation of the data gives us some likely magnitude of the value of η_1 and η_2. Thus, an approximation of these magnitudes is that over 1957-62,

η_1 = 88-85 per cent so that

$U_1 = 100 - \eta_1$ = 12 to 15 per cent

η_2 = 92-88 per cent

U_2 = 8 to 12 per cent.

Table 12

UNEMPLOYMENT RATES

Month-Year	L_t	$U_t(\%)^a$	$U^U_t(\%)^b$	$U_t + U^U_t = U_t$ Adj
October 1957	8,829	7.1	3.4	10.5
November 1958	8,976	7.1	4.3	11.5
October 1959	9,116	5.9	2.9	8.6
October 1960	9,116	6.3	2.1	8.4
October 1961	9,713	6.4	1.6	7.6
October 1962	10,266	6.5	2.0	8.5

[a]Totally unemployed

[b]"With a job, not at work" = underemployed

[c]Fulltime workers are those reported as having worked at least 40 hours during the survey week.

Source: *PSSH, Series No. 18:* Labor Force and *Disability Data, October 1962.* Bureau of the Census and Statistics, p. ix, xii.

For our projections, average values will be used, i.e., η_1 = 86.5 per cent and η_2 = 90 per cent implying a U_1 = 13.5 per cent and a U_2 = 10 per cent, respectively. Using our labor force projections, we can compute two employment series as shown by Table 13.

Now to justify our value of the elasticity of output with respect to the employment rate (β), the first author suggests that such an elasticity is less than Okun's. Some reasons for this may be offered. The elasticity of output with respect to the employment rate depicts how much additional output can be expected from the employment of additional workers. In the US, the employment of an additional worker can lead to a rate of output in accordance with Okun's number because labor is relatively more efficient, being endowed with more amount of complementary capital goods. In the Philippines as in most less developed countries with a large labor force, the most economical used of labor and capital inputs are found generally in labor intensive activities. Therefore, the additional employment of a worker need not lead directly to a rate of output as much as Okun's. In fact, it may be offered that, if anything, it must be at most 1/2 the value assumed for the United States. In accordance with this, we assume that a most optimistic value for the elasticity of output with respect

