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***Distinguished Lecture***

# Complementarity and Conflict among Population and other Policies: Specifying an Economic-Demographic Model for a Developing Country

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## 1. INTRODUCTION

My talk today is based on a research project, housed at the University of Pennsylvania, that we have undertaken for the UNFPA and UNDESD. The project, with the same title as the draft material distributed for this conference, is a collaborative effort among Lawrence Klein, Fred Campano, Dominick Salvatore, and myself.

The principal issue in the project is the simultaneous interaction between demographic and socio-economic variables in the development process of an emerging economy. The main concrete objective is to construct an operational econometric framework which establishes appropriate feedback linkages between demographic and economic movements and allows meaningful examination of conflicts and consistencies of population policies with economic policies. This is essential in formulating appropriate population and other policies and in evaluating their effectiveness in promoting the demographic and socio-economic developmental goals of society.

In technical terms, our ultimate goal is to construct a prototype long-term macroeconometric model for developing countries with an adequate endogenous treatment of demographic changes showing how population affects and is affected by socio-economic variables–with special attention to the latter feedback.

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Support from UNFPA/UNDESD is gratefully acknowledged for the research project on which this paper is based. Conversations with Lawrence Klein, Fred Campano, Dominick Salvatore, Celia Reyes, Winnie Constantino, Aniceto Orbeta Jr., and Inday Feranil have been useful in the preparation of this manuscript. Opinions and errors in the paper are my sole responsibility.

The major milestones in this admittedly ambitious project are:

1. Identification of the specific issues and policy implications to be addressed in this modelling effort;
2. specification of the prototype economic-demographic model;
3. construction and estimation of the econometric model for selected countries;
4. statistical and practical validation of the estimated model; and
5. operational implementation of the model for actual application and policy analysis in specific countries.

We are in the midst of the project cycle, having just finished the first phase; the distributed material contains excerpts from the First Phase Report submitted to UNFPA and UNDESD covering the first two items in the above list and preliminary results of our estimation efforts for a Philippines econometric model.

My task today is to describe our research effort and underscore the key practical, technical, and policy-oriented issues in the project.

In a way, as I go through my presentation today, you will hear an echo of some issues raised in Dr Hemmer's distinguished session yesterday–in particular, on the relative impact on population growth of two policy imperatives: poverty alleviation on one hand and literacy improvement on the other. With adequate endogenisation of population and sufficient available data to support the modelling effort, the resulting model should be "rich" enough to provide at least a partial quantification of these relative effects and shed light on any complementarities and conflicts. The framework also treats these two elements, not in isolation, but rather within the context of their interactions with other factors as well.

## 2. ISSUES IN POPULATION GROWTH AND DEVELOPMENT

Recent discussions of economic-demographic interaction in the development process of a country touch on the following themes; for example, see Orbeta (1991).

### Consequences of Rapid Population Growth on Development

The deleterious effects, so emphasised since Malthus, are now being counterargued with reference to positive contributions which filter through three major economic channels:

- Savings and investment;

- labour market and employment; and
- resource utilisation.

## Population Growth, Savings and Human Capital

### Expenditures–Investment Diversion Effect and Dependency Burden Effect on Savings

A classic proposition in the demographic to economic flow-through is that rapid population growth results in lower output per worker because rapid population growth causes the diversion of resources from more productive activities such as physical capital accumulation to less productive social expenditures such as education and health. The implicit lemma here is that expenditures on health and education are less productive than expenditures on physical capital; they have long-delayed effects and lower rates of return.

This proposition has been criticised 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. Some have 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". Others have 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 have shifted toward the qualitative dimensions of factor inputs". The 1984 World Development Report asserted that "there is little doubt that the key to economic growth is the advance of human knowledge". Furthermore, in developing countries where many technologies are imported, the quality of manpower contributes to the selection of appropriate technologies as well as the absorption, dissemination, and adaptation of these new technologies to local conditions.

## Economic-to-Demographic Feedback

While the economic impact of population growth has been addressed in past modelling efforts, the study of economic growth effects on demographic changes is a more recent phenomenon. Becker's theory of fertility in the 1960s provided the impetus. Now, fertility theories have evolved to a multi-disciplinary approach, taking into account biological, economic, and social factors. Migration theories have also developed and evolved into a multi-disciplinary framework. Mortality theories, heavily dependent before on biological and environmental factors, now employ multi-disciplinary factors, though still focused on infants and children.

