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POPULATION GROWTH, HUMAN CAPITAL EXPENDITURES AND ECONOMIC GROWTH: A MACROECONOMETRIC ANALYSIS

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The paper presents an econometrically estimated model where economic and demographic variables are determined simultaneously. It is used to quantify the importance of human capital expenditures in socioeconomic and demographic development as well as analyze the effects of rapid population growth on human capital expenditures.

The simulation results indicate that human capital expenditures are important determinants of economic development, have appreciable negative effects on both fertility and infant mortality, hence, have negligible net effects on population in human capital expenditures per capita which implies a deteriorating quality of human capital.

1. Introduction

The assessment of the consequences of rapid population growth on development is currently undergoing a revision. The "villain" verdict of the 1970s (National Academy of Sciences, 1971) is being replaced by an "accomplice" judgment in the 1980s (Kelley, 1985; King, 1985; National Research Council, 1986). As views changed, many of the earlier held principles were scrutinized. Foremost among those put to test is the hypothesis on the impact of rapid population growth on savings. This is not surprising as this is the linchpin of the causation from population growth to economic growth, at least as far as traditional economic growth theorizing is concerned. The current "consensus" point to a numerically weak effect and that the direction of the relationship is not robust to changes in sample countries (Ram, 1982; King, 1985; World Bank, 1984; McNicoll, 1984; Hammer, 1985). Several reasons were advanced to explain this apparent weak link

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between dependency burden and savings in developing countries. The reasons point to the narrowness of the framework of analysis that was employed. There was a call then for a more comprehensive framework. It was pointed out that the appropriate framework should acknowledge the joint determination of investment in human resources and the accumulation of financial savings (Kelley, 1988a; Mason, 1987; Hammer, 1986). In this framework it is possible that higher population growth will not significantly affect financial savings but will drastically cut investments in human capital. Williamson (1988) surmised that this may be the real dependency burden effect of rapid population growth.

One of the classic conclusions of Coale and Hoover (1958) is that higher population growth results in the diversion of resources from more productive activities, such as physical capital accumulation, to less productive social expenditures such as education and health. This proposition involves two independent assertions. First, that rapid population growth results in the transfer of resources from physical capital accumulation to social expenditures. Second, that social expenditures such as those on health and education are less productive than expenditures on physical capital; furthermore, that these expenditures have long delayed effect and lower rates of return.

This proposition has been criticized as too narrow. Classifying human capital investments as "unproductive" downplays the value of literacy, numeracy, and other school acquired skills as determinants of income growth (National Research Council, 1986). Cassen (1978) even argued that the real issue is whether "educated and healthy people can make greater contribution to the economy than what would be achieved using the capital to raise the output of a smaller population." McNicoll (1984) also pointed out that "development theory no longer accords the same degree of importance to (physical) capital formation as the engine of growth, and that the sources of growth has shifted toward the qualitative dimensions of factor inputs." The *World Development Report* of 1984 also asserted that "there is little doubt that the key to economic growth is the advance of human knowledge." Furthermore, in developing countries where most technologies are imported, the quality of manpower contributes to the selection of appropriate technologies as well as the absorption, dissemination, and adaptation of these technologies to local conditions (Oshima, 1988).

This study aims to analyze the twin issues embedded in the classic result of Coale and Hoover (1958), namely: (1) Does rapid

population growth divert resources from physical capital accumulation to human capital expenditures? (2) Is human capital less productive than physical capital? In addition, it will look into the potency of human capital expenditures as a tool for development.

Most of the attempts to answer these questions were done using partial analysis and usually employing single–equation models (Tait and Heller, 1982; Kelley, 1976; Simon and Pilarsky, 1979; Schultz, 1987). There is only one study that dealt with similar issues simultaneously (Wheeler, 1984). The model utilized outcome-based indicators of human capital, such as adult literacy rates and life expectancy, and utilized international cross-section data to estimate its parameters. The model can provide answers to the question of potency of human capital as a development tool but not on the problem of diversion and relative productivity of the different expenditures.

Owing to the multiplicity of issues in population and development interactions, a comprehensive mode of analysis is preferred over partial analysis. The latter tended to overstate the impact of higher population growth on development. Kelley (1974) noted that a biased assessment of the impact of population growth will result if the fact that population growth responds to changes in economic conditions is ignored. It was shown that by incorporating simple relations which make population growth endogenous, the benefits of reducing population growth decline by as much as 30 percent.

The above discussions point to the importance of a framework where economic and demographic variables are simultaneously determined in the course of development.

In this study, an economic-demographic econometric model designed to deal with the above-mentioned issues will be presented. The model was developed in the spirit of the population and development framework which is succinctly described in Herrin (1987) as depicted in Figure 1.1.

An economic-demographic model with an endogenous human capital expenditures is described in Section 2. Simulation results using the model are presented in Section 3. The final section contains a summary of the results of the study and areas for future research.

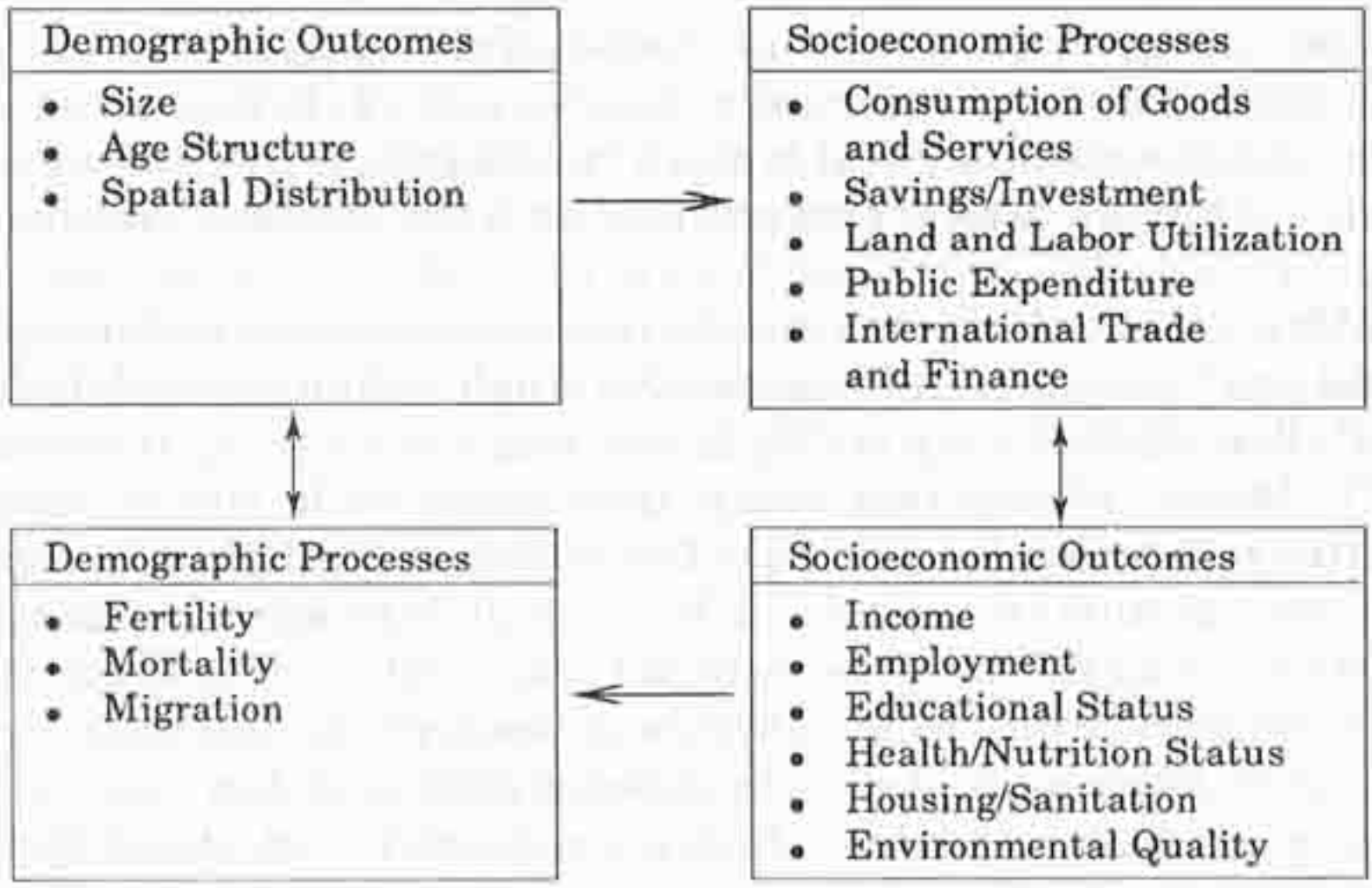

Figure 1.1 - Population and Development Framework: Behavioral Model

2. Human Capital Expenditures in an Economic-Demographic Model

This section discusses the features of the economic-demographic model that will be used in the succeeding sections. Highlighted in the discussions is the modelling of an endogenous human capital expenditure determination and its effect on economic and demographic development.

Four economic-demographic models have been developed for the Philippines, namely: Ruprecht (1967); Encarnación *et al.* (1974); the Bachue-Philippines model of Rodgers *et al.* (1978); and the Population and Development Planning (PDP) Model of Paqueo, Herrin and Associates (1984). Ruprecht's model was developed in the old tradition of measuring demographic changes separately and then feeding the different demographic scenarios into an economic submodel to determine the consequences of alternative population growth on development. The Encarnación, *et al.* model started the modelling of the feedback mechanisms by endogenizing fertility to family income using micro level data in the estimation. The Bachue-Philippines model increased the feedback mechanisms in a demand-driven model involving about 250 equations and some 1750 variables. In this particular model, many of the equations describing demographic processes were estimated using international cross-section data. It

was in this setting that the PDP model of Paqueo, Herrin and Associates, which will be referred to here as PDP I, was developed. An updated and "trimmed" version of the PDP I model is referred to here as PDP II core economic-demographic model. A detailed description of this model is given in Orbeta *et al.* (1989) and Orbeta (1989). More modifications were introduced to the PDP II model to arrive at the version which provided the basic model infrastructure of this study.

The basic direct relationship between economic and demographic variables developed in PDP I and maintained in all of the model versions lie in the determination of private and public consumption expenditures, labor supply, land under cultivation and the output coming from the agriculture sector. Private consumption expenditure is determined by the age structure of the population, while government consumption expenditure is determined by the population size. The sex-specific labor supply is the product of the labor force participation rate[2] and the working age population. Land under cultivation is negatively determined by the population size. The proportion of output coming from agriculture, on the other hand, is negatively determined by income per capita.

The demographic submodel is connected to the economic submodel via the behavioral equations determining infant mortality, marital fertility as well as the proportion of households living in rural areas. While the earlier Bachue-Philippines model used international cross-section data for these relationships, this model uses domestic time-series data. Infant mortality and marital general fertility are determined by socioeconomic variables such as per capita income, employment rate, educational attainment, health expenditures per capita, price of food, and wage rates. The proportion of households living in rural areas is determined by the proportion of workers employed in agriculture.

The key interrelationships in the PDP II model before the endogenous human capital variables were introduced are shown in Figure 2.1. The broken-line boxes denote exogenously determined variables.

[2]This variable was endogenous in PDP I. Updated data, however, did not yield a useful relation for simulation purposes. This was then considered exogenous starting in PDP II.

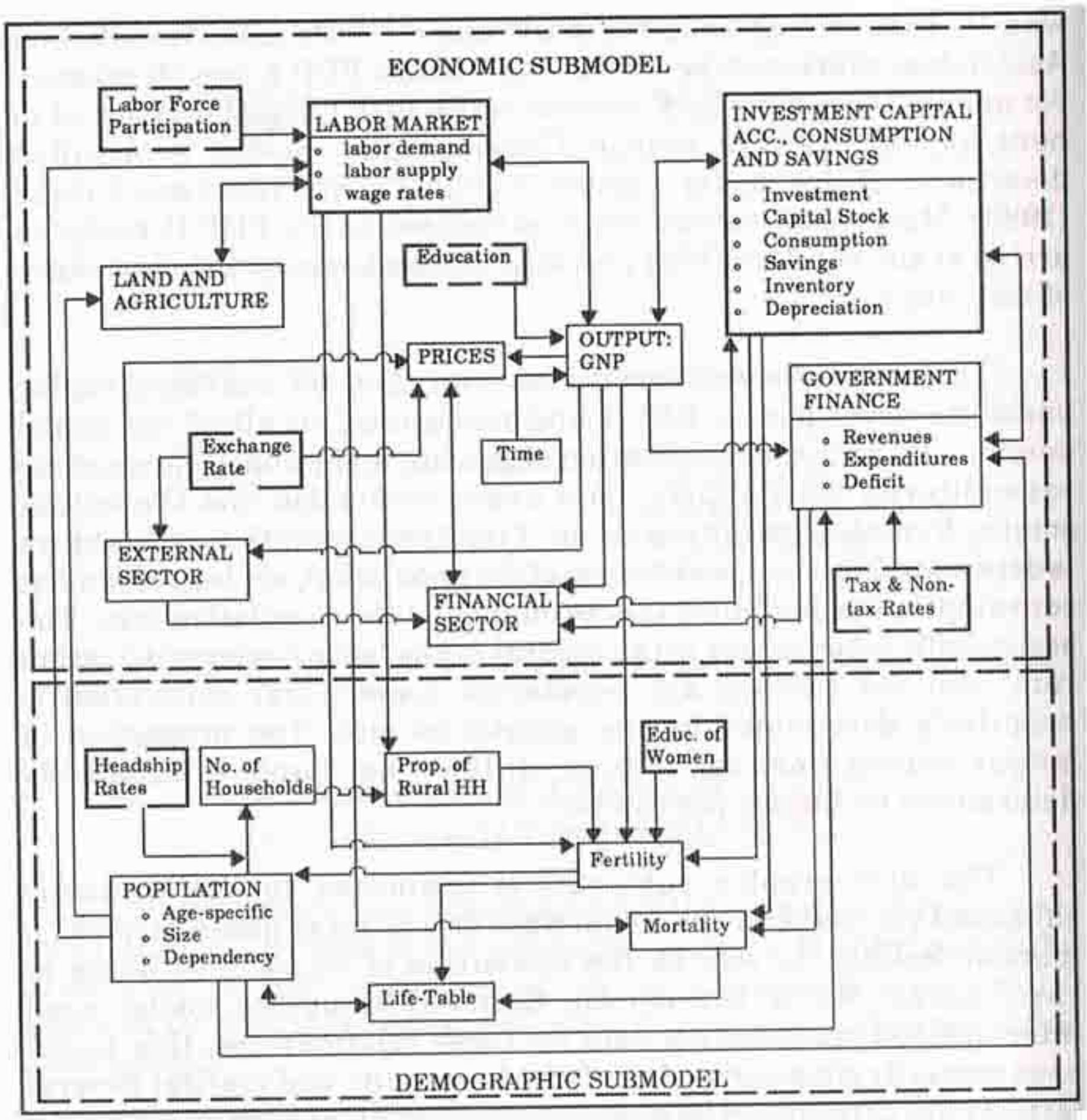

Figure 2.1. - Key Economic-Demographic Interactions in the PDP II Model

Since the model will be used for long-term simulations, premium is always given to correct signs of coefficients and the significance of the t-statistics in the selection of equations to be used in the simulations. This rule will be lifted only when the estimated equation yields a very low R-square which would render the equation not useful for simulation purposes.

