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An Econometric Study on the Linkages of Economic Growth, Income Distribution and Poverty Reduction in Asia and the Pacific*

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This paper is devoted to construction of a small scale simultaneous equation model, in which growth, distribution and poverty reduction are interlinked among themselves and unilaterally affected by other exogeneous explanatory variables. A further devotion is made in this paper to empirically estimate the the model with available statistical information from Asia and the Pacific region in order to investigate inter-connected linkages among various variables. The results would be optimistic evidences that with few exception, by 2015, most of countries in the region would have realized attaining the goal of reducing poverty incidence into a half.

I. Introduction

The region of Asia and the Pacific contains the largest share of the world

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population and accordingly the largest share of the world poor population as well. The poverty reduction in the region of Asia and the Pacific is therefore most essential in poverty reduction in the world. China and India, the largest two countries in the world, occupy more than 40 percent of the world population, and these two countries are not rich yet. Out of 47 least developed countries, LDCs, in the world in 2002, 12 countries belong to Asia and the Pacific region. Poverty eradication and fairer income distribution are two most important preconditions for peace and harmony in the world community.

It is unanimously agreed at least among economists that economic growth is a necessary condition for poverty reduction, even though it may not be a sufficient condition. It has also been extensively witnessed that poverty reduction has only been realized with high income growth surpassing population growth. However, poverty reduction also relies on other factors than economic variables such as empowerment of women, basic health condition, illiteracy rate, human right condition, social caste system, etc.. Even though these factors are non-economic variables, the most important economic variables such as income growth and distribution are definitely affected by these factors. In order to achieve poverty reduction, proper considerations should be given to these factors.

Number of studies has been undertaken to investigate the relations between poverty and growth with or without including non-economic factors (Ravallion and Chen [10], Bourguignon [4], Sala-i-Martin [11], Kakwani and Pernia [8] and Ali and Elbadawi [1]. And some country case studies were also made in this context (Kakwani [7], Kakwani and Son [9], Chen and Wang [5] and Fane and Warr [6]). This paper attempts to construct a small scale simultaneous equation model, in which growth, distribution and poverty reduction are interlinked among themselves and unilaterally affected by other exogenous explanatory variables. A further attempt is made in this paper to empirically estimate the model with available statistical information from Asia and the Pacific region in order to investigate inter-connected linkages among various variables. In many cases, continuous time-series data are not available, and, therefore, whatever available time-series data have to be pooled into whatever is available in cross-section data.

Poverty is a multifaceted and complicated concept. Absolute poverty may be defined by consumption expenditure equivalent to a certain level for mere survival under a given living circumstance. However, a broad concept of poverty based on relative deprivation may subjectively be defined by a welfare level, at which an average citizen feels poorness in his/her community of poor group. With an official level of poverty income in a rich country, a citizen in a poor country may feel richness.

Poverty sometimes is defined to include availability of access to basic health, clean water, primary education, etc.. There are numerous non-economic factors, which also affect poverty. Even though it is well recognized that poverty is not dictated only by income and consumption, it may also be safely assumed that most of these non-economic variables could comprehensively be captured by income.

In addition to these problems, comparability and consistency of poverty levels over time and across countries also pose an even greater problem. Even though the one-dollar-a-day per capita in terms of the purchasing power parity sponsored by the World Bank is not a perfectly ideal criterion in determining poverty level, the concept is most widely accepted by researchers whenever comparison of poverty incidences is necessary over time and across countries.

Since this paper attempts an empirical investigation of poverty incidence over the past decade and across the selected countries in Asia and the Pacific region, it is absolutely necessary to adopt the criteria sponsored by the World Bank.

Ⅱ. A Theoretical Model

How a reduction in poverty incidence is made by income growth and distribution may simply demonstrated in the following manner:

Suppose income Y is distributed in a lognormal manner as usually hypothesized as in

$$Y \sim \ln N(\mu,\ \sigma^2) \tag{1}$$

where μ and σ^2 indicate mean and variance of a lognormal distribution. Then, ln $Y = y$ follows

$$y \sim N(\mu,\ \sigma^2) \tag{2}$$

Suppose further that the income distribution of the year 0 assumed

$$y_0 \sim N(\mu_0,\ \sigma_0^2)$$

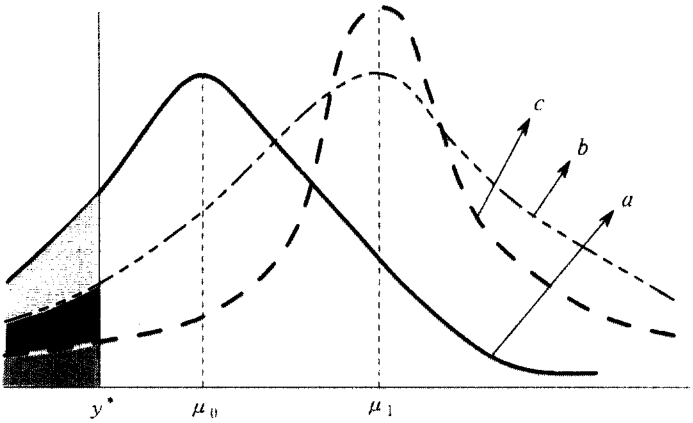
with a probability density function $f(y_0 : \mu_0, \sigma_0^2)$, which can be depicted as a in ⟨Diagram 1⟩.