A partial analysis, which does not take into account in a comprehensive way the demographic-to-economic linkages, tends to overstate the impact of population

growth on economic development. Previous studies indicate that incorporat simple relations that endogenise population growth lead to a substantial reductio the measured benefits from slowing population growth. For our project, I am no a position to confirm, deny, or modify this observation at the moment; but we certainly address it through our econometric models under this project.

A generic framework for modelling the socio-economic-demographic syst can be illustrated in Figure 1, adapted from Orbeta (1991).

Type B models, which abstract completely from demographic factors effects, are standard macroeconometric models. The mirror image, Type D, re sents an exclusively demographic model. Type A depicts the early modelling ef to quantify the impact of demographic changes on the economic process. Typ completes the framework with the incorporation of the last link (from the econo to the population module) in the demographic-economic system.

## Age-Sex-Urban/Rural Disaggregation

It is also important to study developments in the rural and urban ar Rural-urban migration, productivity differences, age and sex structure of the po lation, income differences, consumption patterns, educational opportunity dif ences, housing differences, health care differences are all important urban-r outcomes that interest the policy-making bodies.

In order to explore the full range of population and other developmental p cies, the analysis ought to be done, whenever possible, in terms of the age-s urban/rural distribution of the population. The reason is that the age-sex-regio distribution of the population crucially affects other demographic variables suc the birth rate, the death rate, the labour force participation, migration rates dependency rates, as well as the composition of private final demand and savi and the size and composition of government expenditures on health, education social safety-nets in the rural and urban areas of a country.

These in turn affect the age-sex-regional distribution of the population– closing the circle of two-way relationships between demographic and so economic variables. In short, age-specific demographic variables are taken endogenous, both affecting and being affected by socio-economic variables. level of disaggregation exerts tremendous pressures on data requirement. In earlier efforts, like BACHUE in the 1970s, encountered extreme difficul precisely because required data of this type and level of disaggregation were available during these earlier times. Since then, country statistical offices h improved their nations' data bases and it is well worth the effort to try again. often the most important level of disaggregation of direct demographic policy in est. Indeed, this is true in both developed and developing economies.