Most of the equations of the model were estimated using Ordinary Least Squares. Occasionally, however, the Cochrane-Orcutt procedure was employed to correct autocorrelation problems. Where the estimation involved the Cochrane-Orcutt procedure, the simulation equation utilized the estimated error process.

The complete list of estimated equations and the corresponding test statistics used in this study is given in Orbeta (1991).

2.1 Human Capital Variables in Socioeconomic Development

This sub-section discusses the major interactions among economic and demographic variables and human capital variables and the issues surrounding these interactions. Empirical models designed to capture these interactions will also be presented.

Two types of human capital expenditures are considered. These are expenditures on education and on health.

There are three areas where socioeconomic development and human capital expenditures interact significantly. These are the determination of human capital expenditures, the effect of human capital expenditures on production, and its effect on the demographic processes of fertility and infant mortality. Table 2.1 summarizes the relationships involved. Figure 2.2, a simplified version of Figure 2.1, highlights both the determination of human capital expenditures as well as the effect of human capital expenditures on economic and demographic development.

2.1.1 Determination of Human Capital Expenditures

i) Private Human Capital Expenditures

Conceptual Issues. Human capital expenditures have both consumption and investment motives. Modelling these dual motives, specifically in a household perspective, makes income or expenditures endogenous. It can be shown that in a household model of childbearing and human capital investment, income or expenditures will be endogenous to both the number of surviving children and human capital investment, both of which are choice variables[3]. Owing to these problems, a convenient metholodogy to model the private demand for human capital was to confine the econometric modelling to the consumption motive and then use a complete demand system framework[4]. This is listed as equation (1) in Table 2.1.

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[3]Many of these problems are discussed in Schultz (1988).

[4]This was the strategy adopted by Kim (1988). Kim (1988) noted the impossibility of using the complete demand system when both the consumption and investment motives of demand for education are considered. ANNEX E in Orbeta (1991) also discussed the assumptions needed to arrive at the estimable form of the system of demand equations.

Empirical Issues. There are two considerations in the choice of he functional form to use in estimating a system of demand equations. 'irst, it must be flexible so as not to unnecessarily restrict the 'elationship among the different goods. Second, it should perform vell in the simulations. One such system is the Workings (1943) nodel. It is an AIDS-like model without prices[5].

An estimable form of the model is

$$\mu_i = \alpha_i + \beta_i log\,(X/kP)$$

where μ_i is the share of good i to total expenditures; X is the total expenditure; and P is the general price level. The k parameter was identified by Deaton and Muellbauer (1980) as a deflator that reflects, among others, changes in household composition. The term X/kP is then called a "needs-corrected" total expenditure. This is the parameter that will be used to introduce demographic variables into the demand system[6]. The youth dependency ratio is used as proxy for changes in the demographic structure of the household population. Deaton and Muellbauer (1980a) pointed out that k should have the value 1 for a "standard" household. The youth dependency ratio was then standardized to its 1970 census value. One well-understood consequence of rapid population growth is a higher youth dependency ratio. Therefore, the equation predicts that rapid population growth implies lower needs-corrected total expenditure outlay.

Ordinary Least Squares (OLS) can be used to estimate the system, one equation at a time. However, if cross-equation restrictions, such as adding-up are imposed, a system estimator is necessary. As first pointed out by Barten (1969), this system of equations has a singular covariance matrix. One equation must be dropped to allow system estimation. This estimation procedure used here is the iterative seemingly unrelated regression (SURE) proposed by Zellner (1962).

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[5]The complete AIDS model (Deaton and Muellbauer, 1980a) was estimated. The estimation results are presented in Orbeta (1989a). The simulation results, however, show that the errors in key variables, notably GNP, were almost twice as large as those obtained using the Workings model. This might be due to the poor modelling of the price behavior of the different goods.

[6]Pollak and Wales (1981) identified several types of introducing demographic variables in a system of demand equations. In their terminology, this method is called demographic scaling.

Table 2.1 – Human Capital Expenditures in an Economic-Demographic Model

A. CONSUMPTION

1. Private Consumption Expenditures

1.1 Expenditures Groups

$$Si = F^1 (CP / DEPN^*) \quad (1)$$

$$i = EDR, MEDR, FODR, OTHR$$

1.2 Aggregate

$$CP = F^2 (GNP\text{-}REVR1\text{-}KCAR), DEPN, TBILL / PGNP1) \quad (2)$$

2. Government Consumption Expenditures

2.1 Aggregate

$$CG = F^3 (POP, REVR1) \quad (3)$$

2.2 By Type

2.2.1 Health

$$CHG = HRCG * CG \quad (4)$$

2.2.2 Education

$$CEDG = EDRCG * CG \quad (5)$$

3. Government Capital Expenditures in Education

$$INEDG = IERGNP * GNP \quad (6)$$

B. PRODUCTION

$$GNP = F^4 (KP, KG, L, t) \quad (7)$$

$$L = LABI * PEDOCOL^{\Lambda} * HPCAP1 (^{1-A}) \quad (8)$$

C. AUXILIARY EQUATIONS

1. Total Current Health Expenditures Per Capita

$$HPCAP1 = (CHG + MEDR) / POP \quad (9)$$

2. Total Government Education Expenditures

$$EGEXPR = INEDG + EDR \quad (10)$$

3. Total Education Expenditures

$$EDUC = EGEXPR + EDR \quad (11)$$

4. Number of College Graduates Among 25 years old and over

$$EDCOL_t = EDCOL_{t-1} * (1 - (D25P_t / P25P_t)) + (EDUC_{t-1} / 10269) / 1000 \quad (12)$$

5. Proportion of College Graduates Among 25 years old and over

$$PEDCOL = EDCOL / P25P \quad (13)$$

D. FERTILITY

$$MGFR = F^5 (GNP/POP) * PEDCOL, PROHR, FINFAM, MGFR (-1)) \quad (14)$$

E. MORTALITY

$$INFANM = F^6 (FODR (-1) / POP (-1), HPCAP1, EMP / LABS) \quad (15)$$

List of Variables in Table 2.1

CEDG = Real government current operating expenditures on education
CG = Real total government consumption expenditures
CHG = Real government current operating expenditures on health
CP = Real total private consumption expenditures
*DEPN** = Youth dependency ratio standardized to its 1970 value
EDCOL = Number of college graduates among 25 years old and over
EDR = Real private expenditures on education
EDRCG = Ratio of CEDG and CG
EGEXPR = Total government expenditures on education
EMP = Total employment
FINFAM = Five-year moving average of INFANM
FODR = Real private expenditures on food
GNP = Real gross national product
HPCAP1 = Real health expenditures per capita
RCG = Ratio of CHG and CG
INEDG = Real government capital expenditures on education
INFANM = Infant mortality rate
KP = REal private-originated capital stock
KCAR = Real capital consumption allowance
*L** = Labor input in "efficiency" units
LABI = "Fully" - employed workers
LABS = Labor supply
MEDR = Real private expenditures on health
MGFR = Marital general fertility rate
OTHR = Real private expenditures on other goods
P25P = Population of 25 years old and over
PEDCOL = Proportion of college graduates among 25 years old and over
PGNP1 = GNP deflator
POP = Population
PROHR = Proportion of households living in rural areas
REVR1 = Real government tax and non-tax revenues
Si = Shares of expenditure i to total private consumption expenditures
t = Time
TBILL = 90-day treasury bill rates

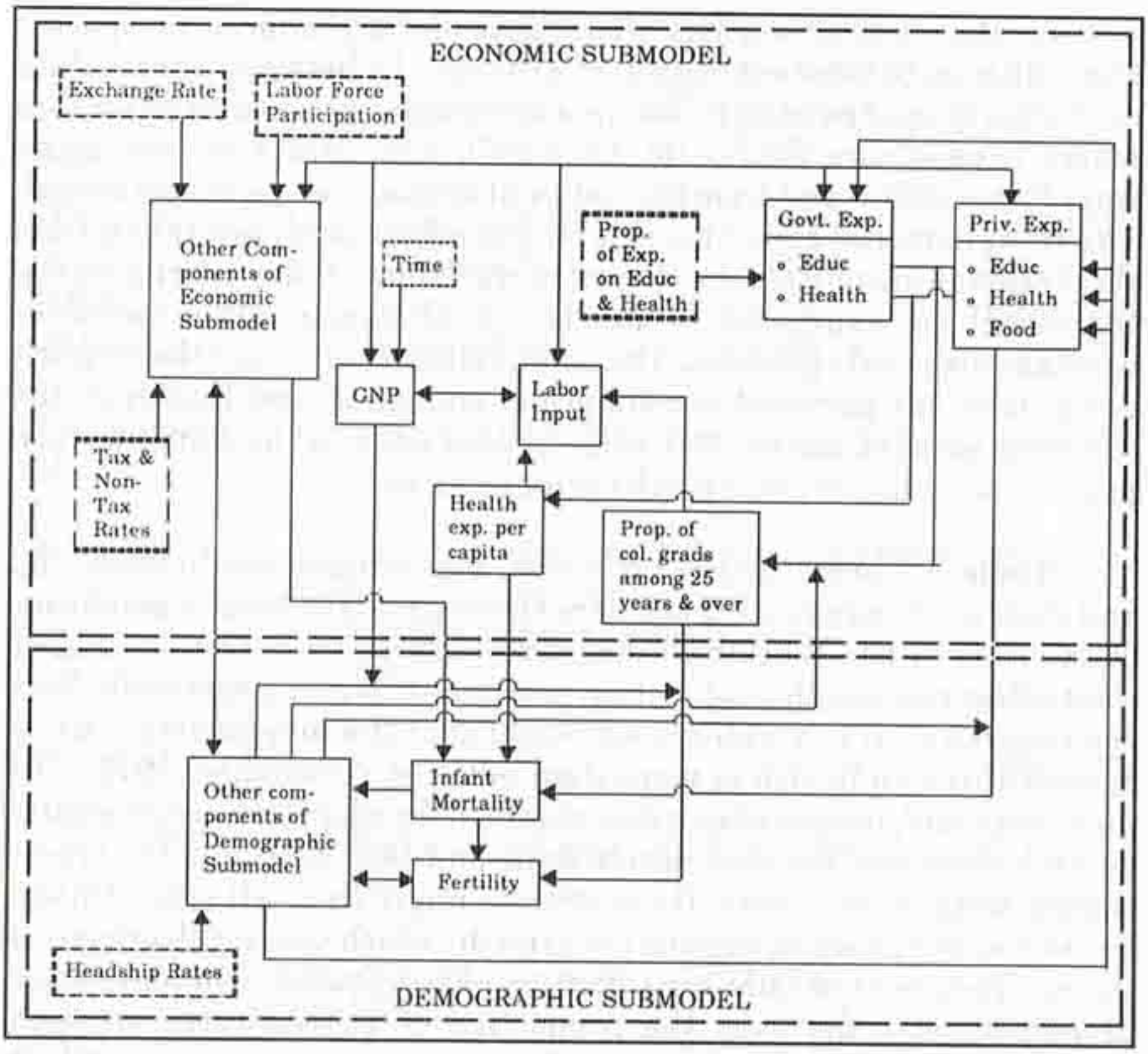

Figure 2.2. - Human Capital Expenditures in an Economic-Demographic Model

While SURE estimates are not invariant to the equation deleted, repeated iterations make the estimates converge to the maximum likelihood estimates which are unique and independent of the equation deleted (Johnston, 1984).

Expenditures on education and health have traditionally been considered as human capital expenditures. Expenditures on food which account for the largest share in the consumption basket is another expenditure group included in the system. Since several studies have already been done on this type of expenditure, results in these said studies can be used to validate the results that will be obtained here. Furthermore, this expenditure is useful in modelling demographic processes. The remaining unallocated expenditures are lumped into a catch-all good labelled as others.

In the estimation, the FIES data on the shares of specific expenditures to total expenditures are used. In-between survey data are linearly interpolated to obtain a continuous series except for food where expenditure shares for 1957-1970 and 1977-1987 are taken from Pante (1977) and from the national account series, respectively[7]. The total personal expenditures, on the other hand, are taken from the national income series. Since the variables in the other parts of the model are expressed in real terms, all consumption variables used are also real variables. The price deflators used are the implicit price index for personal consumption, education and health in the national account series. The price of food used is the national food price index taken from the NSO price division.

Table 2.2 presents the estimated expenditure coefficients, β_i, and their corresponding expenditure elasticities. The total expenditure elasticities in the Workings' model is $1 + (\beta_i / \mu_i)$. The estimated elasticities suggest that education and health are luxuries while food is a necessity[8]. It is a well-known result that the income elasticity of expenditures on health is more than one (e.g. Newhouse, 1977). On the other hand, income elasticities obtained for education are generally greater than one for time-series data and less than one for cross-section data (Kim, 1988). These results imply that, all other things the same, increases in population growth, which cause a decrease in the needs-corrected total consumption expenditures, will more than proportionately decrease the proportion of expenditures on both education and health. These results provide some support, albeit partially, to the Williamson (1988) hypothesis that population growth reduces, not increases, human capital expenditures. However, it remains to be seen whether this implication based on the structural analysis of a single equation will hold when the whole model is simulated. Furthermore, it also remains to be seen whether these intermediate effects will have substantial impact on the movements of macroeconomic variables, such as GNP, in a simultaneous equations context.

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[7]ANNEX F in Orbeta (1991) discusses in detail the derivation of private expenditures on education, health, and food as well as government expenditures on education and health.

[8]The estimated expenditure elasticity for food is not far from those reported in Pante (1979) which is .99.

Table 2.2 - Income Elasticities

	Coefficient	Expenditure Elas.	Mean shares
EDR	0.0053183	1.1258	0.042275
MEDR	0.0020634	1.1135	0.018175
FODR	-0.0274522	0.9532	0.586906
OTHR	0.0200705	1.0569	0.352651

The consumption equations obtained from the estimation are the following:

EDR/CP = -0.0492175 + .0053183 * LOG (*CG*/(*DEPN*/.45719))+
(-2.178) (2.249
0.8293454 * (*EDR*[1]/CP[1])
(10.465)

R^2 = .930 DW = 1.35 1958-1986

MEDR/CP = -0.017952 + .0020634 * LOG (*CP*/(*DEPN*/.45719))
(-3.872) (4.422)

+ 0.7760159 * (*MEDR* [1] / CP [1])
(13.569)

R^2 = .884 DW = 1.94 1958-1986

FODR/CP = 0.4431405 -.0274522 * LOG (*CP*/(*DEPN*/.45719))
(2.546) (-2.431)

+ 0.7405093 * (FODR [1] / CP [1])
(6.923)

R^2 = .876 DW = 1.54 1958-1986

OTHR = *CP - EDR - MEDR - FODR*

where:

EDR = Private expenditures on education, millions;
MEDR = Private expenditures on health, millions;
FODR = Private expenditures on food, millions;
OTHR = Private expenditures on other goods, millions;

CP = Total private consumption expenditures, millions; and
DEPN = Youth Dependency ratio.

ii) Government Expenditures in Human Capital

The government human capital expenditures are modelled as a fixed proportion of total government consumption expenditures for the current operating portion (equations (4) and (5), Table 2.1) and as a fixed proportion of GNP for the capital expenditures portion (equation (6), Table 2.1).

2.1.2 Human Capital Expenditures in Production

Conceptual Issues. The impact of human capital expenditures in production is modelled in this study as a labor-augmenting process.