The share of population under the poverty income line y^*, i.e. the poverty incidence in the year 0 is obtained by

$$P_0 = \int_{-\infty}^{y^*} f(y : \mu_0, \sigma_0^2) dy \tag{3}$$

which is indicated by shaded areas in the diagram.

〈Diagram 1〉



Suppose in the year 1, income distribution shifted to c in the following manner:

$$y_1 \sim N(\mu_1, \sigma_1^2) \tag{4}$$

where $\mu_1 > \mu_0$ and $\sigma_1^2 > \sigma_0^2$, which mean that average income increased while variance decreased with better distribution. Now, the new poverty incidence in the year 1 is obtained as

$$P_1 = \int_{-\infty}^{y^*} f(y: \mu_1, \sigma_1^2)dy \tag{5}$$

which is depicted by the vertically shaded area in 〈Diagram 1〉.

The reduction in poverty incidence between the year 0 and 1, denoted by $\Delta P = P_0 - P_1$ may be obtained as

$$\Delta P = \int_{-\infty}^{y^*} f(y: \mu_0, \sigma_0^2)dy - \int_{-\infty}^{y^*} f(y: \mu_1, \sigma_1^2)dy \tag{6}$$

and could further be decomposed into growth effect and distribution effect with given growth as

$$\begin{aligned} \Delta P &= \Delta P_G + \Delta P_{DIG} \\ &= \left[\int_{-\infty}^{y^*} f(y:\mu_0, \sigma_0^2)dy - \int_{-\infty}^{y^*} f(y:\mu_1, \sigma_0^2)dy \right] \\ &+ \left[\int_{-\infty}^{y^*} f(y:\mu_1, \sigma_0^2)dy - \int_{-\infty}^{y^*} f(y:\mu_1, \sigma_1^2)dy \right] \end{aligned} \tag{7}$$

which is equivalent to Equation (6), where ΔP_G and ΔP_{DIG} denote growth effect and distribution effect with given growth, respectively. There may be some other effects, which may change shapes of function f, when the function is assumed to take distribution other than normal.

With this mechanism as a backdrop, we may start to construct a small scale econometric model beginning from a growth function.

In order to explain economic growth, we may start with a production function. Suppose a usual production function may safely be assumed to take the following implicit form:

$$Y = F(K, N) \tag{8}$$

where Y is income generated in terms of value added, K fixed capital formation and N labour force employed. We may also include other factors of production and variables in addition to K and N. Let us take a total differentiation of Equation (8) and divide both sides by Y. Then we obtain the following form:

$$\frac{dY}{Y} = \frac{\partial F}{\partial K}\frac{dK}{Y} + \frac{\partial F}{\partial N}\frac{dN}{Y} \tag{9}$$

Equation (9) may be rewritten as Equation (10) as:

$$g = \gamma_1 k + \gamma_2 n \tag{10}$$

where $g = \frac{dY}{Y}$, $\gamma_1 = \frac{\partial F}{\partial K}$, $k = \frac{dK}{Y} = \frac{I}{Y}$, $\gamma_2 = \frac{\partial F}{\partial N}\frac{N}{Y}$ and $n = \frac{dN}{N}$.

It is clear now that income growth g is a function of investment share of GDP, k, and employment growth, n, and γ_1 denotes marginal productivity of capital and γ_2 employment elasticity of GDP. Equation (10) may be extended to include other factors than capital and employment by inserting an intercept term as in Equation (11)

$$g = \beta_{10} + \beta_{11} k + \beta_{12} n + u_1 \tag{11}$$

where β_{10} and μ_1 denote an intercept and error terms, respectively.

In explaining income distribution, changes in Gini is expressed as a function of growth and inflation. The income growth variable is included in order to see whether or not the so-called "trickling-down effect" has been empirically observable, and under the hypothesis that inflation usually negatively affects low income group, again inflation variable is treated as one of explanatory variables in the equation. Income distribution is expressed as Equation (12)

$$d = \beta_{20} + \alpha_{21} g + \beta_{23} f + u_2 \tag{12}$$

where d and f denote income distribution and inflation, respectively.