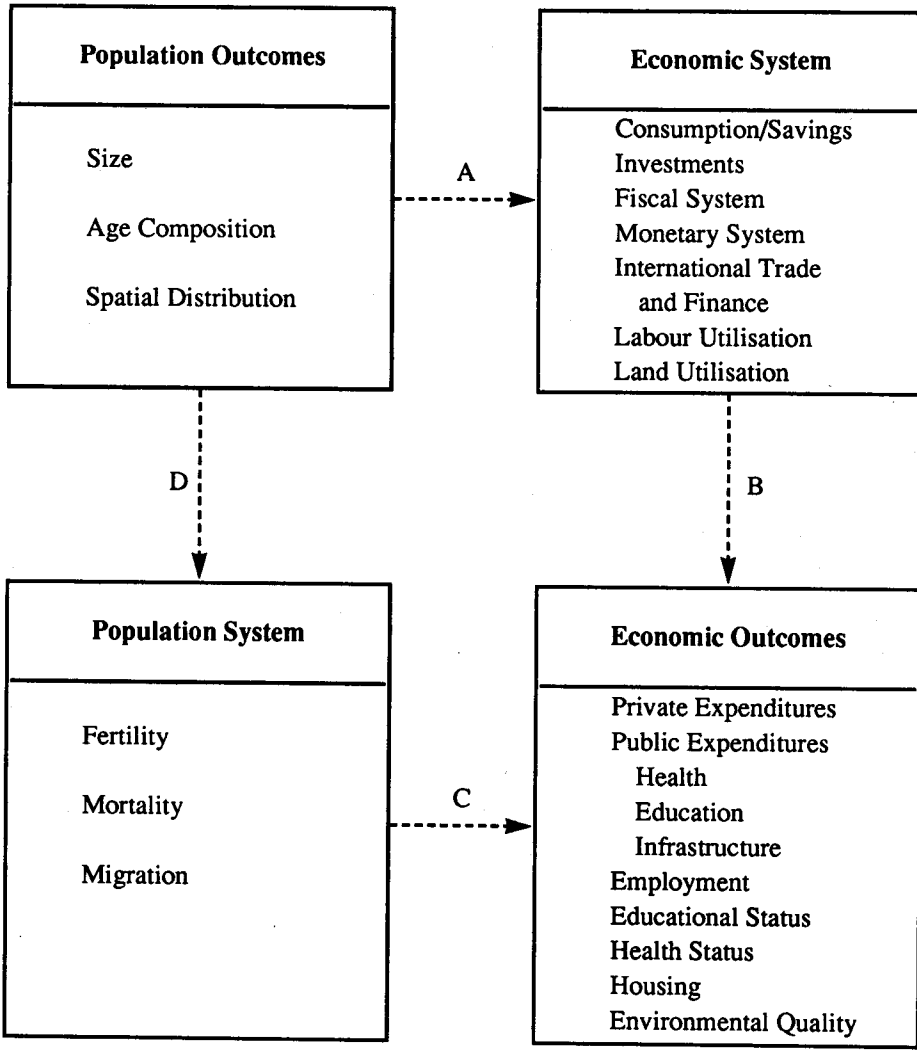


**Fig. 1. Demographic-Economic Linkages–A Generic Framework.**

## 3. PROTOTYPE ECONOMIC-DEMOGRAPHIC MODEL

We have pointed out in the preceding section that earlier studies have sought to model how different demographic scenarios, which are separately computed and considered exogenous, drive the economy into the future. The approach we will follow asserts that this is not the complete story. We argue that development outcomes strongly affect the number, the composition and the location of individuals. It is then emphasised that good development planning should view the two-way relationship as an integral whole and not in separate parts.

The extension of a typical macroeconometric model can be described through Figure 2.

The upper and lower blocks in the diagram summarise in a highly aggregated form the macroeconomic component of the system (Type B in Figure 1). The middle block, corresponding to Type D in Figure 1, represents the demographic part of the system. The arrows from the middle block to the lower block indicate the specific linkages from the demographic to the economic sectors. The feedback effects of economic policies and growth on populations changes are introduced through the arrows from the upper block to the middle block.

The economic component of the model explains the standard set of macroeconomic variables: the country's output, employment, income, and expenditures. As shown in Figure 2, this component of the whole model has the added features of:

- A rural/urban decomposition of income, employment, consumption and savings; and
- an allocation of private and public expenditures for health and education.

Government and private expenditures on health and education compose a major factor in the economic-to-demographic linkage, in as much as these economic decision variables affect fertility, literacy, mortality, and migration (internal and external) in the population. Income and its rural/urban decomposition provide a second channel in this feedback direction.

Finally, as shown in the lower part of Figure 2, population growth affects the size of total labour force and employment, the rate of consumption, savings and investment, as well as private and public expenditures on health and education.

## 4. OPERATIONAL MODELLING APPROACH: THE PHILIPPINES AS A CASE STUDY

Now, let us bring the abstract discussion in the preceding section to a practical and operational level–with the Philippines as a case study.