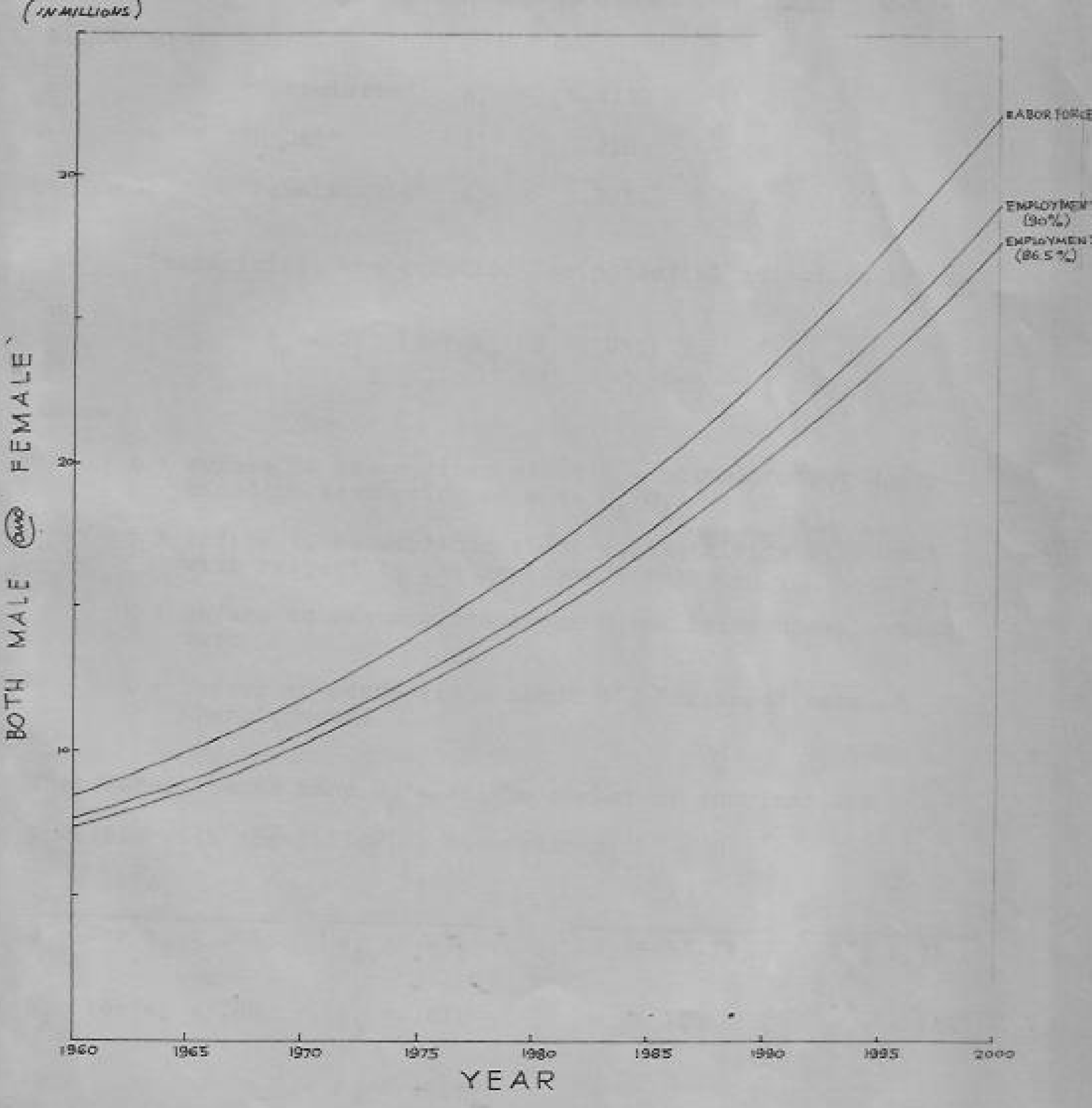
Table 1

EMPLOYMENT PROJECTIONS
(1960-2000)

Year	Labor Force (thousand)			TOTAL EMPLOYMENT (thousand)					
				η_1 = 86.5%			η_2 = 90%		
	Male	Female	Both	Male	Female	Both	Male	Female	Both
1960	6421.2	2178.2	8599.4	5554.3	1884.1	7438.5	5779.1	1960.4	7739.5
1965	7582.9	2561.0	10143.9	6559.2	2215.3	8774.5	6824.6	2304.9	9129.5
1970	8978.2	3021.7	11999.9	7766.1	2613.8	10379.9	8080.4	2719.5	10799.9
1975	10647.1	3574.2	14221.3	9209.7	3091.7	12301.4	9582.4	3216.8	12799.2
1980	12622.1	4227.9	16850.0	10918.1	3657.1	14575.3	11359.9	3805.1	15165.0
1985	14933.8	4986.2	19920.0	12917.7	4313.1	17230.8	13440.4	4487.6	17928.0
1990	17622.0	5865.5	23487.5	15243.0	5073.7	20316.7	15859.8	5279.0	21138.8
1995	20733.3	6885.6	27618.9	17934.3	5956.0	23890.4	18660.0	6197.0	2485[illegible].0
2000	24291.8	8043.9	32335.7	21012.4	6958.0	27970.4	21862.6	7239.5	29102.[illegible]

Figure III

EMPLOYMENT PROJECTIONS
(1960 - 2000)



to the employment rate (β) is 0.015 (or 1.5 per cent). The alternative assumptions of β used in this paper, together with the adjectives describing our own assessment of their plausibility are:

"Optimistic"	β_1	=	0.015
"Modal"	β_2	=	0.010
"Pessimistic"	β_3	=	0.005.