Suppose L is labor input in efficiency units, L_o is raw labor, and e is the vector of human capital indicators, then the following relationship is postulated:

(1) $L = L_o * h\,(e)$

Consider the following production relation

(2) $Q = Q\,(K,L,t)$

where Q is output, K is capital stock, L is labor input in efficiency units, and t is time. Substituting (1) into (2) yields a relation for output with human capital variables and the traditional inputs as arguments.

The foregoing modelling of human capital in production needs to be tempered by the arguments of Peterson (1989) who presented four effects of human capital on the national economy. First, the worker effect – human capital increases labor productivity given the quantity of nonhuman capital by increasing the ability of workers to perform tasks more efficiently. Second, the inventive effect – human capital facilitates the invention and production of new products and/or new and more productive forms of physical capital. Third, the short-run allocative effect – human capital promotes production and adoption of new forms of capital which have higher returns. Fourth, the long-run allocative effect – human capital facilitates equalization of rates of return on nonhuman capital. Furthermore, Peterson pointed out that Welch (1970) earlier argued that only the worker effect,

which is likely to be the least important, will be reflected in any long-run coefficient on human capital in a static production function. Unfortunately, though, the other effects are very difficult to measure and much more to model. Given these, he stressed that it is not possible to accurately measure the full contribution of human capital, which is a dynamic process, with a static model.

Another problem area is the relative effect of education and health on output. While health, like education, augments labor, it does so in a manner different from what education does. While education provides skills which may not be present before[9], or develops latent skills, health improvement restores labor productivity to its potential.

Empirical Issues. What variables appropriately measure e is a major area of debate. Some prefer outcome-based indicators such as enrollment ratios, educational attainment rates, and life expectancy (Wheeler, 1984). Others prefer input-based indicators such as educational and health expenditures per capita. Both have problems. The former will result in over-estimation of the human capital stock if quality is declining. The latter suffers from a form of "dis-embodiment" of human capital from individuals. The embodiment of human capital investments in people is an important distinguishing characteristic of this type of expenditure (Gates, 1984). This is because death totally destroys human capital.

In this study two human capital indicators are included in vector e, namely: the proportion of college graduate equivalents among 25-year-olds and over, and total health expenditures per capita. These indicators belong to the input-based group.

Considering the not-so-encouraging indicators of quality of our graduates, i.e. stagnating NCEE and low achievement test scores (Herrin, 1988), these input-based indicators may capture more accurately the state of our human capital stock. It may be argued that the efficiency of knowledge production might be increasing over

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[9]This is the human capital view to education. This view, however, has been challenged by at least two strands of thinking which point out that education does not impart productivity - boosting skills. The "screening hypothesis" argues that education is a mere proxy for unobserved characteristics that make workers productive (Arrow, 1973). The radical view sees schooling as a tool of the dominant class in perpetuating the status quo (Bowles, 1972) or that it enhances certain docilities that are rewarded by employers (Bowles and Gintis, 1975).

the years so that this indicator may understimate the country's human capital stock. Granting that this may be so, there are also factors that may put these gains in check. For instance, as more students are added to the system, those with poorer backgrounds, both socially and biologically, enter school. This cohort is expected to be poor knowledge producers. There is no simple way to measure the net effect.

To compute the proportion of college graduate equivalents among those 25 years old and over, the method used by Ritzen (1977) in computing the number of workers with a specific educational attainment was adopted. This is given by the following relationship:

$$G_t^i = G_{t-1}^i(1-v) + (I_t^i / c^i)$$

where G_t^i is the number of laborers with skill type i in period t, v is the rate of attrition, I_t^i is the human capital expenditure for skill i, and c^i is the cost (constant) of producing type i skill from raw labor.

It may be argued that there is a lag between entering school and graduation from college. Ritzen (1977) showed that the only impact of the lag is the time cost of money. This can be incorporated by changing c^i but not the whole relationship. For the purposes of this study, only one skill type[10] will be considered, that of a college graduate (4 years of college). ILO (1974), as presented in Alonzo (1976), computed the cost of producing a (4-year) college graduate, c^i, as the sum of the out-of-pocket cost estimates for about 14 years of schooling, (i.e. 6 years of elementary, 4 years of high school and 4 years of college education). This amounts to approximately 10,269 in 1972 pesos.

Admittedly, the full cost of education includes foregone earnings. The accounting of the model, however, includes only out-of-pocket costs.

The total expenditure on education is the sum of the public and private outlays[11]. The rate of attrition employed is the death rate

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[10]Griliches (1970) pointed out that little will be lost by aggregating different skills into one overall index.

[11]APPENDIX F in Orbeta (1991) discusses the methodology used in computing for public and private expenditures on education and health.

among 25-year-olds and over. The implied assumption then is that human capital expenditures do not alter relative mortality rates. Given the number of college graduate-equivalents implied by the current education expenditure, the proportion of college graduates among 25-year-olds can be computed.

The use of a stock concept in the education variable is a recognition that the value of literacy and numeracy stays with the recipient until death. Health expenditures, on the other hand, may stay with the recipient but only for a short period of time.

The estimated form of the production model assumes constant returns to scale. The capital stock variables are normalized by L in the estimation.

The form of the L function is assumed as follows:

$$L = L_o * E^{A} * H^{(1-A)}$$

where E and H are the education and health indicators, respectively. This is equation (8) in Table 2.1. The motivation behind this formulation is the view that the elasticities of output with respect to human capital variables need not be equal. In the absence of estimates for the parameter A, calibration was resorted to. Several values of A in grids of 0.1 were assigned and the GNP equation was estimated and simulations were performed. The one selected for use in the policy simulations was the one which generated the minimum root-mean-square percentage error (RMSPE) for the GNP equation obtained in the historical simulations[12].

The resulting estimated equation is given by the following:

$$\log(GNP/L) = \underset{(0.4204)}{0.1816668} + \underset{(3.2060)}{0.615802} * \log(KP/L) + \underset{(1.9582)}{0.207798} * \log(KG/L)$$

$$\underset{(-5.0632)}{-0.16083} * D8386 \underset{(-1.2426)}{-0.0091} * TIME.$$

$\bar{R}$ SQR = .988 DW = 1.101 1960-1986

[12]The relationship $GNP=f(KP, KG, LABI, PEDCOL, HPCAP, t)$ was also empirically estimated. Simulations using the model, though, showed higher RMSPE for the GNP equation.

where:

L = $LABI * PEDCOL^{0.8} * HPCAP^{0.2}$;
GNP = real gross national product, in millions;
LABI = number of employed workers working 40 hours or more per week, in thousands;
KP = real privately-originated capital stock, in millions;
KG = real government originated capital stock, in millions;
PEDCOL = proportion of college graduate equivalent among 25-year olds, in percent; and
HPCAP = real health expenditures per capita, in thousands.

The implied elasticity is . 176399 for *LABI*, .1411192 for *PEDCOL*, and .0352798 for *HPCAP*.

This equation has shown that human capital variables are potent determinants of output per worker even with the presence of the traditional inputs such as the physical capital stock.

2.1.3. Human Capital Expenditures in Fertility and Infant Mortality

Conceptual Issues. Fertility theories have stressed the importance of demand and supply factors (Easterlin and Crimmins, 1985; Easterlin, Pollak and Wachter, 1980). Human capital expenditures affect both of these factors.

Cochrane (1979) hypothesized that the effect of education was indirect. It may decrease supply by delaying marriage either because of an altered preference for marriage or by mere time demands of schooling. Relatedly, better health also improves fecundity which increases the supply of children.

Education basically decreases the demand for children. This can either be because it raises the cost of raising children or due to changes in preference for children.

Human capital expenditures also affect fertility control. These have positive effect on attitudes toward contraception as well as contraception usage. Education then can increase or decrease indiividual fertility. The decrease is greater for educated women than men and in urban than in rural areas. Relatedly, Cochrane (1979) notes that education is more likely to increase fertility in countries with the lowest level of female literacy.

Birdsall and Griffin (1988) point out that policies designed to improve education and health outcomes are potentially important for reducing both infant mortality and fertility. It is argued that better health reduces infant mortality. In turn, as infant mortality declines, excess births which are required under a high infant mortality regime, as pointed out by the replacement hypothesis, will no longer be necessary. In addition, improved education of women delays marriage, improves the speed of adopting new methods of contraception, increases their tendency to work away from home and to modern sector jobs, and also increases the cost of childbearing. Relatedly, a review of studies on the consequence on health improvements in the Philippines points to the consistent relation between mothers' education and improved child survival at the household level (Herrin and Bautista, 1989).

These considerations are the motivations behind the general marital fertility equation (14) and infant mortality equation (15) in Table 2.1.

Empirical Issues. As earlier noted, human capital expenditures indirectly affect fertility. Thus, the following model must be interpreted as a semi-reduced form model of fertility. Of the two human capital expenditures, the fertility model used only education expenditures directly. Health expenditures indirectly affect fertility through the five-year moving average of infant mortality.

The estimated model used is[13]:

$$\log MGFR = 2.8569 - \underset{(4.4792)}{0.00178} * (GNP/POP) * \underset{(-1.2583)}{PEDCOL}$$

$$+\underset{(2.5778)}{1.3351157} * PROHR + \underset{(3.6506)}{0.00427} * FINFAM$$

$$+\underset{(1.5488)}{0.2653} * \log MGFR\,(-1)$$

[13]This equation suffers from multicollinearity problems. Zero-order correlation coefficients among independent variables are: .958 for *GNP/POP* and *PEDCOL*; .956 for *FINFAM* and *GNP/POP*; .930 for *FINFAM* and *PEDCOL*; .902 for *PROHR* and *GNP/POP*.

R-SQR = .981 DW = 2.16 1960-1986

where the not previously defined variables are:

MGFR = Marital general fertility rate;
POP = Population;
PROHR = Proportion of rural households; and
FINFAM = Five-year moving average infant mortality rate.

The infant mortality model considers directly only the effects of better health outcomes. The model used in the simulation is as follows:

$$\begin{aligned} \log INFANM = {} & 4.7517 - 0.67741 * (FODR(-1)/POP(-1)) \\ & (2.188) \quad (-1.175) \\ & -18.5137 * HPCAP - 0.5143 * (EMP/LABS) \\ & (-2.172) \qquad\qquad (-1.365) \end{aligned}$$

R-SQR = 9.71 DW = 1.48 AR(1) = .973 (14.871) 1959-1986

where the not previously defined variables are:

INFANM = Infant mortality rate;
FODR = Real food expenditures;
EMP = Employment level; and
LABS = Labor supply

2.2 Features of the Economic Submodel

This sub-section discusses the rest of the economic submodel. The economic submodel consists of the following components: the output determination sector; the labor sector; consumption, investment and capital accumulation block; the domestic prices block; government finance; land and agriculture; financial block; and the external sector.

The production function concept employed in the output determination equation suggests that output is supply-determined.

As discussed in the previous sub-section, the determinants[14] of output per worker include capital stock and labor input augmented by human capital variables. Furthermore, the capital stock is broken down into private-originated and government-originated capital stock. This would allow for different productivities and different motivation for accumulation.

The labor market model assumes that the wage rates respond to demographic pressure but with a time lag. This is a departure from both the standard labor surplus economy of Lewis (1954) and Fei and Ranis (1964) as well the neoclassical labor market model.

Population growth affects both private and public consumption expenditures. Private consumption is affected by changes in the population structure as represented by the youth dependency ratio while the public consumption expenditure is determined by the population size.

The general domestic price level is determined by both excess liquidity variable as well as structural variables. The excess liquidity variable is the ratio of money supply to GNP while the structural variables are the domestic price of imported goods and the wage rate.

The demand for land is determined by the population size. The proportion of output from agriculture, on the other hand, is determined by per capita income and a land scarcity indicator. This implies that structural change is both demand- and supply-determined.

The external sector is confined to the determination of the current account and its components.[15]

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[14]In PDP I and II, an exogenous educational attainment variable and an energy variable were among the explanatory variables. The energy variable was dropped in the version used in this study because given the new variables in the GNP equation, it failed to yield acceptable results. The education variable, on the other hand, was replaced by a new endogenous education variable. The PDP I model attempted to develop an education submodel by projecting enrollment rates at several levels of schooling. It was decided not to utilize the submodel due to unacceptable errors it generated in the simulation.

[15]In the PDP I model this sector was detailed enough so as to describe the accumulation of external debt. However, since the capital account was assumed to be exogenous, only the current account interacts with the economic submodel. Nothing is sacrificed then if only the determination of the current account and its components are retained as part of the economic submodel.

The money supply is determined by high-powered or base money.[16] The components of base money, namely, the net domestic assets and net foreign assets of the Central Bank are, in turn, determined by the government deficit and the current account balance, respectively. Furthermore, it is assumed that the financial sector clears with interest rate (90 days T-Bill rates) moving to equate money demand and supply.

To close the model, imports were made a residual to the income-expenditure identity equation. In turn, the domestic price of import goods is a determinant of the general price level.

2.3 Features of the Demographic Submodel

This subsection discusses the remaining portion of the demographic submodel.

The main bulk of the demographic submodel consists of: an abridged life-table driven by the infant mortality rate; equations estimating age-specific (female) population which are primed-up by the number of births; and survivorship functions implied by the life-table. The life-table employs the Brass logit system with the 1970 life-table in Fleiger *et al.* (1981) as standard. The marital general fertility, on the other hand, determines the number of births in each period.

The infant mortality rate, the marital general fertility rate, and the proportion of households living in the rural areas[17] are functions of socioeconomic variables as described in the previous sub-sections. Therefore, it is through these there variables that economic development affects demographic outcomes.

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[16]It was assumed in PDP I that both the exchange rate and the money supply are exogenous. It is however well known that the exchange rate can only be fixed at a certain value only if the Central Bank is willing to purchase domestic currency at that given rate thereby surrendering control over the money supply.

[17]The urbanization and income distribution submodel in PDP I does not have a feedback to the rest of the model. Thus, in the PDP II model only the rate of urbanization is retained.

2.4 Model Validation

Historical Simulation Errors. To know how good the model is in duplicating the values of the endogenous variables, static and dynamic simulations were done using the modified core model for the period 1968-1986. The root mean square percentage errors (RMSPE) and the mean absolute percentage errors (MAPE) are shown in Table 2.3.

Although the static simulation errors are expectedly lower than the dynamic simulation errors, the latter are more relevant in assessing the performance of the model since the model is dynamic.

The new equations added to the PDP II such as the ninety-day treasury bill rate (*TBILL*), private investments (*INVFP*) and domestic import prices (*PMD*) have errors that are more than 10 percent. The same variables have high static simulation errors indicating that the errors are coming from the explanatory variables. In the case of *TBILL*, one of its explanatory variables is money supply (*MS*). Variable *MS* has high errors because its determinants, net foreign assets (*NFA*) and net domestic assets (*NDA*) of the Central Bank have high errors. The source of the high errors of *NFA* and *NDA* are the inherent high errors of their respective determinants, namely, current account balance and government deficit, respectively. Since *TBILL* is an explanatory variable of *INVFP*, this partly explains why it also has high errors. The errors of *PMD* comes from imports (*M*) which is one of the explanatory variables. Recall that imports is computed as a residual to the national income identity in order to close the model, and hence, is bound to yield large errors.

The higher errors on the education variables (*EDUC*, *PEDCOL*, *EDR*) appear to come from the accumulation of errors over time as static simulation errors are low. The high errors for the death among the 25 years old and over (D25P) may be traced to the approximation done in the model which computes for women population only and uses a sex ratio of one to compute for the total number of individuals in the cohort. Since men have a generally shorter life span than women, this equation is expected to continuously understate the number of deaths in this particular cohort.