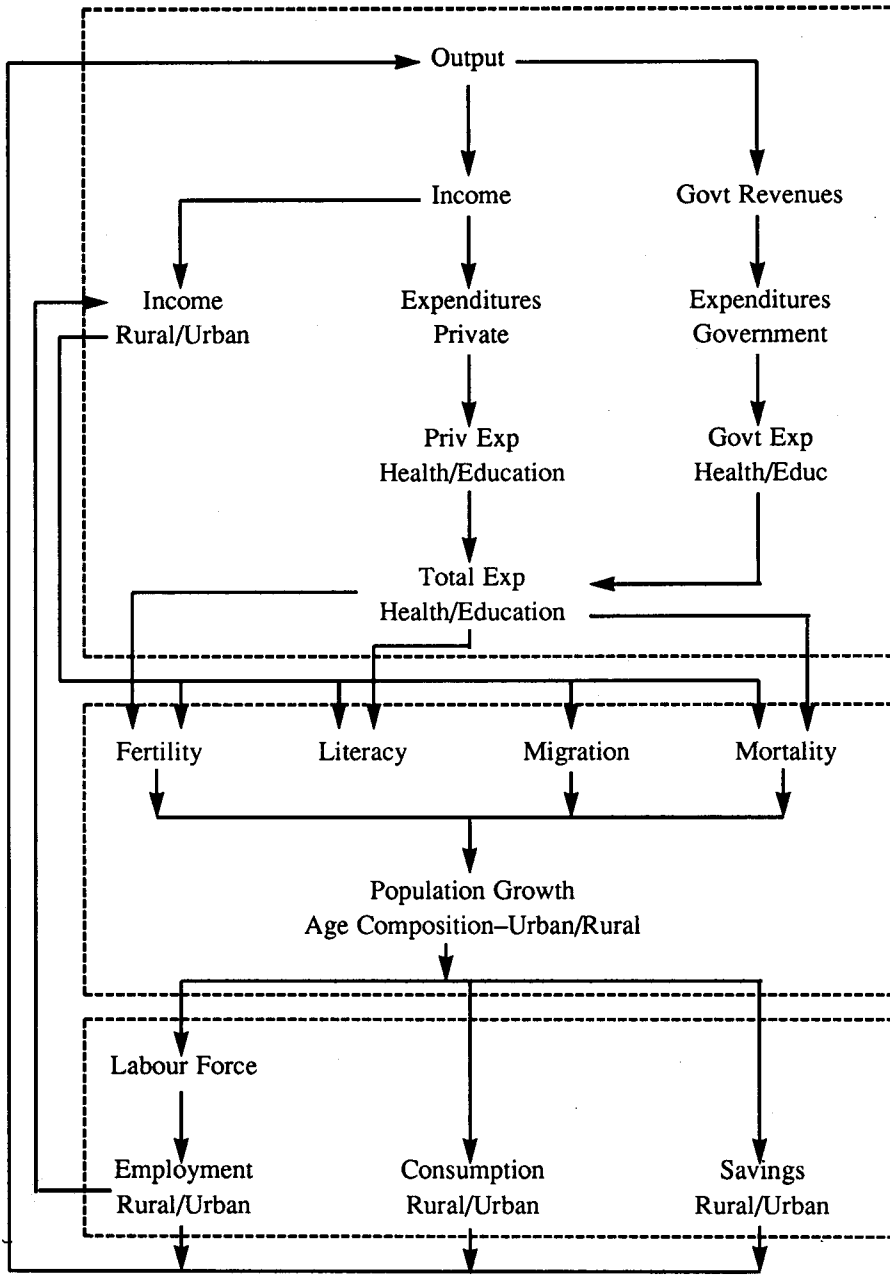


**Fig. 2. Interactions in a Prototype Economic-Demographic Model.**

estimated for these production subsectors.

GNP is then calculated with the addition to GDP of net facto abroad. This is reconciled with the expenditure side by taking the sta ancy as a residual component of GNP from the expenditure side.

The expenditure side of the real sector is disaggregated components in the national income accounts:

- Personal consumption expenditures;
- gross domestic capital formation – GDCF;
- exports of goods and services;
- imports of goods and services; and
- government expenditures.

The linkage from the expenditure side to the production sector major ways. One is in the form of aggregate expenditure categorie arguments in the demand functions in the production sub-bloc. Se ment variables (components of GDCF) also appear as explanatory va of the supply functions in the production sub-bloc. Feedback from side to expenditures is reflected in the use of real output as an acti the equations for some of the expenditure components.

Sectoral prices are determined separately for agriculture, services. An average of these prices, weighted by sectoral output sh implicit price deflator for GDP. Nominal GDP is then calculated as real GDP and its implicit price deflator. Nominal net factor income added to nominal GDP to obtain nominal GNP. The GNP implicit p then obtained as the ratio of nominal GNP to real GNP.

The fiscal sector, consisting of Equations 27, 28, and 29, tre expenditures as exogenous, relates total tax collection and nont revenues to nominal GNP, and calculates the government budget difference between expenditures and revenue.

The budget deficit then feeds into the monetary sector–as a fa in the net domestic assets in the system and hence in the m Fluctuations in the monetary base affects liquidity, which, in turn, a and availability of loans.

In simplifying the treatment of the external sector, other con balance of payments, apart from receipts from merchandise expenditures covering merchandise imports, are all treated ex Equation 36. BOP, in turn, affects the net foreign assets component base and impacts on the rest of the system through this channe exchange rate, exogenous in the model, is used for the conversion of

exchange rate, exogenous in the model, is used for the conversion of the BOP into a peso equivalent.