Finally, the change in poverty incidences, both in terms of one dollar a day and two dollars a day, is expressed as a function of income growth and income distribution in order to see both growth effect and distribution effect, and also as a function of employment change under a hypothesis that an increase in employment would create additional wage income for lower income classes and therefore poverty incident would be reduced accordingly. Also included is inflation variable under a hypothesis that inflation affects mainly the poor, as shown in Equation (13)

$$p = \beta_{30} + \alpha_{31}g + \alpha_{32}d + \beta_{32}n + \beta_{33}f + u_3 \tag{13}$$

Expressing these three structural equations, i.e. Equation (11), (12) and (13), in a simultaneous equation format, we have Equation (14) as:

$$y = Ay + Bx + u \tag{14}$$

where

$$y = [g \quad d \quad p] \tag{15}$$

and note that y here is a vector of endogenous variables and not income as defined in Equation (2) etc.

$$A = \begin{bmatrix} 0 & 0 & 0 \\ \alpha_{21} & 0 & 0 \\ \alpha_{31} & \alpha_{32} & 0 \end{bmatrix} \tag{16}$$

$$x = [1 \ k \ n \ f] \tag{17}$$

$$B = \begin{bmatrix} \beta_{10} & \beta_{11} & \beta_{12} & 0 \\ \beta_{20} & 0 & 0 & \beta_{23} \\ \beta_{30} & 0 & \beta_{32} & \beta_{33} \end{bmatrix} \tag{18}$$

and

$$u = [u_1 \quad u_2 \quad u_3] \tag{19}$$

When Equation (14) is arranged in a reduced form equation, the coefficient matrix takes the following form as Equation (20):

$$(I-A)^{-1}B = \Pi$$

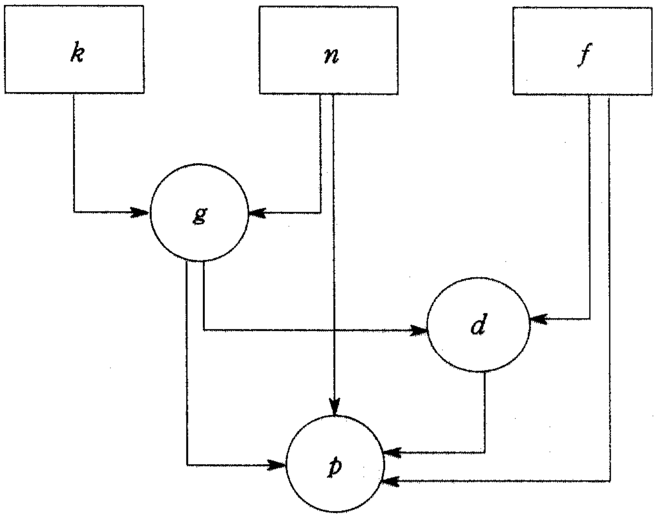
$$= \begin{bmatrix} \beta_{10} & \beta_{11} & \beta_{12} & 0 \\ \alpha_{21}\beta_{10}+\beta_{20} & \alpha_{21}\beta_{11} & \alpha_{21}\beta_{12} & \beta_{23} \\ (\alpha_{21}\alpha_{32}+\alpha_{31})\beta_{10}+\alpha_{32}\beta_{20}+\beta_{30} & (\alpha_{21}\alpha_{32}+\alpha_{31})\beta_{11} & (\alpha_{21}\alpha_{32}+\alpha_{31})\beta_{12}+\beta_{32} & \alpha_{32}\beta_{23}+\beta_{33} \end{bmatrix} \quad (20)$$

It is immediately clear from Equation (16) that the simultaneous structural model is completely recursive and, therefore, contemporal covariances of u_i and u_j $(i \neq j)$ may safely assumed to be null. Accordingly, the single equation estimation bias can also be ruled out from the model. The scheme of the above simultaneous equation model may simply be illustrated as ⟨Diagram 2⟩.

The three exogenous variables, k, n and f affect the three endogenous variables, g, d, and p, recursively. Investment and employment determine the growth of national income, and growth of national income and inflation give changes in income distribution. Finally, growth, distribution, employment and inflation decide changes in poverty incidence.

Once these equations are estimated, the coefficients may be used in estimating various elasticities or propensities of exogenous variables in determining changes in poverty incidence via the channels of other endogenous variables such as growth and distribution. The scheme is illustrated in Equation (21)

〈Diagram 2〉 The Model



where k: the share of domestic capital formation in GDP

n: rate of change in employment

f: inflation rate

g: growth rate of GDP

d: change in Gini

p: change in poverty incidence

▭ : exogenous variables ○ : endogenous variables

$$\varepsilon_{ijh} = \frac{\partial y_i}{\partial y_j}\frac{\partial y_j}{\partial x_h} = \alpha_{ij}\pi_{jh} \tag{21}$$

where ε_{ijh} the h^{th} exogenous variable elasticity of the i^{th} endogenous variable via the channel of the j^{th} endogenous variable, $\frac{\partial y_i}{\partial y_j}$, a partial derivative of the i^{th} structural equation with respect to the j^{th} endogenous variable, and $\frac{\partial y_j}{\partial x_h}$, partial derivative of the j^{th} reduced form equation, respectively. α_{ij} and π_{jh} are the ij and jh elements of matrices denoted as

Equations (16) and (20). For example, $\frac{\partial p}{\partial g}\frac{\partial g}{\partial k}=\alpha_{31}\pi_{11}$ denotes investment elasticities of poverty reduction via the channel of economic growth. In other words, investment positively contributes to economic growth, and economic growth, in turn, also positively contributes to poverty reduction. Investment, therefore, ultimately reduces poverty incidence, and the scale is shown by this elasticity, $\alpha_{31}\pi_{11}$.