Multiplier Analysis. Table 2.4 shows the multiplier values resulting from a one-period increase in the exchange rate. Here, the exchange rate was increased by 10 percent in 1968 — the beginning of the simulation. The simulation run is done for the period 1968-1986.

In general the movement of the variables in response to the shock is damped oscillation. The movement of selected variables is depicted in

Table 2.3 – Historical Simulation Errors: Modified Core Model

Variable	Dynamic RMSPE	Dynamic AMPE	Static RMSPE	Static AMPE
Depreciation Rate	2.95827	2.27151	0.00001	0.00000
Private Cap. Stock	4.05932	3.50594	0.96304	0.75914
Govt. Capital Stock	0.88893	0.79261	0.48876	0.39051
Dep. Allowance	3.00389	2.65839	2.32676	1.70772
GNP Deflator	16.00692	13.56199	7.71650	5.93818
Consumer Price Index	18.40756	16.19419	8.72584	6.62551
Inflation Rate	225.23207	109.84456	312.05154	140.39284
Labor Supply, Male	3.92089	3.81407	3.16883	2.91308
Inventory Stock	4.98077	4.51275	0.00000	0.00000
Nominal Market Wage, Unskilled	11.13104	9.06153	5.61438	4.41325
Nominal Market Wage, Agri.	18.55793	15.32472	7.71241	6.39838
Legislated Wage, Unskilled	13.30954	11.42113	10.27242	8.15229
Legislated Wage, Agri.	13.12531	10.28082	11.54146	9.93136
Weighted Legislated Wage	11.38068	9.58146	9.97643	8.09745
Labor Supply, Female	2.89561	2.43884	1.34231	1.08632
Labor Supply, Total	3.40689	3.35613	2.40119	2.14520
Labor Input, "Full-time" Equiv.	8.79377	6.58631	5.92338	4.79399
Employment, Total	10.86721	8.48151	5.27332	4.39317
Gross National Product	3.67952	3.01566	3.93122	3.21336
Tax Revenues	3.67951	3.01566	3.93122	3.21336
Non-Tax Revenues	3.67952	3.01567	3.93123	3.21336
Total Revenues	3.67952	3.01566	3.93123	3.21337
Gov't. Consumption Expd.	10.42744	8.73038	6.36014	5.38025
Capital Expenditure, Educ.	3.67951	3.01566	3.93122	3.21336
Current Operating Exp., Educ.	10.42745	8.73038	.36015	5.38026
Current Operating Exp., Health	10.42744	8.73037	6.36014	5.38025
Gov't. Educ. Exp., Total	9.83221	8.21378	6.02086	5.07551
Total Govt. Expenditure	7.67191	6.24087	5.21458	4.05558
Govt. Deficit	274.91187	118.04522	189.12296	84.46682
Private Consumption Exp.	3.86632	3.24909	1.12600	0.92216
90-Days TBill Rate	13.66601	11.96748	10.90770	9.54201
Prop. of Value Added from Agri.	3.29926	2.59011	2.33560	1.65727
Valued Added in Agri.	4.11658	2.91234	3.42542	2.84877
Employment, Agriculture	8.50321	6.70660	6.54187	5.16835
Land Under Cultivation	7.38900	6.37197	5.36831	4.54595

TABLE 2.3 – (Continued)

Variable	Dynamic RMSPE	Dynamic AMPE	Static RMSPE	Static AMPE
Exports, Pesos	10.37587	7.73188	8.65987	6.91615
Imports, Pesos	19.83263	15.88204	14.91980	11.26967
Exports, Dollars	10.37587	7.73188	8.65986	6.91615
Imports, Dollars	19.83263	15.88204	14.91980	11.26967
Other Current Account Items	1909.55945	1036.43994	330.60388	206.89661
Current Account Balance	1578.9889	615.22449	1093.65454	359.92755
Price of Food	24.81713	19.48754	16.68436	13.19917
"Full-Time" Unemployment Rate	18.16545	15.07945	14.26525	11.48567
Unemployment Rate	122.76035	106.27325	85.75353	65.39556
Net Domestic Assets, CB	610.44006	202.72829	58.83211	45.02838
Net Foreign Assets, CB	461.40811	252.02544	260.99835	157.54521
Money Supply (M1)	31.74310	27.36895	13.83207	10.58922
Private Fixed Investment	14.86417	12.54265	11.71723	9.09498
Gross Domestic Capital Form.	11.98416	10.90501	10.48947	8.36332
Change in Inventory Stock	1002.66888	273.22324	558.24707	173 10696
Total Educ. Expenditure	11.40658	9.15544	6.16508	4.56308
No. of Coll. Grad. in P25P	8.04315	7.11151	1.83551	1.62961
Prop. of Coll. Grad in P25P	11.33603	10.70831	3.89398	3.48060
Private Exp., Education	12.80740	10.66926	7.34274	5.70882
Private Exp., Health	6.48528	5.63070	5.36554	3.98562
Private Exp., Food	5.92778	5.36772	3.14174	2.19052
Private Exp., Others	5.94098	5.25287	4.35168	2.93340
Capital Exp., Non-Education	3.67951	3.01566	3.93122	3.21336
Health Expenditures Per Capita	5.25972	4.40122	4.50278	3.53726
Total Govt Capital Exp.	3.67952	3.01566	3.93122	3.21336
Price of Investment Goods	3.97982	3.21878	2.44213	2.10673
Prices of Imported Goods	20.51940	15.69748	13.65252	10.95931
Prop. of Rural Households	8.52660	7.28945	0.53210	0.45419
Infant Mortality Rate	14.08435	11.93662	6.08257	5.20030
Marital General Fertility	8.55826	5.92741	1.33390	0.94120
Population, Female	3.25907	2.95627	2.63942	2.23598
Population, Male	3.89827	3.62138	3.08160	2.83980
Population, Total	3.56632	3.28171	2.82598	2.51954
Youth Dependency Ratio	7.61896	6.74124	6.20129	5.61461
Population 15 and over, Female	2.89561	2.43884	1.34232	1.80632
Population 15 and over, Male	3.92201	3.81488	3.17015	2.91388
Population Growth Rate	12.95875	8.87039	20.18143	18.21761
No. of Households	2.91515	2.62176	1.67209	1.39484
Population 15 and over	4.09664	4.03512	2.14257	1.91142
Death rate among P25P	12.45742	7.65661	27.47950	24.00500

Figure 2.3. A one-period devaluation causes a slight contraction on the year of the shock and expansion in the near term succeeding the shock period. It is then followed by periods of contraction which appear to be slow in returning to the unshocked path. This long contraction period seems to result from the decline in the private capital stock which is brought about by a large decline in the investment at the period of the shock. It appears that decline in private capital stock is not recovered at least throughout the simulation period.

The movement of other variables of interest such as exports, imports and current account balance appears to be well-behaved. All these variables rapidly returned to their unshocked values.

3. Population Growth, Human Capital Expenditures and Economic Growth: Simulation Results

The two objectives of this study underline the simulation experiments that will be discussed in this section. First, how does population growth affect human capital expenditures in the course of development? Second, how important are human capital expenditures in development? These two issues will be dealt with in three types of simulation experiments.

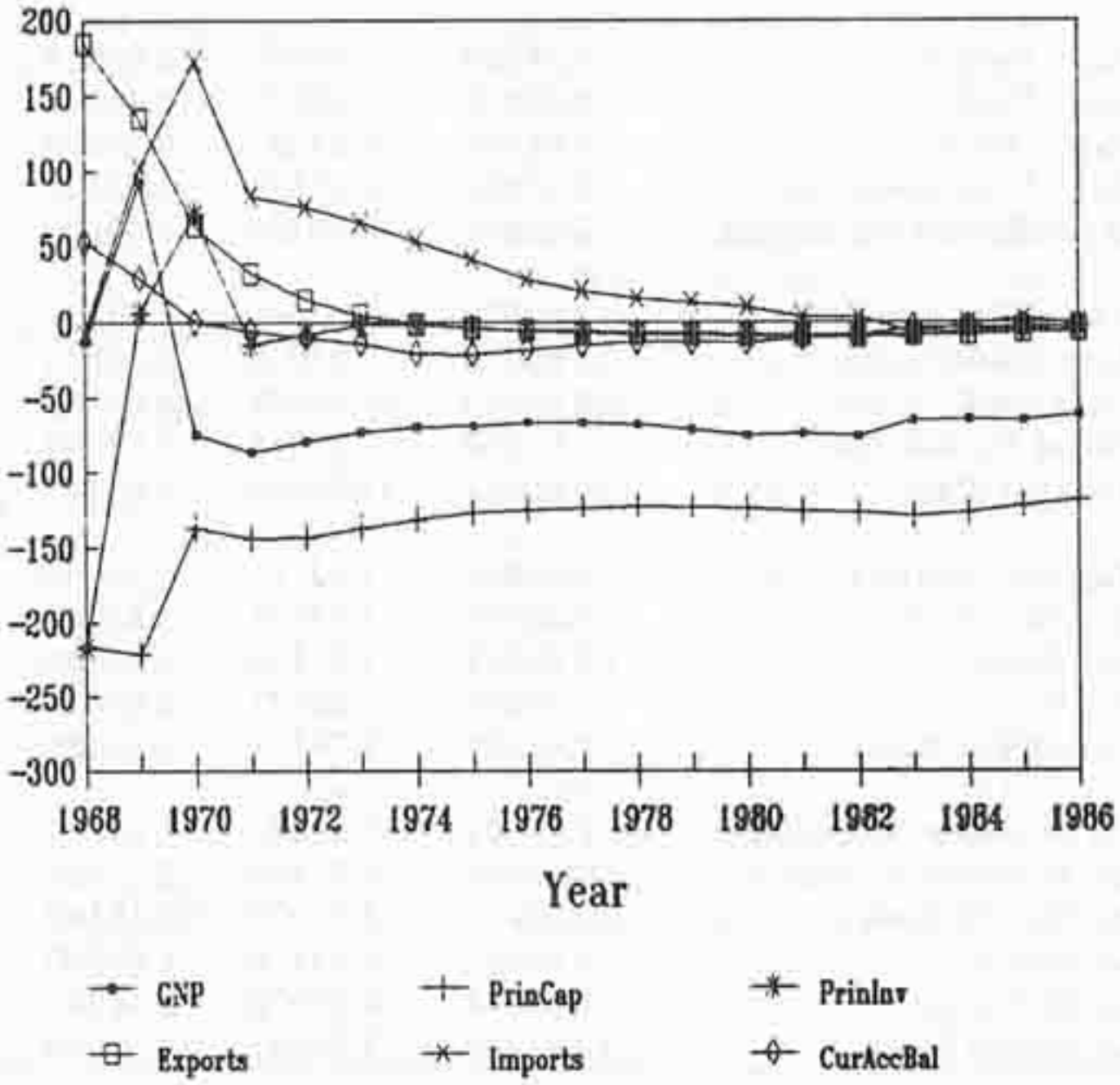

Figure 2.3 - Multiplier Values for Selected Variables: One Period Shock on the Exchange Rate

Table 2.4 – Multiplier Values
Variable Shocked: Exchange Rate

Variable	1968	1969	1970	1974	1978	1982	1986
Depreciation Rate	0.000	-0.000	-0.000	-0.000	0.000	0.000	0.000
Private Cap. Stock	-215.593	-221.079	-137.364	-131.279	-123.618	-127.249	-118.630
Govt. Capital Stock	-0.237	2.920	2.384	-2.915	-15.786	-29.318	-31.154
Dep. Allowance	-12.386	-12.549	-7.801	-7.821	-8.170	-9.195	-8.851
GNP Deflator	0.035	0.003	0.003	0.002	-0.001	-0.002	-0.003
Consumer Price Index	3.889	0.337	0.286	0.188	-0.066	-0.207	-0.277
Inflation Rate	6.095	-5.338	-0.174	-0.084	-0.016	-0.004	0.006
Labor Supply, Male	0.000	0.465	1.193	0.501	-0.055	-0.207	-0.289
Inventory Stock	0.000	-5.856	37.159	-51.654	-47.514	-49.260	-52.033
Nominal Market Wage, Unskilled	0.123	0.098	0.191	-0.022	-0.016	-0.016	-0.018
Nominal Market Wage, Agri.	0.085	0.063	0.077	0.003	-0.007	-0.011	-0.014
Legislated Wage, Unskilled	0.040	0.066	0.117	0.057	0.011	-0.021	-0.053
Legislated Wage, Agri.	0.030	0.047	0.066	0.062	0.039	0.012	-0.018
Weighted Legislated Wage	0.039	0.075	0.087	0.058	0.026	-0.003	-0.034
Labor Supply, Female	0.000	0.217	0.604	0.237	-0.029	-0.113	-0.161
Labor Supply, Total	0.000	0.683	1.796	0.738	-0.085	-0.319	-0.449
Labor Input, "Ful-time" Equiv.	53.005	143.761	-26.854	-20.108	-10.375	-7.040	-5.357
Employment, Total	51.918	139.908	-26.059	-18.914	-9.322	-6.130	-4.679
Gross National Product	-12.968	92.614	-74.807	-69.929	-68.273	-75.835	-61.150
Tax Revenues	-1.180	7.983	-7.161	-8.683	-7.993	-7.796	-5.736
Non-Tax Revenues	-0.174	1.213	-1.035	-0.744	-0.909	-1.236	-0.335
Total Revenues	-1.353	9.195	-8.197	-9.427	-8.901	-9.030	-6.073
Govt. Consumption Expd.	-0.234	2.038	-0.409	-1.914	-3.503	-4.838	-4.866
Capital Expenditure, Educ.	-0.018	0.154	-0.095	-0.142	-0.094	-0.096	-0.089
Current Operating Expd., Educ.	-0.077	0.666	-0.127	-0.277	-0.707	-1.313	-1.085
Current Operating Exp., Health	-0.012	0.118	-0.025	-0.082	-0.192	-0.305	-0.290
Govt. Educ. Exp., Total	-0.094	0.820	-0.221	-0.419	-0.801	-1.410	-1.174
Total Govt. Expenditure	-0.488	4.949	-1.317	-3.927	-8.020	-9.517	-6.504
Govt. Deficit	0.865	-4.246	6.881	5.500	0.880	-0.486	-0.431
Private Consumption Exp.	16.021	25.757	16.988	-10.524	-30.785	-44.721	-47.354
90-Days TBill Rate	0.205	0.033	-0.005	0.002	-0.001	-0.008	-0.013
Prop of Value Added from Agri.	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Valued Added in Agri.	15.824	14.844	-44.923	-4.419	-9.861	-13.362	-11.731
Employment, Agriculture	10.936	2.519	-13.042	-2.205	-2.626	-2.788	-2.307
Land Under Cultivation	38.251	23.527	-19.350	-20.966	-11.928	-6.744	-3.641
Exports, Pesos	184.087	135.364	63.031	-1.180	-7.629	-9.537	-5.756
Imports, Pesos	-7.911	102.240	172.189	53.030	15.462	3.332	-0.998
Exports, Dollar	-202.234	16.269	7.866	-0.319	-1.783	-2.738	-1.183
Imports, Dollar	-280.700	10.899	18.707	13.333	4.540	1.309	-0.319
Other Current Account Items	-25.958	23.595	11.099	-7.034	-6.879	-5.019	-1.955

Table 2.4 – (Continued)