Klein, Mariano, Salvatore and Campano (1992) and Mariano and Constantino (1993) provide further details on this model.

## Expansion to an Economic-Demographic Model for the Philippines

The basic model described above can be categorised as a standard medium-term macroeconometric model for a developing open economy. Further modifications are required for the analysis in our project. The major extensions/enhancements of the model, for purposes of the project, include

1. Endogenous treatment of population variables. This can be done through equations explaining fertility, mortality and migration–with economic and policy variables as possible explanatory factors. Preliminary results indicate the possibility of disaggregating fertility and mortality rates by age-groups. Historical series for private expenditures on health and education can be constructed by applying share ratios, calculated from national family income expenditure surveys, to total private expenditure data in the national income accounts. Fertility and mortality rates by age-groups are based on five-year national demographic surveys; for inter-survey years, we utilise the interpolated figures published by the national statistical office. Literacy and government and private expenditures on health and education come out statistically significant in our preliminary regressions for fertility and mortality.
2. Re-specifying and expanding the model to reflect implications of demographic changes on productivity, employment in various sectors (agriculture, industry, and services), and consumption expenditures (through the age-composition of the population).
3. Develop an income-distribution component in the model to establish linkages among macroeconomic policies/developments, changes in income distribution, and demographic movements. Income distributions by region and by urban/rural are available for 1985 and 1988. These are two years for which comparable regional data are available from family income and expenditure surveys in the Philippines. Regional GDP and GDP components are available on an annual basis, from 1981 to 1990. Inflation, by region, is also available over this period. Initially, we can attempt to use some of these variables to explain variations in income inequality measures or income percentiles across regions and over time.

We can do this by pooling regional data (on income and expenditures) for 1985 and 1988.

4. Interphase the model with a Philippine input-output table to analyse sectoral requirements for meeting final demand. The most recent tables available are the 1985 and 1988 I-O Accounts of the Philippines.

For purposes of this project, we intend to use an aggregate 11 × 11 table covering the following sectors:

- Agriculture, fishery, and forestry;
- mining and quarrying;
- manufacturing;
- construction;
- electricity, gas, and water;
- transportation, storage, and communications;
- trade;
- finance;
- real estate;
- private services; and
- government services.

## 5. CONCLUDING REMARKS

As you can see, what we discuss in this paper is work in progress towards the construction of an operational economic-demographic model for a developing country. The major task here is endogenising demographic variables and encompassing relevant government policy instruments in the model.

The model must strike a balance between realism and manageability–if it is to be of any practical use in disentangling complementarities and conflicts between population policies and economic policies. Thus, we must be keenly conscious of not only the theoretical underpinnings and econometric behaviour of our constructed model but also the operational complexities in the policy applications of the model.

Furthermore, as we have done in the case of the Philippines, it would be useful to involve government economic/demographic planners (from other countries of interest) from the early stages of model construction. These planners are the ultimate endusers of the model.

## REFERENCES

Klein, Lawrence, Roberto S. Mariano, Dominick Salvatore and Fred Campano

(1992) Complementarity and Conflict Among Population and Other Policies: Policy Models/Applications. First Phase Report for a joint UNFPA/UNDESD research project. July.

Mariano, Roberto S., and Winnie M. Constantino (1993) MRM-93: An Annual Philippine Macroeconometric Model for Policy Analysis. In S. Ichimura (ed) *Econometric Models of Asia-Pacific Economies*. Tokyo: Springer Verlag. (Forthcoming.)

Orbeta, Aniceto Jr. (1991) A Population-Development Econometric Model of the Philippines. Ph.D. dissertation, School of Economics, University of the Philippines.

## Comments on "Complementarity and Conflict among Population and other Policies: Specifying an Economic-Demographic Model for a Developing Country"

Professor Mariano has presented us with a highly interesting and logically persuasive model of extreme intellectual quality. To my understanding, the model is perfectly fashioned and could be used, especially in the academic world, to highlight linkages between social and economic data which, although of tremendous practical influence in development policy, are often neglected. However, I seriously doubt whether the model can be used outside academia by political and administrative practitioners in developing countries, for instance in a country like Pakistan.