Ⅲ. Data Used

Six variables are used in the estimation of the model in the paper. The statistical data used are shown in <Appendix 1>. The average annual per capita constant GDP growth rate, g, is calculated using the following formula:

$$X_{2000} = X_{1990}e^{10g} \tag{22}$$

where X_{2000} is the constant annual per capita GDP of year 2000, etc., g is, therefore, an average annual per capita GDP growth rate covering the period of 1999~2000. For some countries, the per capita GDP is not available for this entire period and a shorter period was covered in the case.

Income distribution measure, d, is simply the difference of Gini coefficients of those two time points, 1990 and 2000. Again, when data are not available, a shorter period was used. The GDP share of the poorest quintile is also used to measure the size income distribution of each of the countries in the region. However, statistical significance cannot be observed from the various estimations and is, therefore, omitted.

Reduction of poverty incidence, p, is again simply obtained in the following manner:

$$p = \left(\frac{P_{2000}}{P_{1999}} - 1\right) \times 100 \tag{23}$$

where P_{2000} is the poverty incidence of year 2000, etc., and 100 is multiplied to estimate the change in percent. Both one dollar and two dollars a day are used in the estimation. Again, the poverty incidence under national poverty line is also used. However, the number of observations is extremely limited and accordingly the statistical significance cannot be found from the use.

The share of domestic capital formation in GDP is also calculated in the following manner:

$$k = \sum_{i=1}^{t} \left[\frac{\Delta K}{GDP}\right]_i \Big/ t \tag{24}$$

where ΔK is annual domestic fixed capital formation increment and t is the number of years over which it is added.

The growth rate of employment of labours denoted by n is calculated as Equation (25)

$$N_{2000} = N_{1990} e^{10n} \tag{25}$$

where N_{2000} is number of labour employed in year 2000, etc.. Finally, inflation rate is calculated as the difference of average annual nominal per capita GDP growth rate and constant per capita GDP growth rate, which is exactly the implicit GDP deflator in annual average terms.

Ⅳ. Estimation Methods

Since the model hypothesized in this paper basically assumes a completely recursive system as shown by Equation (16), as it is previously mentioned, no single equation estimation bias is expected. Accordingly, it seems that simultaneous equations estimators such as two-stage least squares estimator, etc., would not be necessary. Ordinary least squares estimator was initially tried, and a slightly different version of estimated results is shown in <Appendix 2> for reference. However, considering the fact that 17 countries covered in the study vary enormously both in terms of size of population and economic magnitude, the simple OLS estimator would not properly capture a correct picture of the region, because the estimator weighs the countries like China and India with the same scale with the countries like Lao PDR and Papua New Guinea. In order to attain statistical sufficiency, a weighted least squares (WLS) estimator is used in the estimation. The weight used in the WLS is the share of each population in permil. Each of the structural equation is premultiplied by $W^{\frac{1}{2}}$

$$W^{\frac{1}{2}} y_i = W^{\frac{1}{2}} Y_i \alpha_i + W^{\frac{1}{2}} X_i \beta_i + W^{\frac{1}{2}} u_i$$

and the estimator is obtained as

$$\begin{bmatrix} \widehat{\alpha}_i \\ \widehat{\beta}_i \end{bmatrix} = \begin{bmatrix} Y_i' W Y_i & Y_i' W X_i \\ X_i' W Y_i & X_i' W X_i \end{bmatrix}^{-1} \begin{bmatrix} Y_i' W y_i \\ X_i' W y_i \end{bmatrix}$$

where Y_i, X_i, $\widehat{\alpha}_i$, and $\widehat{\beta}_i$ are matrices of endogenous, exogenous variables and estimated parameters in the i^{th} structural equation, and $W = W^{\frac{1}{2}} W^{\frac{1}{2}}$ and $W^{\frac{1}{2}}$ a 17×17 diagonal matrix with elements of $\sqrt{w_i}$ $(i = 1, 2, \cdots, 17)$.

The WLS estimator used in this study gives a greater weight to the country like China, while far smaller weight to Lao PDR, and consequently reflects the relative importance of big countries in poverty reduction linkages in the region. When the 17 countries are treated equal in the estimation, an outlier like Kazakhstan or Mongolia would affect the estimation result with an equal scale with China or India. With the use of WLS estimator, the Chinese and Indian situations are relatively more highly considered than other small countries. Other weights such as GDP could have been used. However, the population variable seems to be statistically most accurate. The weights used in the study is given in <Appendix 3>.