Summarizing, the equation for potential output is given by

$$Q_P = Q_{A_i} [1 + \beta_j (U_K - U^*_1)]$$

where

i = refers to assumptions about Q_A, actual output determined by assumption of m (= Q^A_A/Q_A)

j = refers to assumptions about β, elasticity of output with respect to the employment rate

k = refers to assumptions about U, existing unemployment rate

l = refers to assumptions about U^*, "desired" rate of unemployment.

There shall be as many Q_P's as the number of combinations possible with the following assumptions:

Q_{A_i}	β_j	U_k	U^*_l
Q_{A_1} for m_1 = .05	β_1 = .015	U_1 = 13.5%	U^*_1 = 7%
Q_{A_2} for m_2 = .04	β_2 = .010	U_2 = 10%	U^*_2 = 10%
	β_3 = .005		

We shall present only two sets of the many possible potential output series that may be computed from the various assumptions we have made. Each set will correspond to the two assumptions about the growth rate of output, Q_A. The first involves an assumed growth rate of output equal to 5 per cent and the other a growth rate of 4 per cent. For each set, there will be three estimates -- "optimistic," "modal," and "pessimistic." Tables 14 and 15 show the different potential output figures for these two sets of assumptions. When graphed on paper, the results become more revealing. An "optimistic" assumption based on the pessimistic rate of growth of output may come out inferior to the most "pessimistic" assumption based on the sanguine rate of output growth. This situation is depicted by the wide distance between pessimistic Q_{P_2} and optimistic Q_{P_2}.

The advantage of presenting these projected values of output is not so much the fact that we are able to tell exactly how much output definitely results from a given set of assumptions. It is the fact that we are able to place limits on the set of possibilities, no matter how many they are.

The projections of potential output may be recast in per capita terms. This is done by dividing the potential output computed and the population projected. Table 16 and

Table 14

POTENTIAL OUTPUT (Q_{P_1}) PROJECTIONS[a]

Year	Q_{A_1} (m_1 = .05) mil. ₱	$Q_{P_1\ j}U_kU_1$: "Optimistic" ($Q_{P_{1121}}$)[b] mil. ₱	"Modal" ($Q_{P_{1111}}$)[c] mil. ₱	"Pessimistic" ($Q_{P_{1112}}$)[d] ($Q_{P_{1212}}$)[e] ($Q_{P_{1312}}$)[f] mil. ₱
1960	10804.0	11857.4	11290.2	
1965	13872.3	15224.6	14496.5	
1970	17812.6	19549.3	18614.2	
1975	22872.1	25102.1	23901.3	
1980	29368.5	32231.9	30690.1	
1985	37709.2	41385.8	39406.1	$= Q_{A_1}$
1990	48420.3	53141.3	50599.2	
1995	62172.7	68234.5	64970.5	
2000	79831.8	87615.4	83424.2	

[a]Based on an actual output rate of growth m_1 = .05, which gives a series of actual output Q_{A_1}.

[b]$Q_{P_{1121}} = Q_{A_1}\ [1 + \beta_1(U_2 - U_1^*)]$

[c]$Q_{P_{1111}} = Q_{A_1}\ [1 + \beta_1(U_1 - U_1^*)]$

[d]$Q_{P_{1112}} = Q_{A_1}\ [1 + \beta_1(U_1 - U_2^*)]$

[e]$Q_{P_{1212}} = Q_{A_1}\ [1 + \beta_2(U_1 - U_2^*)]$

[f]$Q_{P_{1312}} = Q_{A_1}\ [1 + \beta_3(U_1 - U_2^*)]$

Table 15

ESTIMATES OF POTENTIAL OUTPUT (Q_{P_2})[a]