Variable	1968	1969	1970	1974	1978	1982	1986
Current Account Balance	52.508	28.965	0.257	-20.686	-13.201	-9.067	-2.820
Price of Food	0.079	0.056	0.044	0.017	0.009	0.006	0.004
"Full-Time" Unemployment Rate	-0.430	-1.240	0.233	0.144	0.061	0.036	0.024
Unemployment Rate	-0.421	-1.205	0.230	0.137	0.055	0.031	0.021
Net Domestic Assets, CB	-12.720	-9.797	1.868	15.107	4.135	-13.522	-12.689
Net Foreign Assets, CB	21.049	32.102	-1.357	-42.396	-23.682	-3.751	-0.419
Money Supply (M1)	2.494	8.548	6.559	-13.103	-23.203	-22.315	-17.981
Private Fixed Investment	-217.078	5.748	71.171	-1.848	-6.671	-8.108	-3.366
Gross Domestic Capital Form.	-222.254	54.901	17.502	-3.297	-10.873	-13.392	-4.137
Change in Inventory Stock	-5.856	43.015	-52.711	0.564	0.369	-0.613	0.753
Total Educ. Expenditure	0.526	1.726	0.651	-0.680	-2.276	-3.984	-4.189
No. of Coll. Grad. in P25P	0.000	-0.036	-0.011	0.056	-.279	-1.057	-1.957
Prop. of Coll. Grad in P25P	0.000	-0.001	-0.002	-0.000	-0.002	-0.005	-0.008
Private Exp., Education	0.605	1.084	0.872	-0.262	-1.475	-2.582	-3.016
Private Exp., Health	0.281	0.488	0.375	-0.0141	-0.630	-1.037	-1.169
Private Exp., Food	9.392	14.599	8.948	-6.599	-16.804	-23.064	-23.712
Private Exp., Others	5.741	9.582	6.793	-3.526	-11.876	-18.056	-19.462
Capital Exp., Non-Education	-0.282	2.536	-0.812	-1.870	-4.409	-4.579	-1.563
Health Expenditure Per Capita	0.000	0.000	0.000	-0.000	0.000	0.000	0.000
Total Govt. Capital Exp.	-0.300	2.691	-0.906	-2.012	-4.503	-4.676	-1.652
Price of Investment Goods	0.015	0.000	-0.001	0.000	0.000	0.000	0.000
Prices of Imported Goods	0.091	-0.001	-0.010	-0.006	-0.005	-0.007	-0.006
Prop. of Rural Households	0.000	-0.001	-0.001	0.000	0.000	0.000	0.000
Infant Mortality Rate	-0.240	-0.585	0.015	0.000	0.022	0.019	0.020
Marital General Fertility	-0.054	-0.370	-0.565	-0.384	-0.109	-0.062	-0.058
Population, Female	0.000	1.157	2.649	-0.728	-5.132	-8.574	-9.971
Population, Male	0.000	1.157	2.649	-0.728	-5.132	-8.574	-9.971
Population, Total	0.000	2.314	5.297	-1.456	-10.265	-17.148	-19.941
Youth Dependency Ratio	0.000	0.000	0.000	-0.000	0.000	0.000	0.000
Population 15 and over, Female	0.000	0.586	1.536	0.609	-0.065	-0.257	-0.344
Population 15 and over, Male	0.000	0.586	1.536	0.609	-0.065	-0.257	-0.344
Population Growth Rate	0.000	0.001	0.003	-0.002	-0.004	-0.002	0.000
No. of Households	0.000	0.486	1.286	0.484	-0.507	-0.207	-0.287
Population 15 and over	0.000	0.980	2.574	0.965	-0.115	-0.409	-0.554
Death rate among P25P	0.000	0.980	1.614	0.955	0.110	-0.096	-2.551

To test the investment diversion effect, the marital general fertility rate is raised and its effects on human capital expenditures are analyzed. These exercises are discussed in sub-section 3.1.

To gain insights on the second issue, two types of simulations are done. viz: one, counterfactual simulations employing one-period shock on human capital variables to analyze the dynamic impact of the shock on development variables; and two, ex-ante forecast simulations where human capital variables and fertility rates were subjected to sustained shocks. Comparison of the shocked and unshocked simulation results yields measures of the relative potency of human capital variables as tools for economic and demographic development. These experiments are discussed in sub-sections 3.2 and 3.3, respectively.

3.1 Population Growth and Human Capital Expenditures

Impact of an Increase in Fertility. Figure 3.1 traces the effects of fertility changes on economic-demographic development. The main avenue of the effect is in causing a change in the demographic structure of the population. This change is then fed into the economic submodel. Several feedback effects are also shown in the figure. These include changes in the GNP per capita, the educational status variables, the rate of urbanization (*PROHR*) and the infant mortality rate.

The Policy Handle. To address the issues of the effects of population growth on human capital expenditures, the marital general fertility rate (MGFR) is adjusted upwards by 20 per thousand married women for the period 1968-1986. This is implemented via constant adjustment because MGFR is an endogenous variable.

The Simulation Results. Table 3.1 reports the percentage differences of human capital expenditures computed from MGFR - adjusted and unadjusted runs. The base run values are given in Table 3.2.

The rise in fertility rates causes an increase in the current operating expenditures on health and education relative to their baserun values. This rise in current operating expenditures on education and on health is due to the increase in total government consumption expenditures - a variable which is positively related

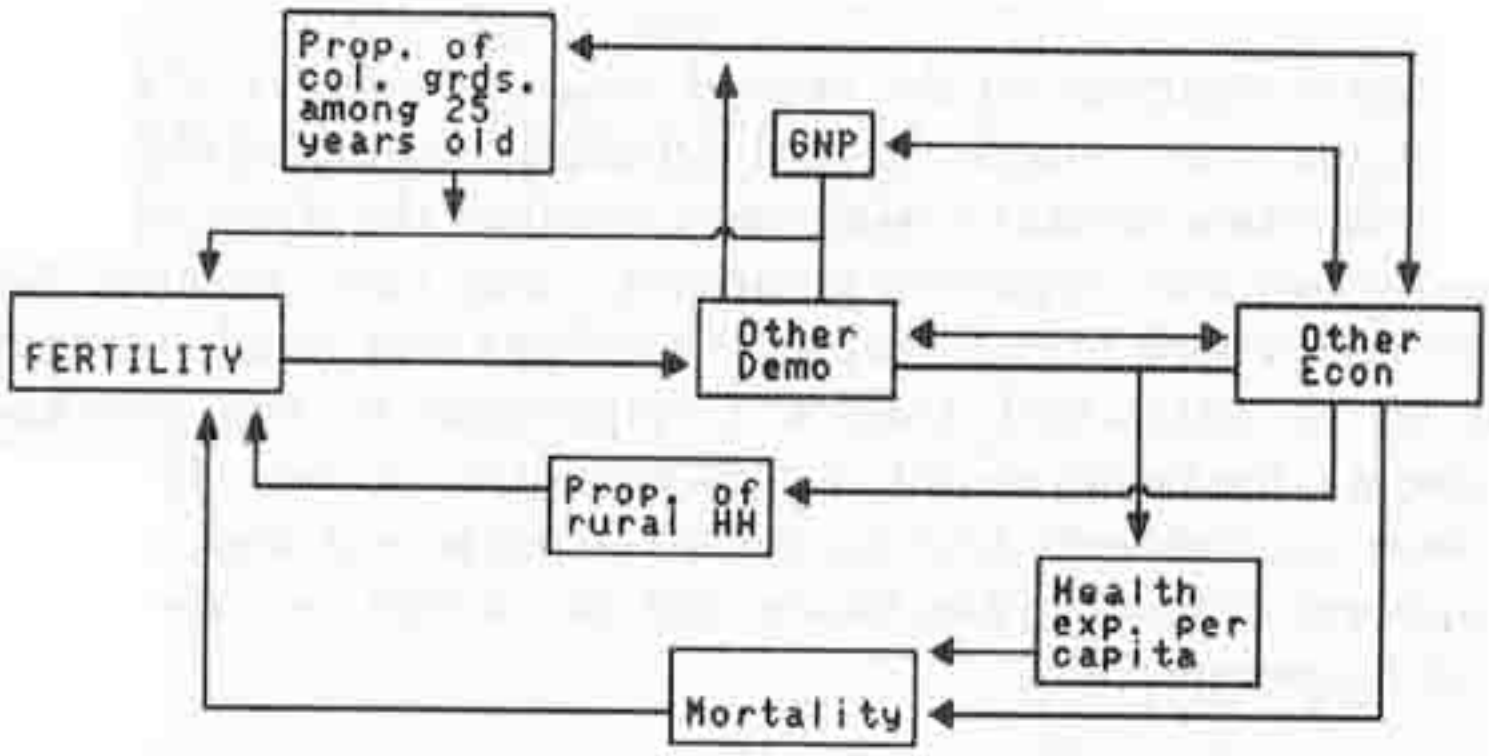

Figure 3.1 - Impact of Fertility

with population size. Capital expenditures on education[18], on the other hand, follow the percentage decline of the GNP relative to its baserun values. When the per capita expenditures are computed, lower figures relative to their baserun values for both health and education are obtained. There are shown in Figure 3.2 and Figure 3.3. Generally, therefore, human capital expenditures do rise with population growth but the increase is not sufficient to maintain the level of per capita expenditures. This result is consistent with what Schultz (1987) found in his study on educational expenditures. It was reported that education expenditures grew with the school age population although the growth was slower than the growth of the cohort, resulting in lower expenditures per capita. He hypothesized that this took the form of more enrolled children per teacher and lower teacher salaries.

The effect of an increase in fertility rates on other socioeconomic development indicators is shown in Table 3.3. Table 3.4 shows the base values of the socioeconomic and demographic development indicators.

Per capita incomes are shown to be lower relative to their baserun values, with higher fertility rates. An explanation to this result can be gleaned from the lower investment per capita which accompanies an even larger percentage decline in per capita savings.

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[18] Note that this variable is computed as a fixed proportion of GNP (Table 2.1).

Table 3.1 - Percentage Change From Base Case Due to Fertility Rate Increase

Variable	1968	1969	1970	1974	1978	1982	1986
HUMAN CAPITAL EXPENDITURES							
GOVERNMENT:							
CURRENT OPERATING:							
Education	0.000	0.216	0.400	1.506	1.965	2.333	3.655
Health	0.000	0.216	0.400	1.506	1.965	2.333	3.655
CAPITAL EXP.							
ON EDUC.	0.000	-0.003	-0.003	-0.017	-0.050	-0.140	-0.326
PRIVATE							
Education	0.000	-0.004	-0.008	0.015	0.108	0.220	0.105
Health	0.000	-0.000	0.003	0.066	0.213	0.386	0.324
TOTAL EDUC. EXP.	0.000	0.103	0.188	0.446	0.752	1.062	1.298
HEALTH EXP. PER CAPITA	0.000	-0.067	-0.130	-0.703	-0.912	-1.086	-1.782
EDUCATION EXP. PER CAPITA	0.000	-0.024	-0.061	-0.655	-0.842	-0.972	-1.695
GNP	0.000	-0.003	-0.003	-0.017	-0.050	-0.140	-0.326
POPULATION	0.000	0.127	0.249	1.109	1.607	2.054	3.043
YOUTH DEP. RATIO	0.000	0.176	0.348	1.678	2.500	3.111	4.567

Table 3.2 - Human Capital Expenditures: Base Values

Variable	1968	1969	1970	1974	1978	1982	1986
HUMAN CAPITAL EXPENDITURES (1972 Pesos)							
Government (Millions):							
CURRENT OPERATING:							
Education	1160	1244	1304	792	1363	2272	1911
Health	184	220	254	235	370	528	511
CAPITAL EXP. ON EDUC.	64	84	66	127	112	129	128
PRIVATE (Millions):							
Education	1135	1236	1339	1810	2443	3239	3545
Health	541	578	615	786	1018	1305	1396
TOTAL EDUC. EXP. (MILLIONS)	2359	2563	2709	2728	3918	5640	5584
HEALTH EXP. PER CAPITA	22	23	25	26	32	36	35
EDUCATION EXP. PER CAPITA	71	75	77	70	90	112	102
GNP (Millions)	47117	50092	52161	62433	81495	101759	87825
POPULATION ('000)	33011	34103	35308	39093	43486	50514	54583
YOUTH DEP. RATIO	0.4186	0.4176	0.4171	0.3956	0.3881	0.3971	0.4048

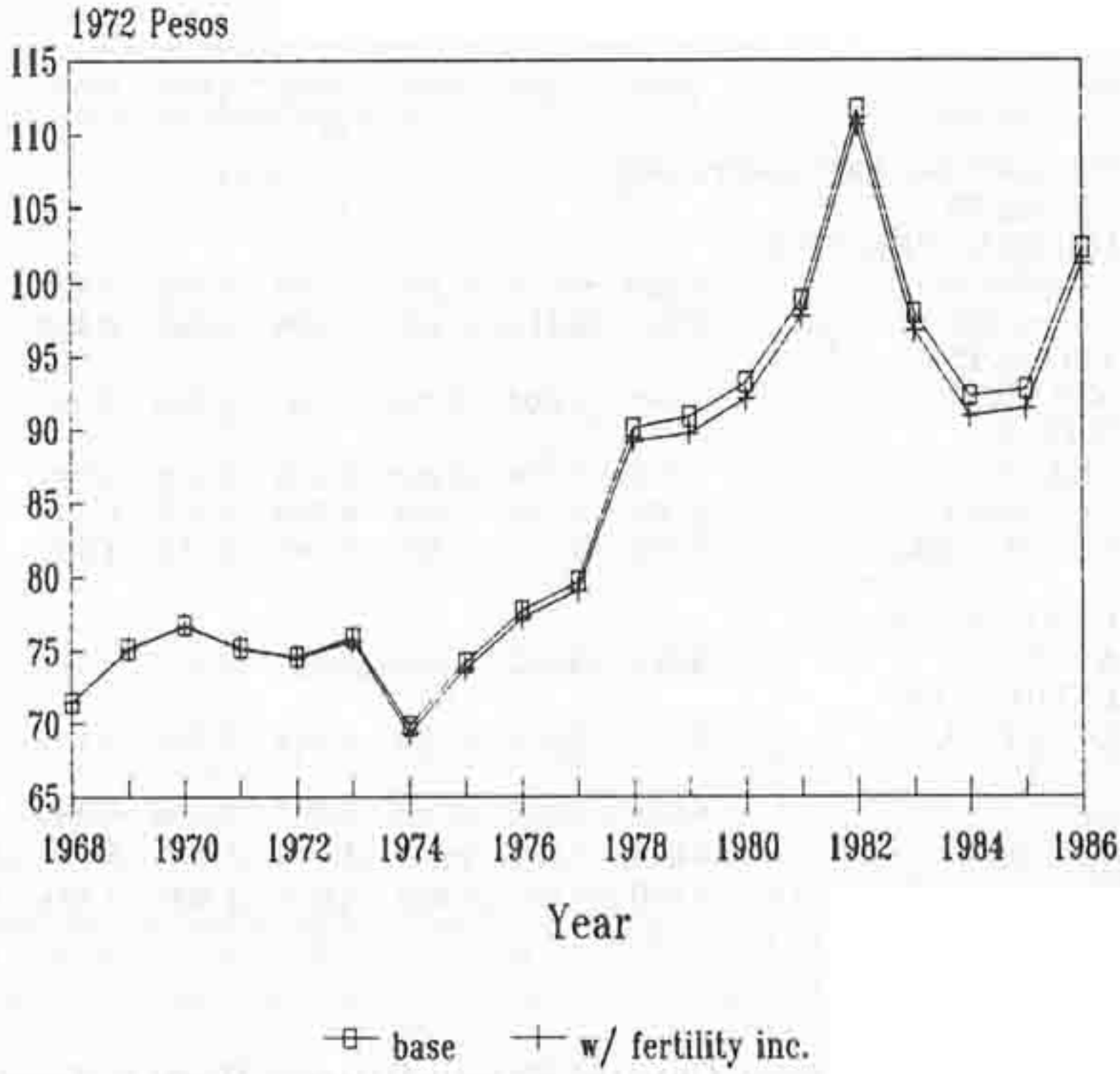

Figure 3.2 - Effects of Fertility Increase on Education Expenditure Per Capita

Compared to their baserun values, the real wage rates yield higher values as a result of the increase in fertility rates. This result implies that the demographic pressure, which is measured by the employment ratio, arising from the applied higher fertility rates is not sufficient to depress real wages. The "full-time" unemployment rate, however, does rise with higher fertility rates as expected. These results highlight the assumption of partial adjustment in the labor market employed in this study. The immediate effect of higher fertility rates is seen in increased unemployment rate rather than a decline in real wage rates.