V. Estimated Results

The four estimated equations with relevant test statistics are given below

Growth Equation

$$\begin{aligned} g = &-1.6107 + 0.2070k + 0.0036n \\ &(-1.5771)\ (6.3446)\ \ (0.0115) \end{aligned} \tag{26}$$

$$r^2 = 0.9604$$
$$DW = 1.6574$$
$$F(3, 12) = 97.0280$$

Income Distribution Equation

$$\begin{aligned} d = &\ 2.6399 + 0.1192g + 0.2313f \\ &(0.6641)\ (0.1835)\ \ (1.6511) \end{aligned} \tag{27}$$

$$r^2 = 0.7071$$
$$DW = 1.2990$$
$$F(3, 13) = 11.2662$$

Poverty Reduction Equation (One dollar a day)

$$p = \underset{(-2.0687)}{-48.5430} \underset{(-2.3907)}{-8.4448g} + \underset{(3.3408)}{5.5335d} \underset{(-0.9095)}{-7.3872n} + \underset{(2.9480)}{2.6456f} \tag{28}$$

$r^2 = 0.9460$

$DW = 3.2482$

$F(5, 10) = 175.1561$

Poverty Reduction Equation (Two dollars a day)

$$p = \underset{(-0.5762)}{-7.5975} \underset{(-3.5199)}{-7.7193g} + \underset{(2.5033)}{2.5454d} \underset{(-0.7607)}{-4.8918n} + \underset{(1.9321)}{1.1739f} \tag{29}$$

$r^2 = 0.9550$

$DW = 1.6491$

$F(5, 9) = 38.2400$

where the figures in parentheses below the estimated coefficients are the Student-t statistics, r^2 is square of correlation coefficient, DW is Durbin-Watson-d statistics, and $F(m, n)$ is F statistics with degrees of freedom of m and n. Even though all of the test statistics are not very strong, most of them shows high statistical significance, and the signs and magnitudes of the estimated coefficients are reasonable and as expected.

For the convenience of readers, the two of sets of estimated parameters for both structural and reduced form equations are arranged in matrices.

One dollar a day

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 0.1192 & 0 & 0 \\ -8.4448 & 5.5335 & 0 \end{bmatrix} \tag{30}$$

$$B = \begin{bmatrix} -1.6107 & 0.2070 & 0.0036 & 0 \\ 2.6399 & 0 & 0 & 0.2313 \\ -48.5430 & 0 & -7.3872 & 2.6456 \end{bmatrix} \tag{31}$$

$$\Pi = \begin{bmatrix} -1.6107 & 0.2070 & 0.0036 & 0 \\ 2.4479 & 0.0247 & 0.0004 & 0.2313 \\ -21.3955 & -1.6115 & -7.4152 & 3.9255 \end{bmatrix} \tag{32}$$

Two dollars a day

$$A = \begin{bmatrix} 0 & 0 & 0 \\ 0.1192 & 0 & 0 \\ -7.7193 & 2.5454 & 0 \end{bmatrix} \tag{33}$$

$$B = \begin{bmatrix} -1.6107 & 0.2070 & 0.0036 & 0 \\ 2.6399 & 0 & 0 & 0.2313 \\ -7.5970 & 0 & -4.8918 & 1.1739 \end{bmatrix} \tag{34}$$

$$\Pi = \begin{bmatrix} -1.6107 & 0.2070 & 0.0036 & 0 \\ 2.4479 & 0.0247 & 0.0004 & 0.2313 \\ 11.0664 & -1.5351 & -4.9185 & 1.7627 \end{bmatrix} \tag{35}$$

Instead of Π being estimated directly from the reduced form equation, it is calculated from A and B based on Equation (20). Perhaps due to strong multicolinearity among the exogenous variables, the estimated results from the reduced form equation are neither statistically significant nor matching with Equation (20). The estimated results could have also been biased.

VI. Poverty Reduction Linkages

The linkage between the change in domestic fixed capital formation as share of GDP and the change in poverty incidence through the channel of economic growth is investigated as in Equation (36).

$$\frac{\partial g}{\partial k}\frac{\partial p}{\partial g} = \pi_{11}\alpha_{31} = -1.7481 \quad (36)$$
$$= -1.5979$$

Two figures are given in Equation (36), as in other following equations. The first one is for one-dollar-a-day poverty line and the second for two-dollar-a-day line. The figures may be interpreted as an investment elasticity of poverty reduction through income growth. One percent increases in annual average domestic capital formation as a share of GDP would result in approximately 1.75 percent reduction in poverty incidence in a decade under one-dollar-a-day criterion and 1.60 percent reduction under two-dollar-a-day criterion, respectively. The impact of domestic capital formation on poverty reduction would be made through change in income growth rate.

Again domestic fixed capital formation would also give an impact to poverty reduction through channel of deteriorated income distrubution as in Equation (37).

$$\frac{\partial d}{\partial k}\frac{\partial p}{\partial d} = \pi_{22}\alpha_{22} = 0.0199 \quad (37)$$
$$= 0.0629$$

Since income growth was not accompanied by better income distribution in big countries like China, India, Russia, and Indonesia and Pakistan, the so-called "trickling-down effect" could not be accomplished.