Year	Q_{A_2} $(m_2 = .04)$ mil. ₱	$Q_{P_2\beta_jU_1U_1^*}$ "Optimistic" $(Q_{P_{2121}})$[b] mil. ₱	"Modal" $(Q_{P_{2111}})$[c] mil. ₱	"Pessimistic" $(Q_{P_{2112}})$[d] $(Q_{P_{2212}})$[e] $(Q_{P_{2312}})$[f] mil. ₱
1960	10804.0	11857.4	11290.2	
1965	13196.0	14482.6	13789.8	
1970	16117.4	17688.8	16842.7	
1975	19686.0	21605.4	20571.9	
1980	24044.3	26388.6	25126.3	$= Q_{A_2}$
1985	29368.5	32231.9	30690.1	
1990	35870.4	39367.8	37484.6	
1995	43812.4	48084.1	45784.0	
2000	53512.2	58729.6	55920.2	

[a]Based on an actual output rate of growth $m_2 = .04$, which gives a series of actual output Q_{P_2}.

[b]$Q_{P_{2121}} = Q_{A_2}\ [1 + \beta_1(U_2 - U_1^*)]$

[c]$Q_{P_{2111}} = Q_{A_2}\ [1 + \beta_1(U_1 - U_1^*)]$

[d]$Q_{P_{2112}} = Q_{A_2}\ [1 + \beta_1(U_1 - U_2^*)]$

[e]$Q_{P_{2212}} = Q_{A_2}\ [1 + \beta_2(U_1 - U_2)]$

[f]$Q_{P_{2312}} = Q_{A_2}\ [1 + \beta_3(U_1 - U_2^*)]$

Figure IV

ACTUAL & POTENTIAL OUTPUT PROJECTIONS

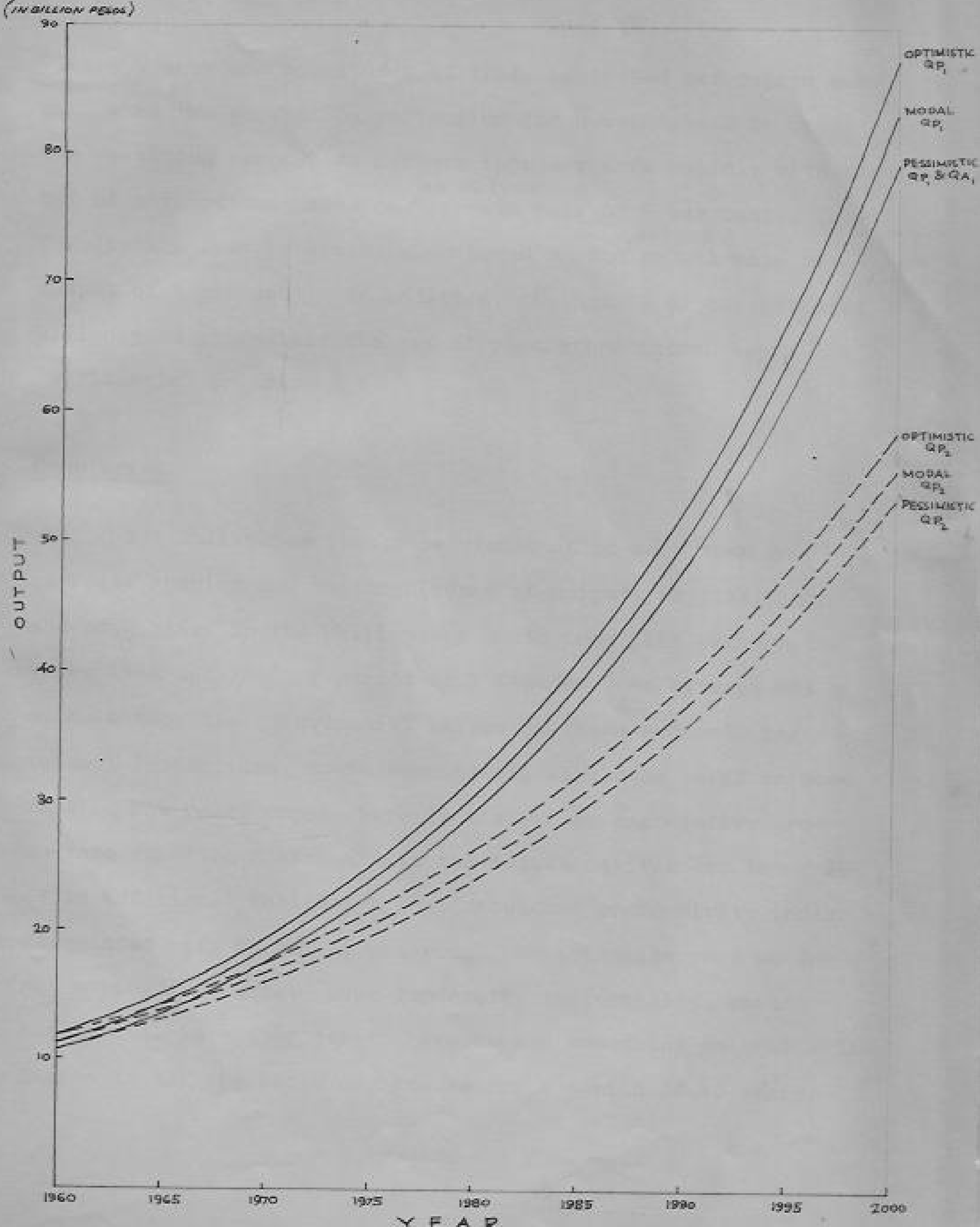


Figure V show the magnitudes of these projected per capita output, when the population projection for Hypothesis C is used. The resulting per capita outputs increase more rapidly with the set of assumptions based on an output growth rate of 5 per cent. The results are less promising when based on the output growth rate of output of 4 per cent. In addition, the nature of the estimate will depend on whether the set of parameters chosen are "optimistic" or not.

Conclusion