The first practical problem with the model is how to obtain the relevant data. I sincerely doubt whether a country like Pakistan–and this goes for most Third World countries–would be able to ensure that the required data are collected on time at a reasonable cost. I am familiar with many examples–especially in Africa–where the GNP figure, even according to reliable government sources, should be taken with a margin of error of ± 50 percent. And this figure is more reliable than most others in the national accounts statistics. But because the World Bank, the IMF, the United Nations and bilateral donors want exact figures that is what they get–irrespective of their relation to reality. If, to cite another example, I consider the immense difficulty of obtaining realistic data on interpersonal income distribution, and these data are a must in Professor Mariano's model, I am sceptical about the conditions for an adequate functioning of the model being fulfilled. I personally used to tell my students when discussing international statistics that the quality of statistics could be taken as an appropriate or extremely informative indicator of development. Least developed countries are the ones suffering most from high population growth; at the same time they are the ones with the least reliable statistics. How far is this taken into account in Professor Mariano's model?

Additionally, as the structural parameters are constant in the model but not in reality, a situation can occur where, once collected (which, as I already mentioned, takes time), the data are no longer valid. Also, many parameters are influenced by non-quantifiable determinants–I need only cite religion as an example. It takes a long time to obtain an adequate estimate of their magnitude–which country has it?

A third question arises with respect to the handling of the model. A large computer has to be programmed, and it makes economic sense to do so at a single

developed). This would open up a large market for that university. But is it in the interest of other countries to have no possibility of calculating alternative assumptions themselves? This type of model reminds me a little bit of the 1970s, when the cost-benefit analysis (CBA) was in vogue. As a CBA specialist in those days I found practical work with CBA far removed from the clear lines of the methodology published by the big donors, be it the World Bank, UNIDO or, with respect to German bilateral aid, the Kreditanstalt für Wiederaufbau (KfW). Several times I found that the costs of a really sophisticated CBA exceeded the net benefits of the whole project. With Professor Mariano's model one would have to be careful to avoid a similar outcome.

I do not know what policy conclusions can best be derived from the model. I was a theoretician when I was young; now, after many years in practical development policy, I have to ask what policy recommendations can the model provide and what alternatives in what order of priority. And, having received those recommendations, I have to check whether they are feasible, both technically and politically. Here I would merely cite the institution theory–and governments and their ministries are such institutions–which has proved quite clearly that different institutions pursue different objectives. I do not believe that these institutions would be willing to subordinate their objectives to the output of a computer model. To this extent the model is only a first, but doubtlessly necessary, step towards a more realistic population policy. But in order to raise it to the level of practical policy-making, many more steps will have to be taken. I look forward to following Professor Mariano's progress in this direction.

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## Comments on "Complementarity and Conflict among Population and other Policies: Specifying an Economic-Demographic Model for a Developing Country"

Let me first congratulate Professor Mariano for undertaking such a detailed and painstaking modelling exercise in which he has attempted to integrate both demographic and economic variables in a macroeconometric model framework. This paper conveys messages which are timely and highly relevant for Pakistan because a family planning programme is now being seriously considered here. The message is clear: a family planning programme cannot be implemented in isolation. It has to be linked with the broad macroeconomic policies of the government if the desired result is to be achieved.

The main contribution of the paper is that it has linked demographic variables with the key macroeconomic aggregates in a model framework. Professor Mariano has pointed out that effective family planning policies and increased educational expenditures tend to reduce fertility. Furthermore, raising the educational level of females will also increase their participation rate in the work force, thus raising output levels and reducing fertility. Increasing the educational level of women and increasing health expenditures on children will reduce infant mortality which also tends to reduce fertility. Reduced fertility reduces population growth and thus increases savings and investment.[1] Higher investment and lower population growth increase per capita income and thus increases resource availability for further improvements in education and health, and the cycle goes on.

Regarding rural-urban migration–a serious problem in Pakistan, Professor Mariano has argued that increased industrial investment in urban areas must be counter balanced with increased educational and health expenditures in rural areas in order to discourage increased rural-urban migration, which contributes to urban overcrowding and environmental degradation. The basic rationale behind his argument is that fertility rates are much higher in rural than in urban areas and, thus, more likely to fall rapidly as a result of increased expenditures on education and health in rural areas.