Domestic fixed capital formation contributes to income growth, and income growth slightly worsened size income distribution. Deteriorated size income distribution would slightly increase poverty incidence. One percent increases in annual average domestic fixed capital formation as a share of GDP would increase in a decade poverty incidence by 0.02 percent under one-dollar-a-day criterion and 0.06 percent under two-dollar-a-day criterion.

Similarly, new creation of labour employment would also reduce poverty incidence. Equation (38) may be termed employment elasticity of poverty reduction through income growth.

$$\frac{\partial g}{\partial n}\frac{\partial p}{\partial g} = \pi_{31}\alpha_{12} = -0.0304 \\ = -0.0278 \tag{38}$$

Equation (38) shows that one percent increases in average annual employment of labour would bring about 0.03 percent reduction in poverty incidence in a decade under one-dollar-a-day criterion and two-dollar-a-day line.

Again, however, increased employment of labour would increase poverty through worsened size income distribution as well. This channel is shown by Equation (39).

$$\frac{\partial d}{\partial n}\frac{\partial p}{\partial d} = \pi_{22}\alpha_{32} = 0.0022 \\ = 0.0061 \tag{39}$$

The elasticity in these two cases is very negligible and close to nil. However the direct impact of increase in employment on the poverty reduction by generating wage income seems to be very great. This is indicated by β_{33} which is bigger than one. The overall impact made by employment shows positive poverty reduction by being channelled by through both growth and wage income creation.

Finally, inflation also plays a role in changing poverty incidence. As hypothesized, inflation affects negatively low income wage earners, whose real income would be aggravated and size income distribution would consequently be worsened. This would increase poverty incidence. This process is shown by Equation (40).

$$\frac{\partial d}{\partial f}\frac{\partial p}{\partial d} = \pi_{23}\alpha_{32} = 1.2799 \tag{40}$$
$$= 0.5888$$

One percent annual average inflation would result in slightly more than one percent increase in poverty incidence in a decade under one-dollar-a-day criterion and about 0.6 percent under two-dollar-a-day criterion.

In sum π_{31}, π_{32}, and π_{33} show the total impact of k, d and n on poverty either through growth or distribution or directly, as indicated in Equations (41), (42) and (43).

$$\pi_{31} = \alpha_{31}\pi_{11} + \alpha_{32}\pi_{21} + \beta_{31} \tag{41}$$

$$\pi_{32} = \alpha_{31}\pi_{12} + \alpha_{32}\pi_{22} + \beta_{32} \tag{42}$$

$$\pi_{33} = \alpha_{31}\pi_{13} + \alpha_{32}\pi_{23} + \beta_{33} \tag{43}$$

In general, the impact under one-dollar-a-day criterion is greater than two-dollar-a-day, as expected. As it is often observed in China and elsewhere (Chen and Wang [5]), the initial poverty reduction strategy is very effective in eradicating extremely low income poverty. However, the effectiveness of later-stage poverty reduction strategy is usually blocked by "diminishing marginal return" in terms of percentage reduction of poverty incidence. This is exactly what is revealed from the two different responses from one-dollar-a-day and two-dollar-a-day criteria. As poverty line is increased, the impact of exogenous variables in poverty reduction becomes less effective, which indicates "diminishing marginal return".

Optimistic aspects of the evidences found from this exercise are that, first, out of 17 countries in the region with proper poverty statistics, six countries have already reached or are reaching the target of reducing the 1990 level of poverty incidence into a half in 2000, and, second, some countries may easily reach that goal far before 2015 with slight increase in per capita income growth rate and slight decrease of Gini coefficient either through increased capital formation and creation of new jobs. Except a limited few, by 2015, most of the countries in the region would have realized attaining the goal of reducing poverty incidence into a half. The largest two countries in the region and world as well, China and India, are included in these categories.

Even though it is not evidenced by this type of statistical exercises, non-quantifiable and non-economic variables, such as health, sanitation, empowering gender, etc. will definitely affect domestic savings, capital formation, employment creation, income distribution and eventually growth positively and will also contribute to poverty reduction. Transparency, accountability and good governance are very important in mobilizing both domestic resources and foreign investment.

Ⅶ. Summary and Concluding Remarks

A vast nation-wide organic structure of poverty reduction linkages is an extremely complex mechanism, in which various socio-economic factors are inter-twined. Some are visible and measurable, but some are hidden and hardly measurable. Where there is rampant corruption, scarce domestic and foreign resources are mostly squandered for wrong purposes, and economic growth and development and left behind with permanently lasting hard core poverty in the nation. However, the degree of intensity and extensiveness of corruption is hardly revealed and, therefore, cannot be captured in measurable terms properly. Where female gender is discouraged to participate in work forces and to enroll in educational institutes, one half of precious human capital is virtually wasted. This aspect is not easy to be captured in an explicit form of statistical information.