1. This paper should be viewed as no more than an exercise showing how the magnitudes of output, capital, labor and population in the Philippines would look like between the years 1960 and 2000, a period of 4 decades. An attempt was made to show the quinquennial values of these economic magnitudes. Projections, to be meaningful, should be based on some model. The model chosen here is that of an aggregative production function having as its two inputs capital and labor and as an additional variable a time dependent productivity index associated with technical progress. We emphasize that we are not making forecasts. Even forecasts, incidentally, would hardly call it a fair job to have to say something on what will happen to all the above magnitudes for a period of 40 years.

Table 16

ESTIMATES OF ACTUAL AND POTENTIAL PER CAPITA INCOMES
(1960-2000)

Year	Population (P_c)[a] thous.	Per-capita Income[d] (pesos per annum)					
		Q_{A_1}/P_c[b]	Q_{A_2}/P_c	$Q_{P_{1111}}/P_c$	$Q_{P_{2111}}/P_c$	$Q_{P_{1121}}/P_c$	$Q_{P_{2121}}/P_c$
1960	27087.7	398.85	398.85	416.80	416.80	437.74	437.74
1965	31846.4	435.60	414.36	455.20	433.01	478.07	454.76
1970	37402.2	476.24	430.92	497.68	450.31	522.68	472.93
1975	43872.1	521.33	448.71	544.79	468.91	572.17	492.46
1980	51406.8	571.30	467.73	597.00	488.77	627.00	513.33
1985	60144.5	626.98	488.30	655.20	510.27	688.11	535.91
1990	69800.2	693.70	513.90	724.91	537.03	761.33	564.01
1995	80281.5	774.43	545.73	809.28	570.29	849.94	598.94
2000	91683.5	870.73	583.66	909.91	609.93	955.63	640.57

[a]Population projection based on Hypothesis C of Dr. Frank Lorimer.