The effect of higher fertility rates on structural transformation is shown by the movement of the proportion of workers employed in agriculture and the proportion of output contributed by agriculture. The results imply that higher fertility rates retard the movement of workers and output from agriculture to non-agriculture.

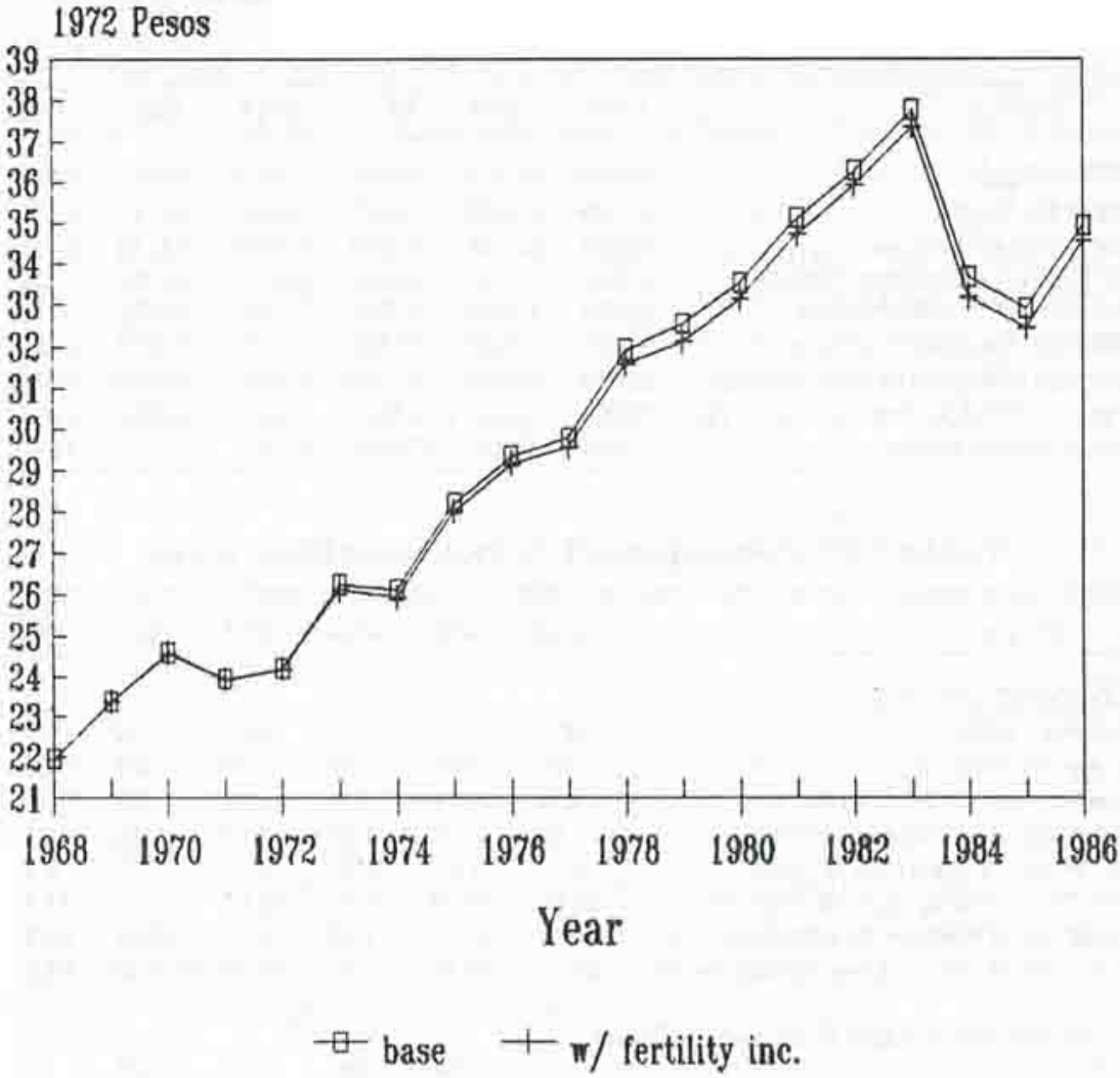

Figure 3.3 - Effects of Fertility Increase on Health Expenditure Per Capita

These results have to be qualified by what is assumed about external financing. Recall that Williamson (1988) pointed out that external financing eases off the pressure of rapid population growth on development. The availability of external financing is reflected in the model by the movement of the current account balance. Table 3.3 shows a general deterioration of the current account balance with higher fertility rates. This implies that some external financing was availed off, hence, the impact shown in the table should be taken as somewhat attenuated by external financing.

This set of results supports many of the previous results obtained from simulating the effects of higher population growth rates (Coale and Hoover, 1958; National Research Council, 1986).

Table 3.3 - Percentage Change From Base Values Due to Fertility Increase

Period	1968	1970	1974	1978	1982	1986
GNP Per Capita	0.0000	-0.2614	-1.2186	-1.8473	-2.0244	-2.0223
Savings Per Capita	0.0000	-0.6518	-3.1627	-4.3744	-5.0117	-8.1377
Total Invetment Per Capita	0.0000	-0.2328	-1.1959	-2.0282	-2.6110	-3.6694
Real Wages of Agricultural Workers	0.0000	0.0364	0.1282	0.2504	0.3068	0.3124
Real Wages of Unskilled Workers	0.0000	0.0499	0.1916	0.4639	0.6766	0.7611
"Full-Time" Unemployment Rate (%)	0.0000	0.0359	0.1649	0.2789	0.4635	-0.3504
Proportion of Workers in Agriculture (%)	0.0000	0.0609	0.3745	0.6942	1.0782	0.8242
Proportion of Output from Agriculture (%)	0.0000	0.1068	0.5816	1.0849	1.7671	2.0273
Current Account Balance	0.0000	-3.9450	-37.0530	-61.1950	-23.3740	-37.5400

Table 3.4 - Development Indicators: Base Case

Period	1968	1970	1974	1978	1982	1986
ECONOMIC (1972 Pesos):						
GNP Per Capita	1427	1477	1597	1874	2014	1609
Savings Per Capita	260	291	340	532	641	299
Total Investment Per Capita	270	269	319	428	437	188
Real Wages of Agricultural Workers	4.52	4.19	4.09	4.23	4.15	4.11
Real Wages of Unskilled Workers	8.64	7.01	6.47	7.05	7.75	9.20
"Full-Time" Unemployment Rate (%)	38.54	33.99	36.44	35.07	32.21	41.78
Proportion of Workers in Agriculture (%)	60.07	58.06	57.11	56.54	54.63	55.46
Proportion of Output from Agriculture (%)	30.41	28.10	27.51	26.73	24.90	28.61
Current Operating Expenditures on (Millions):						
Health	184	254	235	370	528	511
Education	1160	1304	792	1363	2272	1911
Capital Expenditures on (Millions):						
Education	64	66	127	112	129	128
Non-Education	1027	566	1670	5264	6144	2245
DEMOGRAPHIC:						
Marital General Fertility (per 1000)	305.14	302.12	274.82	253.28	231.99	224.53
Infant Mortality (per 1000)	96.59	83.03	74.79	62.75	52.12	53.45
Population ('000)	33011	35308	39093	43486	50514	54583

3.2 Human Capital Expenditures in Development

The simulation experiments discussed in this section employ one-period shocks on human capital expenditures, particularly, government expenditures on education and health. These exercises yield measures of the dynamic effects of changing human capital expenditures.

Impact of Education Expenditures. A simplified version of the model highlighting the impact of education expenditures on economic-demographic development is presented in Figure 3.4. An increase in education expenditures has two direct effects, namely: i) an increase in the proportion of college graduates among 25 years old and over, thereby increasing the productivity of labor which together with GNP per capita causes the reduction in fertility rates, and ii) an increase in the total government expenditures. Figure 3.4 also shows several feedback effects. These basically result from increased income and expenditures, on the economic side; and changes in the structure of the population, on the demographic side.

Impact of Health Expenditures. Figure 3.5 presents a simplified model of the impact of health expenditures. Increases in health expenditures have two direct effects, namely: i) an increase in health expenditures per capita which causes an increase in the productivity of labor and a decrease in infant mortality rates, and ii) an increase in total government expenditures. The feedback effects are identical to those resulting from changes in educational expenditures.

Measuring the Impact on Output. The dynamic effect on development of changing different human capital expenditures will be measured through their effects on GNP. The indicators used are the ratio of two multiplier values and the corresponding elasticities of GNP with respect to the shocked expenditures.

In order to appreciate how the ratio of the multiplier values indeed measures the dynamic impact of human capital expenditures on development, some elaboration is needed. Recall that the multiplier value for any endogenous variable Y at any time t as a result of a shock applied at time 0 to an exogenous variable X is given by the ratio dY_t/dX_o. The term dY_t is the difference between the shocked and the unshocked values of Y at any time t and dX_o is the difference for variable X at the time of the shock. Suppose dZ_o is the difference in human capital expenditure Z, another endogenous variable, at the time when the shock is applied to X. Then, the change in Y due to the change in Z can be approximated by the ratio $(dY/dX_o)/(dZ_o/dX_o)$. This is the ratio of the multiplier values of Y at time t and the multiplier value of Z at the time when the shock is applied. This ratio then measures the per peso effect on GNP of a change in human capital expenditures.

The weakness of the approximation described above emanates from its being a discrete measurement of the impact. Note that the

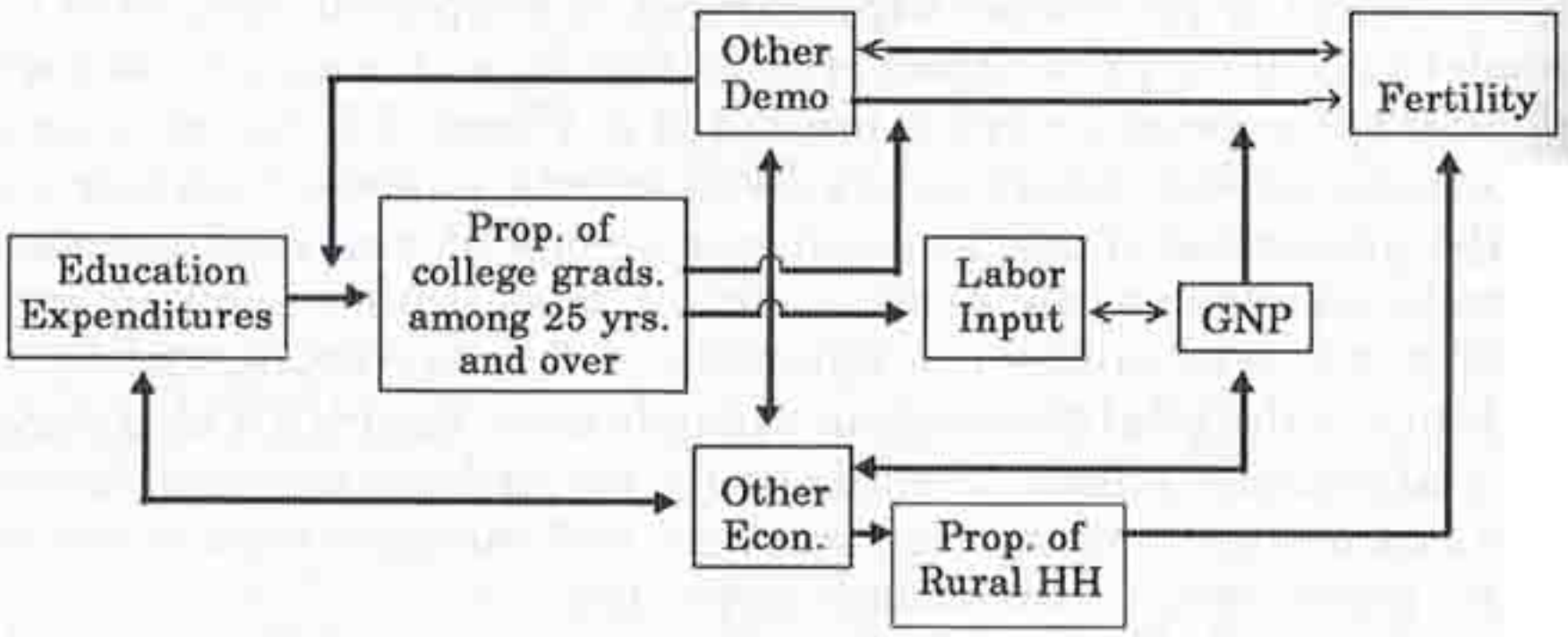

FIGURE 3.4 - Impact of Education Expenditures

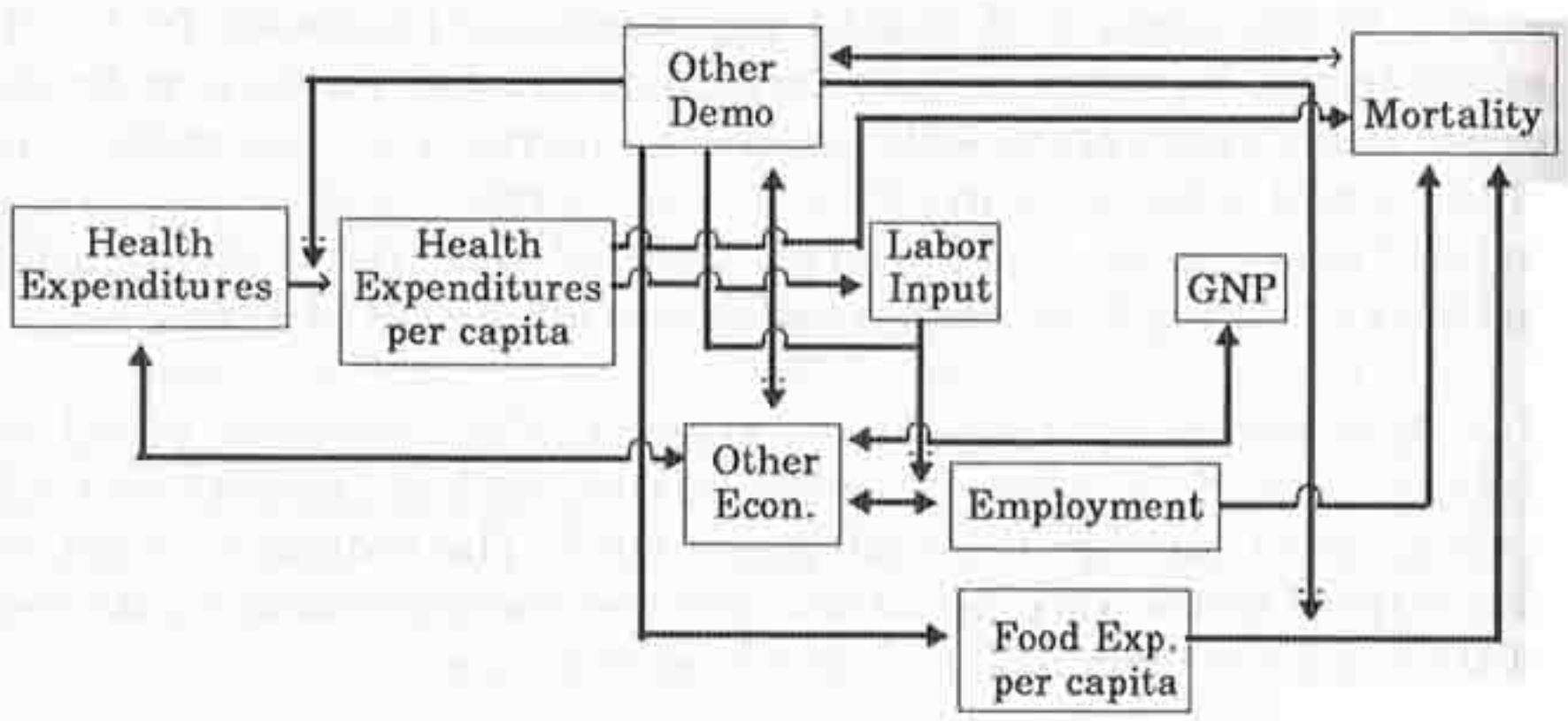

FIGURE 3.5 - Impact of Health Expenditures

value of the multiplier: $dY_t/dX_o = (Y_t^s - Y_t)/(X_o^s - X_o)$ is dependent on how large $(X_o^s - X_o)$ is and the shape of the $Y=f(X,...)$ function. The variables with superscript s are shocked values. Given a concave function f, the larger the difference $(X_o^s - X_o)$, the smaller the values of the ratio dY_t/D_o.