Even though it is keenly recognized that this type of non-measurable factors also play important roles in poverty eradication, quantifiable economic variables are only used in this paper in constructing a small scale simultaneous equation model, primarily due to lack of properly quantifiable information. The model is made of three structural equations, describing economic growth, income distribution and poverty incidence. Fixed capital formation, employment of labour and inflation are treated as exogenous variables, even though these variables should be treated as endogenous in a larger model.

The estimated result shows a reasonably high level of statistical significance in most cases and matches with theoretically hypothesized signs in all cases. It is statistically corroborated that while human resources and physical capital determine growth, growth and inflation affect income distribution, and growth, distribution and employment contribute to poverty reduction in one way or another. The so-called growth and distribution effects in poverty reduction are separately and clearly identified form the model. And it is found that in most cases growth contributed definitely to poverty reduction. Estimated elasticities of poverty reduction with changes of all of exogenous variables also indicate theoretically hypothesized directions and scales. Finally, an optimistic conclusion is derived from this exercise in conjecturing feasibility of realizing the goal of reducing poverty of the 1990 level into a half even far earlier than the targeted year of 2015 in Asia and the Pacific region, particularly in large countries.

A continued effort should be made in further advanced studies to attempt to include non-economic variables in the poverty reduction linkages, and the importance of the roles assumed by these factors should also be emphasized as much as possible.

〈Appendix 1〉

Statistical Data

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
China	1990~2000	5.59	1990~1998	5.7	1990~2000	-47.6	-31.3
Mongolia	1992~1998	1.06	1995~1995	0.0	-	-	-
Rep. Korea	1990~2000	4.99	1993~2000	0.1	1990~2000	-	-100.0
Cambodia	1990~2000	1.38	1990~1997	0.0	1990~2000	-29.4	-9.3
Indonesia	1990~2000	2.54	1990~1999	-1.4	1990~2000	-61.1	-17.9
Lao PDR	1990~2000	3.47	1992~1997	6.6	1990~2000	-50.0	-15.5
Malaysia	1990~2000	4.18	1989~1987	0.8	1990~2000	-100.0	-73.1
Philippines	1990~2000	0.63	1991~1997	1.2	1990~2000	-33.5	-14.2
Thailand	1990~2000	3.25	1990~1998	-7.4	1990~2000	-80.0	-36.2
Vietnam	1990~2000	5.25	1992~1998	-0.6	1990~2000	-82.1	-37.8
Bangladesh	1992~1999	3.49	1992~1996	5.3	1992~1999	-18.9	-
India	1990~1997	3.29	1990~1997	8.1	1990~1997	-15.8	-2.9
Pakistan	1990~1999	1.80	1988~1999	6.2	1990~1999	-35.1	-
Sri Lanka	1990~1998	3.80	1990~1995	4.3	1990~1995	73.7	10.2
Kazakhstan	1996~2000	-3.19	1993~1996	2.4	1993~1996	-25.0	26.4
Russia	1993~1998	-5.05	1993~1998	17.7	1993~1998	255.0	139.4
PNG	1990~2000	1.98	1996~2000	0.0	1990~2000	-26.2	-9.4

Source: Poverty Centre/Unit Compilation of Statistics from UNSD, IMF, World Bank, and ADB.

Country	λ		π		f	
	Years	%	Years	%	Years	%
China	1991～2000	34.26	1991～2000	1.03	1990～2000	9.13
Mongolia	1992～2000	25.44	1992～2000	0.18	1992～1998	44.06
Rep. Korea	1991～2000	31.04	1991～2000	1.41	1990～2000	4.74
Cambodia	1991～2000	11.17	1991～2000	2.46	1990～2000	23.32
Indonesia	1991～2000	26.88	1991～2000	1.80	1990～2000	13.92
Lao PDR	1991～2000	21.06	1991～2000	2.37	1990～2000	25.07
Malaysia	1991～2000	35.89	1991～2000	3.49	1990～2000	3.82
Philippines	1991～2000	16.01	1991～2000	2.11	1990～2000	8.36
Thailand	1991～2000	23.76	1991～2000	0.66	1990～2000	3.49
Vietnam	-	-	1991～2000	2.71	1990～2000	16.36
Bangladesh	1992～1999	19.51	1992～1999	1.79	1992～1999	3.43
India	1991～1997	22.39	1991～1997	0.63	1990～1997	8.89
Pakistan	1991～1999	16.96	1991～1999	3.00	1990～1999	16.97
Sri Lanka	1991～1995	24.09	1991～1995	0.86	1990～1998	9.26
Kazakhstan	1993～1996	21.62	1993～1996	-2.93	1996～2000	19.67
Russia	-	-	1993～1998	1.48	1993～1998	60.70
PNG	1991～2000	18.35	1991～2000	1.03	1990～2000	3.83

⟨Appendix 2⟩

Ordinary Least Squares (OLS) Estimation Results

Growth Equation

$$g = -1.1616 + 0.1602k + 0.2110n \qquad \text{(A1)}$$
$$\quad (-1.1291) \; (3.8828) \; (1.1322)$$