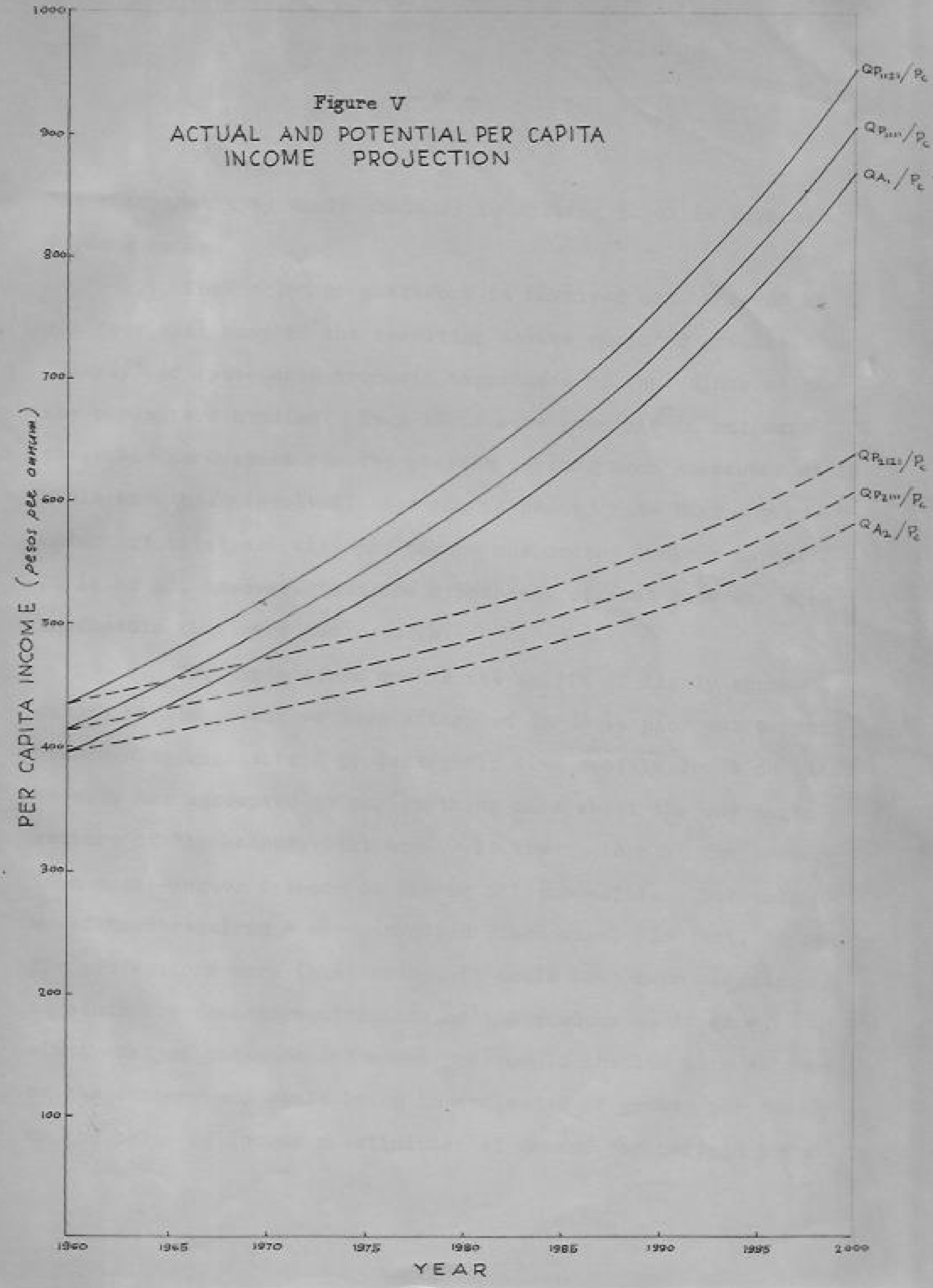
[b]Equal to the "pessimistic" estimate of potential output Q_{P_1}.