The elasticity of Y with respect to the Z is also computed. This measure will express the effects in percentage changes. To get the elasticities, the ratios earlier presented are multiplied by the term (Z_o/Y_t).

Comparing the multiplier ratios and the elasticities obtained from shocks applied to different human capital variables and non-human capital variables allows one to compare the relative potency

of the variables in terms of their effects on the movement of key variables.

The deviation of other development indicators from their base run values is also presented and analyzed.

The Policy Handles. There are three government expenditure ratios that can be shocked to obtain the effects of changes in human capital variables on development. These are:

HRCG = the ratio of current operating expenditures on health to total government consumption expenditures;
EDRCG = the ratio of current operating expenditures on education to total government consumption expenditures; and
IERGNP = the ratio of capital expenditures on education to GNP.

The ratio of government's non-education capital expenditures to GNP (INRGNP) is also shocked to enable us to compare the effect of non-human capital expenditure[19].

In the exercises, a 10 percent increase in 1968 is applied to these variables and their effects are worked out in separate simulation runs for the period 1968-1986.

The Simulation Results. The ratio of multiplier values between GNP and the corresponding expenditure variables are given in Table 3.5. The table shows that health expenditure is very potent at the time of the shock but the effect dies out very quickly while that of education gradually builds up and appears to be more lasting. Non-human capital expenditures appear to be much more potent and also have lasting effects on output.

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[19]Note that capital expenditures on health are subsumed in this variable as explained in the previous section. This is because while current expenditures may have no lasting effects (or have high depreciation rate), the same cannot be said of capital expenditures on health. The services of these expenditures last with the equipment. It is for this reason that these expenditures were lumped with the other government capital expenditures.

Table 3.5 - Ratio of Multiplier Values of GNP and Shocked Variables

Shocked Variable	1968	1969	1970	1974	1978	1982	1986
Current Operating Expenditures on:							
Health	2.4368	0.2359	0.2240	-0.1066	0.2069	0.2789	0.2908
Education	0.000	0.5430	0.5702	0.4908	0.5214	0.5689	0.4528
Capital Expenditures on:							
Education	0.0073	0.5142	0.5826	0.4929	0.5331	0.5758	0.4441
Non-Education	0.9924	1.0878	1.1768	1.1952	1.0761	1.1200	0.9339

The values of the elasticities given in Table 3.6 express the impact in terms of percentage changes.

Tables 3.7 and 3.8 shows the effects on other economic-demographic development indicators. (Table 3.4 in the previous section presented the base values of the socioeconomic and demographic development indicators.) These tables also reflect the fact that health expenditures have a substantial effect immediately after the shock but which dies down rapidly while education has a small but long lingering effect. A very discernible differential effect between increasing education vis-a-vis health expenditures can also be seen in their impact on per capita income. A one-time increase in education expenditures has a consistent positive effect on per capita income. The same is not true for health expenditures. Instead, a high immediate impact followed by an oscillation is observed. Another observable differential effect of increasing education vis-a-vis health expenditures is on structural transformation. Education expenditures have a consistent negative effect on the proportion of worker and output from agriculture. The same cannot be said of the effect of health expenditures. This result follows from the effect on per capita income which, among others, is the determinant of these variables. Still another appreciable differential effect of education as compared with health expenditures is on demographic development. Education expenditures have a consistent favorable effect on fertility, mortality, and population size. Health expenditures, on the other hand, bring forth large favorable effects only in the immediate term leaving the movements in the succeeding periods to be determined by the movements in the unemployment rate.

Despite the shortcomings in modelling the effects of human capital in production, these results support the hypothesis that human capital expenditures do have an appreciable effect on socioeconomic development. While the results seem to suggest that human capital

Table 3.6 - Elasticities of GNP with Respect to Shocked Variables

Shocked Variable	1968	1969	1970	1974	1978	1982	1986
Current Operating Expenditures on:							
Health	0.0105	0.0010	0.0009	-0.0003	0.0005	0.0006	0.0007
Education	0.0000	0.0138	0.0139	0.0100	0.0082	0.0071	0.0066
Capital Expenditures on:							
Education	0.0000	0.0007	0.0008	0.0006	0.0005	0.0004	0.0004
Non-Education	0.0238	0.0245	0.0255	0.0216	0.0149	0.0124	0.0120

Table 3.7 - Percentage Difference from Base Case Shocked Variable: Proportion of Current Expenditures on Health

Period	1968	1970	1974	1978	1982	1986
ECONOMIC:						
GNP Per Capita	0.0953	0.0091	-0.0179	0.0090	0.0210	0.0217
Savings Per Capita	0.4620	0.0021	-0.0535	0.0251	0.0481	0.0807
Total Investment Per Capita	-0.0659	-0.0567	-0.0090	0.0101	0.0255	0.0325
Real Wages of Agricultural Workers	-0.0180	0.0081	0.0049	-0.0005	-0.0035	-0.0046
Real Wages of Unskilled Workers	-0.0270	0.0063	-0.006	-0.0026	-0.0051	-0.0084
"Full-Time" Unemployment Rate	-0.0823	0.0006	0.0467	-0.0051	-0.0090	-0.0041
Proportion of Workers in Agriculture	-0.0197	0.0074	0.0014	-0.0089	-0.0104	-0.0047
Proportion of Output from Agriculture	0.0000	0.0000	0.0000	0.0000	-0.0402	0.0000
Current Account Balance	1.8590	0.7990	-0.4770	0.4750	0.2060	0.2700
DEMOGRAPHIC:						
Marital General Fertility	-0.0012	-0.1115	-0.0341	-0.0063	-0.0084	-0.0086
Infant Mortality	-1.0484	0.0035	0.0123	-0.0088	-0.0129	-0.0097
Population	0.0000	-0.0012	0.0148	-0.0043	-0.0159	-0.0156

Table 3.8 - Percentage Difference from Base Case Shocked Variable: Proportion of Current Expenditures on Education

Period	1968	1970	1974	1978	1982	1986
ECONOMIC:						
GNP Per Capita	0.0000	0.1265	0.0927	0.0797	0.0761	0.0771
Savings Per Capita	0.0000	0.5213	0.2428	0.1414	0.1262	0.1903
Total Invesment Per Capita	0.0000	0.1635	0.0498	0.0633	0.0697	0.0800
Real Wages of Agricultural Workers	0.0000	0.0122	0.0368	0.0133	0.0018	-0.0013
Real Wages of Unskilled Workers	0.0000	0.0280	0.0316	-0.0103	-0.0171	-0.0142
"Full-Time" Unemployment Rate	0.0000	-0.2236	-0.1100	-0.0622	-0.0546	-0.0239
Proportion of Workers in Agriculture	0.0000	-0.0402	-0.0286	-0.0131	-0.0128	-0.0103
Proportion of Output from Agriculture	0.0000	-0.0356	-0.0364	-0.0374	-0.0402	-0.0350
DEMOGRAPHIC:						
Marital General Fertility	0.0000	-0.0345	-0.0629	-0.0687	-0.0662	-0.0604
Infant Mortality	0.0000	-0.0599	-0.0694	-0.0711	-0.0721	-0.0649
Population	0.0000	0.0004	-0.0015	-0.0054	-0.0113	-0.0173

expenditures are less productive than non-human capital expenditures, if the effect on GNP is the only gauge, this must be qualified by the fact that what is captured in the formulation used in this study might be the least significant among the effects of human capital expenditures on output (Peterson, 1989).[20] Given Peterson's arguments, the results presented here must be viewed as a first approximation.

3.3 *Human Capital Expenditures and Fertility in Future Economic-Demographic Development*

The simulations discussed in section 3.2 employed one-period shocks. These were designed to yield information on the dynamic effects of changing the different types of government expenditures. In this section sustained shocks on human capital expenditures and fertility are applied throughout the ex-ante simulation period, 1987-2015. This exercise is designed to provide insights into the relative potency of these variables as tools of future development.

The Baseline Scenario. A baseline scenario on future economic-demographic development is constructed given a set of assumptions about the exogenous variables. The assumptions involve the use of trend values for level variables and the average value of the preceding decade (1977-1986) for ratio variables.

The baseline scenario indicates that the five-year average annual GNP growth of the economy goes as high as 5.7 percent to as low as 4.9 percent (Table 3.9). GNP per capita, on the other hand, is expected to increase to 4,645, in 1972 prices, by 2015 (Table 3.12). Unemployment rate, considering only "full-time[21]" employed workers, declines to 27.24 by 2015 from 45.61 in 1985 (Table 3.13). The real wage rate of agricultural workers is shown to slightly increase in the intermediate run before it declines for the rest of the simulation period (Table 3.14). The real wage rate of unskilled urban workers, on the other hand, follows the behaviour of agricultural wages, except that it declines to a level even below the 1985 rate (Table 3.15). The rate of structural transformation, as measured by the proportion of output contributed by agriculture and the proportion of total workers employed in the agricultural sector, is shown to be gradual and sometimes tentative (Tables 3.16 and 3.17). The marital general

[20]See discussion in 2.1.2.

[21]Those employed forty hours or more per week.

fertility rate declines from 193 per thousand married women in 1985 to 120 per thousand married women in 2015 (Table 3.18). The infant mortality rate, on the other hand, declines from 44 per 1000 live births in 1985 to 16 per 1000 live births in 2015 (Table 3.19). These estimates for fertility and infant mortality are slightly higher than those projected for East-Asian countries as computed in 1984 (UN, 1984). The population size is expected to increase to 98.3 million by 2015 (Table 3.20). This estimate is higher than the medium variant projection of the NCSO based on the 1980 census (NCSO, 1985).

The Policy Shocks. The policy changes applied involved raising the ratio of current operating expenditures on health and on education to total government consumption expenditures by 10 percent, reducing marital general fertility by 20 per thousand married women, and combining these changes throughout the ex-ante simulation period, 1987-2015.

The Simulation Results. The simulated values of the key variables resulting from the policy changes are given in Tables 3.9 to 3.20.

Table 3.9 indicates that individually, reducing fertility rates and raising the proportion of current operating expenditures on health and education affect GNP growth appreciably. The effect of combining these shocks does not approximate the sum of the separate effects, indicating that the effects may not be independent nor linear. In terms of the change in per capita incomes, the decrease in fertility rates yields the largest effect while increasing the human capital expenditures has very marginal effects (Table 3.12). Tables 3.13 to 3.15 shows that the shocks applied to the system do not substantially affect employment and wage rates. Separately raising human capital expenditures or lowering fertility rates do not appreciably affect employment rates but a combination of both yields substantial effects but only after about twenty years into the simulation. This implies that to make a dent in employment, fertility reduction, coupled with an expanding economy[22], will be necessary. In addition, this effect is

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[22]A similar conclusion was arrived at in a recent assessment of the employment prospects of the country over the medium term (ILO, 1990). In particular, it was argued that in order to absorb the current stock of open unemployed and the new entrants to the labor force the economy has to grow from 8 to 10 percent. This was based on the assumption that employment grows at 4 percent and that the estimate of employment elasticities is between 0.4 to 0.5.

Table 3.9 - Average GNP Growth Rate (Percent)

	BASE	Decline in Fertility		Increase in Operating Expenditure on				Combination of			
				Health		Education		(B) & (C)		(B) & (D)	
	(A)	(B)	% Diff	(C)	% Diff	(D)	% Diff		% Diff		% Diff
1985-1990	4.872	4.794	-1.6010	4.824	-0.9852	4.838	-0.6979	4.824	-0.9852	4.842	-0.6158
1991-1995	5.746	6.016	4.6989	6.006	4.5249	6.058	5.4299	6.024	4.8381	6.076	5.7431
1996-2000	5.048	5.436	7.6862	5.388	6.7353	5.440	7.7655	5.446	7.8843	5.490	8.7559
2001-2005	5.352	5.828	8.8939	5.750	7.4365	5.794	8.2586	5.836	9.0433	5.874	9.7534
2006-2010	5.562	6.090	9.4930	6.008	8.0187	6.040	8.5940	6.096	9.6009	6.130	10.2122
2011-2015	5.426	6.020	10.9473	5.940	9.4729	5.970	10.0258	6.020	10.9473	6.048	11.4633

Table 3.10 - Total Savings Per Capita (1972 Pesos)

	BASE	Decline in Fertility		Increase in Operating Expenditure on				Combination of			
				Health		Education		(B) & (C)		(B) & (D)	
	(A)	(B)	% Diff	(C)	% Diff	(D)	% Diff		% Diff		% Diff
1985	251	251	0.0000	251	0.0000	251	0.0000	251	0.0000	251	0.0000
1990	420	424	0.9524	422	0.4762	423	0.7143	426	1.4286	428	1.8913
1995	725	756	4.2759	727	0.2759	733	1.1034	759	4.6897	765	5.4570
2000	1029	1118	8.6492	1033	0.3887	1044	1.4577	1123	9.1351	1134	10.0575
2005	1446	1629	12.6556	1453	0.4841	1471	1.7289	1636	13.1397	1655	14.2080
2010	1995	2294	14.9875	2004	0.4511	2032	1.8546	2304	15.4887	2336	16.7815
2015	2685	3136	16.7970	2698	0.4842	2741	2.0857	3150	17.3184	3200	18.7888

Table 3.11 - Total Investment Per Worker (1972 Pesos)