$r^2 = 0.5753$

$DW = 2.8851$

$F(3, 12) = 8.1263$

Income Distribution Equation

$$d = 2.6286 - 0.5879g + 0.1130f \qquad \text{(A2)}$$
$$\quad (0.6250) \; (-0.8039) \; (0.8741)$$

$r^2 = 0.3172$

$DW = 1.6013$

$F(3, 13) = 3.1093$

Poverty Reduction Equation (One dollar a day)

$$p = -0.0301 - 14.0428g + 8.7171d - 6.7129n \qquad \text{(A3)}$$
$$\quad (-0.0011) \; (-2.3537) \; (3.2601) \; (-0.8006)$$

$r^2 = 0.7865$

$DW = 2.7509$

$F(4, 10) = 12.2759$

Poverty Reduction Equation (Two dollars a day)

$$p = \underset{(1.2760)}{13.9690} - \underset{(-4.5144)}{12.0078g} + \underset{(2.7704)}{3.3515d} - \underset{(-2.4458)}{0.0521n} \tag{A4}$$

$r^2 = 0.9000$

$DW = 1.0639$

$F(4, 9) = 26.9874$

where the figures in parentheses below the estimated coefficients are the Student-t statistics, r^2 is square of correlation coefficient, DW is Durbin-Watson-d statistics, and $F(m, n)$ is F statistics with degrees of freedom of m and n.

One dollar a day

$$A = \begin{bmatrix} 0 & 0 & 0 \\ -0.5879 & 0 & 0 \\ -14.0428 & 8.7171 & 0 \end{bmatrix} \tag{A5}$$

$$B = \begin{bmatrix} -1.1616 & 0.1602 & 0.2110 & 0 \\ 2.6286 & 0 & 0 & 0.1130 \\ -0.0301 & 0 & -6.7129 & 0 \end{bmatrix} \tag{A6}$$

$$\Pi = \begin{bmatrix} -1.1616 & 0.1602 & 0.2110 & 0 \\ 3.3075 & -0.0942 & -0.1240 & 0.1130 \\ 45.1487 & -3.0706 & -3.9314 & 0.9850 \end{bmatrix} \tag{A7}$$

Two dollars a day

$$A = \begin{bmatrix} 0 & 0 & 0 \\ -0.5879 & 0 & 0 \\ -12.0078 & 3.3515 & 0 \end{bmatrix} \tag{A8}$$

$$B = \begin{bmatrix} -1.1616 & 0.1602 & 0.2110 & 0 \\ 2.6286 & 0 & 0 & 0.1130 \\ 13.9690 & 0 & -0.0521 & 0 \end{bmatrix} \tag{A9}$$

$$\Pi = \begin{bmatrix} -1.1616 & 0.1602 & 0.2110 & 0 \\ 3.3115 & -0.0942 & -0.1240 & 0.1130 \\ 39.0158 & -2.2393 & -3.0015 & 0.3787 \end{bmatrix} \quad \text{(A10)}$$

$$\frac{\partial d}{\partial f}\frac{\partial p}{\partial g} = \pi_{11}\alpha_{31} = \begin{matrix} -2.2497 \\ -1.9236 \end{matrix} \quad \text{(A11)}$$

$$\frac{\partial d}{\partial k}\frac{\partial p}{\partial d} = \pi_{22}\,22_{22} = \begin{matrix} -0.8212 \\ -0.3157 \end{matrix} \quad \text{(A12)}$$

$$\frac{\partial g}{\partial n}\frac{\partial p}{\partial g} = \pi_{31}\alpha_{12} = \begin{matrix} -2.9630 \\ -2.5336 \end{matrix} \quad \text{(A13)}$$

$$\frac{\partial d}{\partial n}\frac{\partial p}{\partial d} = \pi_{22}\alpha_{32} = \begin{matrix} -1.0809 \\ -0.4156 \end{matrix} \quad \text{(A14)}$$

$$\frac{\partial d}{\partial f}\frac{\partial p}{\partial d} = \pi_{23}\alpha_{32} = \begin{matrix} -0.9850 \\ -0.3787 \end{matrix} \quad \text{(A15)}$$

〈Appendix 3〉

Weights

Country	Years	Population in Million	W	$W^{\frac{1}{2}}$
China	1997	1244	390	19.7
Mongolia	1999	3	1	1.0
Rep. Korea	1999	47	15	3.9
Cambodia	1999	11	3	1.7
Indonesia	1999	207	65	8.1
Lao PDR	1999	5	2	1.4
Malaysia	1999	23	7	2.6
Philippines	1999	75	24	4.9
Thailand	1999	62	19	4.4
Vietnam	1999	79	25	5.0
Bangladesh	1999	127	40	6.3
India	1999	987	309	17.6
Pakistan	1999	135	42	6.5
Sri Lanka	1999	19	19	2.4
Kazakhstan	1999	15	5	2.2
Russia	1995	146	46	6.8

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