Increasing the average real per capita incomes, as well as reducing population growth and changing its age structure, also changes the structure of demand for

[1]Empirically it has been found by Khan *et al.* (1993) and Fry (1991) that a higher dependency ratio, which is directly linked with population growth, reduces saving rates.

final goods and services and imports of the country. Changes in the structure of demand also change the structures of the economy which then affect the country's exports.

Most of these linkages are known to economists but what is the real contribution of this paper is that all these linkages are explained in a system of simultaneous equations and are estimated with the help of data.

After discussing the general linkages between demography and economics, let me turn to the model itself. I concentrate on the demography part of the model where fertility, female labour force participation, mortality, infant mortality, internal and international migration, literacy and income distribution are determined.

**Fertility Equation**

The authors have talked about the demand-side as well as the supply-side of fertility determination. Sanderson (1980) calls the former as the "Chicago-Columbia" model and latter as the "Pennsylvania" model. In the fertility equation the authors have attempted to combine these two models. For example, literacy and female labour force participation are demand variables while infant mortality is the supply variable and the rest are regulation cost factors. There are several other biological or supply-side factors which seem important and have been found significant in the case of Nicaragua by Behrman and Wolfe (1984), for example, women's health status [long-run illness experience may be inversely related with fertility for supply-side reasons because it reduces fecundity]; breastfeeding and nutritional level. Furthermore, age at marriage and cultural practices are also important variables in determining fertility. These biological variables are ignored in the study.

**Female Labour Force Participation Rate Equation**

(a) In the female labour force participation rate equation international migration is an important variable particularly for countries like the Philippines, Thailand, and Sri Lanka from where a large number of females have migrated to the Gulf and other countries of the Middle East. International migration creates a vacuum in the job market and encourages females to enter the workforce.

(b) Extended versus nuclear family is also an important variable. In an extended family, at least someone is at home to look after the children while the mother can work outside. A dummy variable can be used in this case.

**Migration Equation (rural-urban and international)**

(a) In the rural-urban migration equation, rural-urban migration is defined as the ratio of rural-to-urban employed labour force in the *ith* age-group. Any fall in

the ratio means that migration is taking place from rural to urban areas. My question is: how can the author detect whether the rural labour force migrated to urban areas or outside the country. In either case the ratio would fall.

(b) International migration is assumed to come from urban areas only. This is a rather strong assumption. In a labour exporting country like Pakistan most of the migrants come from rural areas.

(c) Rural-urban migration is explained by one variable i.e., average private urban capital-labour ratio. In a recent study for Bangladesh,[2] the land-man ratio in the rural area is also found to be a significant variable in rural-urban migration. The rationale behind this variable is that those who have some land in the rural areas are less likely to move out from rural areas. Skills of the farmers would be least acceptable or would be of the most limited applicability for work in the urban areas.

**Literacy Equation**

(a) What is the definition of literacy? Has this definition changed over time?

(b) Beside the primary school enrolment rate and average government expenditures on consumption and investment on education, an income variable deserves a place in the literacy equation. Furthermore, cost of schooling is also a relevant variable. This is because in the case of Sri Lanka where the literacy level is around 80 percent education is free from kindergarten to the university level.

At the end I must congratulate the author once again for undertaking such a gigantic work by integrating demographic and economic variables in a model framework. I am sure that in the process of estimation the author must have tried several alternative specifications before arriving at the final version. Some of the variables which I have listed here may have been tried in alternative equations.

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## REFERENCES

Ahmed, Salehuddin (1979) The Policy Implications of Rural-Urban Migration: Policy Simulations for Bangladesh. Canada: Department of Economics, McMaster University. (Working Paper No. 79-10.)

[2]See Ahmed (1979).

Behrman, J. R., and Barbara L. Wolfe (1984) A More General Approach to Fertility Determination in a Developing Country: The Importance of Biological Supply Considerations, Endogenous Tastes and Unperceived Jointness. *Economica* 51: 203, August.

Fry, Maxwell J. (1991) Domestic Resource Mobilization in Developing Asia: Four Policy Issues. *Asian Development Review* 9:1.

Khan, Ashfaque H., Lubna Hasan and Afia Malik (1993) Why is the Rate of Saving Low in Pakistan? Submitted for publication in *World Development.*

Sanderson, W. (1980) Comment. In R. A. Easterlin (ed) *Population and Economic Change in Less Developed Countries.* Chicago: National Bureau of Economic Research and University of Chicago Press.