	BASE	Decline in Fertility		Increase in Operating Expenditure on				Combination of			
				Health		Education		(B) & (C)		(B) & (D)	
	(A)	(B)	% Diff	(C)	% Diff	(D)	% Diff		% Diff		% Diff
1985	644	644	0.0000	644	0.0000	644	0.0000	644	0.0000	644	0.0000
1990	1038	1038	0.0000	1040	0.1927	1040	0.1927	1040	0.1927	1041	0.2890
1995	1300	1306	0.4615	1302	0.1538	1306	0.4615	1308	0.6154	1312	0.9231
2000	1587	1610	1.4493	1591	0.2520	1600	0.8192	1613	1.6383	1622	2.2054
2005	2010	2061	2.5373	2015	0.2488	2030	0.9950	2066	2.7861	2081	3.5323
2010	2573	2657	3.2647	2581	0.3109	2603	1.1660	2665	3.5756	2688	4.4695
2015	3261	3368	3.2812	3271	0.3067	3303	1.2879	3378	3.5879	3411	4.5998

Table 3.12 - Per Capita GNP (1972 Pesos)

	BASE	Decline in Fertility		Increase in Operating Expenditure on				Combination of			
				Health		Education		(B) & (C)		(B) & (D)	
	(A)	(B)	% Diff	(C)	% Diff	(D)	% Diff		% Diff		% Diff
1985	1609	1609	0.0000	1609	0.0000	1609	0.0000	1609	0.0000	1609	0.0000
1990	1812	1819	0.3863	1815	0.1656	1816	0.2208	1822	0.5519	1823	0.6071
1995	2181	2224	1.9716	2185	0.1834	2192	0.5044	2227	2.1091	2235	2.4759
2000	2564	2668	4.0562	2569	0.1950	2585	0.8190	2673	4.2512	2689	4.8752
2005	3085	3279	6.2885	3092	0.2269	3118	1.0697	3287	6.5478	3314	7.4230
2010	3779	4105	8.6266	3790	0.2911	3829	1.3231	4116	8.9177	4158	10.0291
2015	4645	5152	10.9150	4659	0.3014	4716	1.5285	5168	11.2594	5231	12.6157

Table 3.13 - "Full-Time Unemployment Rate (Percent)

	BASE	Decline in Fertility		Increase in Operating Expenditure on				Combination of			
				Health		Education		(B) & (C)		(B) & (D)	
	(A)	(B)	% Diff	(C)	% Diff	(D)	% Diff		% Diff		% Diff
1985	45.61	45.61	0.0000	45.61	0.0000	45.61	0.0000	45.61	0.0000	45.61	0.0000
1990	41.39	41.37	-0.0483	41.37	-0.0592	41.33	-0.1488	41.35	-0.0966	41.31	-0.1933
1995	35.12	35.11	-0.0285	35.11	-0.0424	35.00	-0.3468	35.07	-0.1424	34.97	-0.4271
2000	32.77	32.77	0.0000	32.77	-0.0150	32.61	-0.4947	32.76	-0.0305	32.61	-0.4883
2005	31.08	31.08	0.0000	31.08	-0.0010	30.88	-0.6406	31.14	0.1931	30.94	-0.4505
2010	28.96	28.96	0.0000	28.96	0.0031	28.73	-0.7932	27.72	-4.2818	27.49	-5.0760
2015	27.24	27.22	-0.0734	27.22	-0.0576	26.96	-1.0143	24.52	-9.9853	24.26	-10.9398

Table 3.14 - Real Wages for Agricultural Workers (1972 Pesos)

	BASE	Decline in Fertility		Increase in Operating Expenditure on				Combination of			
				Health		Education		(B) & (C)		(B) & (D)	
	(A)	(B)	% Diff	(C)	% Diff	(D)	% Diff		% Diff		% Diff
1985	3.69	3.69	0.0000	3.69	0.0000	3.69	0.0000	3.69	0.0000	3.69	0.0000
1990	4.20	4.20	-0.0452	4.20	0.0000	4.20	0.0000	4.20	-0.0571	4.20	-0.0595
1995	4.14	4.13	-0.1787	4.14	0.0000	4.14	0.0000	4.13	-0.1836	4.13	-0.1957
2000	4.12	4.11	-0.3592	4.12	-0.0728	4.12	-0.728	4.10	-0.3665	4.10	-0.3738
2005	4.12	4.10	-0.3835	4.12	-0.0728	4.12	-0.0728	4.10	-0.3908	4.10	-0.4053
2010	4.13	4.13	-0.0412	4.13	0.0484	4.13	0.0484	4.13	-0.0436	4.13	-0.0436
2015	4.16	4.16	-0.0288	4.16	-0.1202	4.16	-0.1202	4.16	-0.0288	4.15	-0.1971

Table 3.15 - Real Wages for Unskilled Workers (1972 Pesos)

	BASE	Decline in Fertility		Increase in Operating Expenditure on				Combination of			
				Health		Education		(B) & (C)		(B) & (D)	
	(A)	(B)	% Diff	(C)	% Diff	(D)	% Diff		% Diff		% Diff
1985	4.38	4.38	0.0000	4.38	0.0000	4.38	0.0000	4.38	0.0000	4.38	0.0000
1990	4.63	4.63	0.0324	4.63	0.0648	4.63	0.0648	4.63	0.0302	4.63	0.0346
1995	4.58	4.57	-0.2162	4.58	-0.0873	4.58	-0.0655	4.57	-0.2227	4.57	-0.2118
2000	4.48	4.47	-0.2254	4.48	0.0223	4.48	0.0446	4.47	-0.2366	4.47	-0.2254
2005	4.41	4.40	-0.2766	4.41	0.0227	4.41	0.0227	4.40	-0.2880	4.40	-0.2857
2010	4.37	4.37	-0.1030	4.37	-0.0229	4.37	0.0000	4.37	-0.1121	4.37	-0.1030
2015	4.35	4.35	-0.0299	4.35	-0.1149	4.35	-0.0920	4.35	-0.345	4.35	-0.0276

Table 3.16 - Proportion of Workers in Agriculture (Percent)

	BASE	Decline in Fertility		Increase in Operating Expenditure on				Combination of			
				Health		Education		(B) & (C)		(B) & (D)	
	(A)	(B)	% Diff	(C)	% Diff	(D)	% Diff		% Diff		% Diff
1985	49.44	49.44	0.0000	49.44	0.0000	49.44	0.0000	49.44	0.0000	49.44	0.0000
1990	44.50	44.43	-0.1573	44.50	0.0067	44.50	0.0090	44.43	-0.1573	44.43	-0.1573
1995	41.22	40.87	-0.8491	41.22	0.0073	41.22	-0.0049	40.87	-0.8491	40.87	-0.8491
2000	40.45	39.82	-1.5575	40.46	0.0148	40.46	0.0124	39.83	-1.5328	39.83	-1.5328
2005	40.36	39.48	-2.1804	40.37	0.0173	40.37	0.0149	39.48	-2.1804	39.48	-2.1804
2010	40.64	39.49	-2.8297	40.64	0.0049	40.64	-0.0098	39.49	-2.8297	39.48	-2.8543
2015	41.05	39.61	-3.5079	41.06	0.0268	41.05	-0.0097	39.61	-3.5079	39.60	-3.5323

Table 3.17 - Proportion of Output from Agriculture (Percent)

	BASE	Decline in Fertility		Increase in Operating Expenditure on				Combination of			
				Health		Education		(B) & (C)		(B) & (D)	
	(A)	(B)	% Diff	(C)	% Diff	(D)	% Diff		% Diff		% Diff
1985	29.91	29.91	0.0000	29.91	0.0000	29.91	0.0000	29.91	0.0000	29.91	0.0000
1990	28.42	28.34	-0.2815	28.40	-0.0704	28.39	-0.1056	28.33	-0.3167	28.33	-0.3167
1995	26.34	25.95	-1.4806	26.33	-0.0380	26.28	-0.2278	25.93	-1.5566	25.88	-1.7464
2000	24.58	23.84	-3.0106	24.55	-0.1211	24.47	-0.4475	23.81	-3.1326	23.73	-3.4581
2005	22.62	21.59	-4.5535	22.59	-0.1326	22.47	-0.6631	21.56	-4.6861	21.46	-5.1282
2010	20.56	19.31	-6.0798	20.53	-0.1459	20.41	-0.7296	19.27	-6.2743	19.16	-6.8093
2015	18.60	17.19	-7.5806	18.57	-0.1613	18.43	-0.9140	17.16	-7.7419	17.03	-8.4409

Table 3.18 - Marital General Fertility Rate (Per 1000)

	BASE	Decline in Fertility		Increase in Operating Expenditure on				Combination of			
				Health		Education		(B) & (C)		(B) & (D)	
	(A)	(B)	% Diff	(C)	% Diff	(D)	% Diff		% Diff		% Diff
1985	193	193	0.0000	193	0.0000	193	0.0000	193	0.0000	193	0.0000
1990	171	144	-16.0292	171	-0.2807	171	-0.1637	143	-16.2456	143	-16.1170
1995	157	129	-17.5478	157	-0.2866	157	-0.2293	129	-17.8917	129	-17.8344
2000	146	118	-19.3904	145	-0.5822	145	-0.7329	177	-19.6986	117	-19.8562
2005	136	108	-20.3015	136	0.0662	136	-0.3088	108	-20.5882	107	-20.9706
2010	128	100	-22.1641	127	-0.4062	127	-1.0391	99	-22.4219	98	-23.0547
2015	120	91	-24.0417	119	-0.4750	118	-1.4000	91	-24.2583	90	-25.1883

Table 3.19 - Infant Mortality Rate (Per 1000)

	BASE	Decline in Fertility		Increase in Operating Expenditure on				Combination of			
				Health		Education		(B) & (C)		(B) & (D)	
	(A)	(B)	% Diff	(C)	% Diff	(D)	% Diff		% Diff		% Diff
1985	44	44	0.0000	44	0.0000	44	0.0000	44	0.0000	44	0.0000
1990	37	37	-1.0270	36	-2.5135	37	-0.8378	36	-2.7838	37	-1.1081
1995	32	31	-1.9062	31	-2.7500	32	-1.0938	31	-3.8750	31	-2.2188
2000	28	27	-2.5000	27	-3.1429	28	-1.2857	27	-4.6071	27	-3.1071
2005	24	23	-2.2083	23	-2.4583	24	-1.0417	23	-4.5000	23	-3.0833
2010	20	19	-4.8000	19	-3.2000	20	-1.9000	19	-7.2500	19	-5.9500
2015	16	15	-7.5000	16	-2.6875	16	-1.5000	14	-10.1875	15	-9.000

Table 3.20 - Population (Thousands)

	BASE	Decline in Fertility		Increase in Operating Expenditure on				Combination of			
				Health		Education		(B) & (C)		(B) & (D)	
	(A)	(B)	% Diff	(C)	% Diff	(D)	% Diff		% Diff		% Diff
1985	54607	54607	0.0000	54607	0.0000	54607	0.0000	54607	0.0000	54607	0.0000
1990	61382	61151	-0.3763	61.395	0.0212	61382	0.0000	61163	-0.3568	61151	-0.3763
1995	68248	66996	-1.8345	68262	0.0205	68241	-0.0103	67009	-1.8154	66989	-1.8447
2000	75450	72770	-3.5520	75459	0.0119	75426	-0.0318	72776	-3.5441	72745	-3.5852
2005	82923	78589	-5.2265	82925	0.0024	82865	-0.0699	78586	-5.2302	78531	-5.2965
2010	90586	84387	-6.8432	90584	-0.002	90478	-0.1192	84377	-6.8543	84276	-6.9658
2015	98335	90040	-8.4355	98335	0.0000	98153	-0.1851	90024	-8.4517	98956	0.6315

observable only after a considerable delay. The wage rates, on the other hand, do not show an appreciable response even with the combination of the shocks employed. Fertility reduction yields substantial effects on structural transformation as indicated by the effects on the proportion of workers employed in agriculture (Table 3.16) and the proportion of value added from agriculture (Table 3.17). The same is not true with increasing human capital expenditures. This is because structural transformation is determined by, among others, per capita GNP. Since, as mentioned above, fertility decline yields a relatively larger effect on per capita income, the results obtained for structural transformation variables reflect this fact.

Tables 3.18 to 3.20 show the potency of direct fertility reduction in obtaining desired demographic objectives. The effect of human capital expenditures on fertility appears to be relatively small. Table 3.19, however, shows substantial effects of a sustained increased in human capital expenditures on infant mortality, particularly for health expenditures. This result follows from the high immediate impact effect of increasing health expenditures on infant mortality as mentioned in the previous section. The same is true with a decline in fertility rates. The effects appear to be independent from each other as shown by the results obtained from combining the shocks. The effects of the separate experiments approximately add up to the total effects of the combined shocks. In terms of the effects on population growth, it appears that increasing human capital expenditures does not have a substantial effect (Table 3.20). A consistent negative effect on population growth can be observed from raising expenditures on education. Raising expenditures on health, on the other hand, failed to show appreciable effect on population growth. This follows from the earlier-mentioned result that health expenditures have large negative effect on infant mortality and also an appreciable negative effect on fertility, hence, the net effect on population growth is negligible. Only a decline in fertility produces consistent negative effects on population growth. These results suggest that direct fertility reduction may be necessary to moderate population growth quickly

4. Conclusions

Human capital expenditures figure prominently in the current revision of views on the consequences of higher population growth in development. While previous studies incorporated human capital expenditures in the analysis of the interaction of economic and demographic variables in the course of development, these variables

are usually exogenous in the models employed and more often these are partial analyses. This study endogenized human capital expenditures in a comprehensive economic-demographic model and provided policy levers to analyze the role of these variables in development.

The results of the simulation can be summarized in the following statements:

i. Human capital expenditures generally rise with rapid population growth, but the increase is insufficient to maintain per capita levels. This implies that the quality of human capital will suffer with rapid population growth.

ii. Human capital variables significantly affect the economy's growth potential. It appears, however, that the effects of human capital expenditures on output are relatively smaller than the effect of non-human capital expenditures. In terms of the relative effects among different human capital expenditure items, health expenditures have large effects in the immediate term but this rapidly dies down. Education expenditures, on the other hand, have low but long lingering effects.

iii. Increases in human capital expenditures have desirable effects on the demographic processes of fertility and infant mortality but these do not generate appreciable reduction in population growth. Comparing these effects to those generated by direct fertility reduction, the magnitude of the effects of increasing human capital expenditures is relatively small. These results suggest that direct fertility intervention may be necessary to moderate population growth quickly.

Given the limitations of the methodology employed in this study as discussed above, several interesting areas of future research can be identified. First, modelling the effect of human capital variables on output should put more attention to the dynamics effects. Furthermore, the relative effects of different human capital variables on output should be given attention. Second, the dynamic interaction of economic and demographic variable is another promising area of research. The current model captures only the relationships prevailing in the estimation period. As development proceeds, however, many of the economic-demographic interactions will weaken while others will

grow stronger. As an example, highly educated mothers may not figure significantly in family calculations on an additional child if the existing labor market does not pay highly skilled workers well. As the labor market tightens, however, the opportunity cost of educated mothers will rise, thus, it is expected to influence more importantly the household decision on childbearing. Another example would be the role of social insurance schemes in the calculus of having additional children. With the unfolding of economic development, it is expected that more economic activities become less idiosyncratic and insurance schemes expand in scope and the family becomes a less attractive institution for risk sharing. Third, while this study used the consumption motive in the determination of human capital expenditures, a shift to the investment motive may alter many of the results obtained here[23].

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