[c]Equal to the "pessimistic" estimate of potential output Q_{P_2}.

[d]Range goes from "pessimistic," "modal," and "optimistic," for m_1 = .05 and m_2 = .04.

Figure V

ACTUAL AND POTENTIAL PER CAPITA INCOME PROJECTION



The most that they would probably be willing to do is forecast 5 years hence.

2. That a lot of guesswork is involved can be found by the fact that many of the resulting values computed are based on "likely" or reasonable economic magnitudes of the values of the key parameters studied. Even if it were possible to estimate these key parameters for the present period, much guesswork still would have been involved. For how is one to know that a parameter of this year will not change one or two decades hence? It is hoped, however, that the hypotheses offered here are more reasonable than mere conjectures.

3. The projections are in the spirit of highly aggregative models. What we have attempted to do is pick out certain economic aggregates and project their time profile for 4 decades. We have not attempted to say anything more about the way certain sectors of the economy will move. To try to look at the economy in a multi-sector fashion is not at all impossible. But this would have required a more involved discussion. In fact, to make the projections more interesting, it would have been necessary to study the demand requirements of the economy as it grow, since most of these demand magnitudes would involve more sectors of the economy and would bring in estimates of growth per sector on the basis of income elasticities of demand for certain types

of output. These interesting details are deserving of more intensive study, but as we have stressed in the beginning, we ere not ready to get more involved than the way we have chosen.

4. We can say a number of interesting concluding remarks on the basis of the aggregate production function model used.

a) Firstly, we have to take as datum the rate of growth of the labor force (or of the population). Demographic factors determine this magnitude   If the rate of population growth remains a datum, the only other crucial input in the production function is the capital input. The higher the rate of growth of capital is, the greater will be the growth of output. To the extent that the production function itself shifts only in terms of the productivity component (neutral technical change), having more capital inputs helps in increasing the level of output. The need to encourage the rate of growth of the capital stock is therefore self-evident. In fact, much of the discussion of economic development in the literature has always emphasized the importance of capital accumulation. This is still an important dictum of growth, despite the fact that more attention lately has been shifted to the role of technological progress as a generator of growth, to which we shall address ourselves secondly.

b) In the production function, in this study, technological progress is the term which we associated with a time-dependent productivity index. All the changes in productivity that accrue to the economy or those that make inputs more productive are subsumed under the name of disembodied technical change. It is clear, therefore, that technical change is as important a component of the growth process as capital formation. Policy oriented decisions that direct themselves to the problem of improving the general conomic environment, improving the efficiency of the inputs, labor and capital, and the like will push the rate of growth of output upward.

c) Finally, some thought can be given to policy objectives regarding what we consider "full employment" or an "optimum employment policy." In the two-factor world of capital and labor and one output (the kind we investigate here), the factor which is relatively abundant would tend to suffer from unemployment. In the Philippines, labor is the more abundant factor. The employment statistics noted show the high percentage of the population in the labor force which is classified as unemployed. By using a potential output series given at a level of unemployment that policy makers would wish to consider as "desirable in the view of the circumstances," it is possible to draw a profile of total output over time that meets some employment target criteria.

In view of this, some notion of a desirable employment level that ought to be complemented by growth of the capital stock and by productivity changes makes policy makers aware of the optimum output target achievable.

5. We end with a note stressing again that the magnitudes of output, potential output, capital, labor and population in this paper are no more than projections. Between the most "optimistic" of the optimistic time profiles of these magnitudes and the most "pessimistic" of the pessimistic profiles is probably the more likely order of magnitude to be expected. But as one can see, the farther away we are from 1965, the greater is the absolute margin between the two extremes of the two time profiles. Although this is more of a negative note, no scientist can claim to have an infallible estimate of magnitudes like gross national product or the population to the year 2000, without some probability limits in mind.