The Developing Economies, XXIV-1 (March 1986)

RURAL-URBAN MIGRATION: POLICY SIMULATIONS IN A DUAL ECONOMY MODEL OF BANGLADESH

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I. INTRODUCTION

THIS paper focuses on the process of rural-urban migration of the population within a dual economy model and analyzes some policy implications which may be adopted to reduce migration rate consistent with overall development of the Bangladesh economy.

In the late 1960s, economists tried to answer the perplexing question of why increasing numbers of people in developing countries moved from the rural to urban areas in spite of growing urban unemployment. Formulation of appropriate strategies for economic development requires an understanding of migration to the urban areas—in both its quantitative significance and its behavioral features. However, the policy prescriptions of the existing migration literature are somewhat narrow and tentative, due to data, design, and methodological problems.

The high labor migration rate from the rural to urban sectors poses many problems for developing countries. It leads to increasing urban unemployment, creation of urban slum areas, and other associated problems. Rapid urbanization in the low-income countries is said to hamper economic development because of increasing demand for less productive projects (urban socioeconomic services) on the scarce capital resources. The process of economic development in the less-developed countries often does not consist of a rapid equilibrating mechanism; the persistence of sectoral inequalities in productivities and prices in these economies, is a common feature of the process of economic development of these countries.

Due to heavy pressure of population on scarce land in the agricultural sector and due to the higher urban wage rate, Bangladesh has been experiencing large movement of rural people to the urban region. However, the relatively small urban manufacturing and service sectors have not been able to absorb all these new workers. Moreover, given the limited capacity to increase urban employment due to the scarcity of capital resources, the manufacturing sector's ability to absorb this influx of workers is severely restricted. The high rate of migration from rural to urban sectors may not appear to be an immediate problem to the policymakers. This apparent apathy toward the phenomenon is dangerous. The migration feature is the tip of the iceberg of abysmal rural poverty—it is the

The author wishes to thank Stuart Mestelman, David Feeny, and Doug Welland for their helpful comments. The views expressed here are author's own.

manifestation of deprivation and disabilities of the rural poor. This paper will argue that reduction of migration is not an end in itself but will contribute in solving rural poverty.

II. A DUAL ECONOMY MODEL OF BANGLADESH

In this paper a two-sector general equilibrium model containing the rural (agricultural) and urban (manufacturing) sectors with interactions of the product and factor markets of the sectors, is presented.

Two broad categories of general equilibrium dual economy models have emerged; (a) the classical models of Lewis [14] and Fei and Ranis [7], and (b) the neoclassical models of Jorgenson [10] [11] and Kelley, Williamson, and Cheetham [13].

In the present study, a neoclassical general equilibrium model is developed to study the policy implications to tackle migration problem within dualistic economic development in Bangladesh. It is assumed that wages in the rural and urban sectors are both determined endogenously as against the classical assumption of exogenous wage rate. Both theoretical and empirical considerations prompted us to follow the neoclassical approach to labor supply. Jones in his study of dualistic economic development [9] has shown that the neoclassical labor assumption based on marginal product pricing may be a more useful assumption for a dualistic model, because the rural people behave as rational optimizers.

The assumption of rational optimizing behavior of the rural people both as consumers and producers allows the derivation of the aggregate supply and demand relationships with better theoretical foundation.[1] Moreover, the neoclassical models appear to have been able to better predict the process of economic development than the classical-type growth models.[2]

The economy of Bangladesh is viewed as having two basic sectors, agriculture and manufacturing. These sectors are linked through input and output markets and by the process of rural-urban migration of population.

There are fourteen equations in our model, out of which eight equations are aggregate demand functions for food, manufactured good, jute (major cash crop), land used for food production, land used for jute production, labor used for food production, labor used for jute production, and labor used for production of manufactures. Five supply equations are for food, jute, manufactured good, labor in the rural sector, and labor in the urban sector. One equation on migration captures the movements of population due to factors operating both in the rural and urban sectors.

Links between the rural agricultural sector and the urban manufacturing sector include the consumption of food and manufactured good in both the sectors, the

1 Ahmed [2] provides with a model.

2 Kelley, Williamson, and Cheetham [13] show that their neoclassical assumptions explain the development process quite aptly. A later work by Kelley and Williamson [12] on the economic history of Japan shows the better predictive power of a model based on neoclassical assumptions.

use of jute as an input in the manufacturing sector, and the movement of people from one sector to another due to sectoral wage differential and other factors. The effects of international trade sector enters (indirectly) through the world demand for jute and through the price of substitutes of jute in the world market.

A. *Agricultural (Rural) Sector*

The general approach followed for this sector is based on the work by Yotopoulos and Lau [18]. The agricultural (rural) sector is assumed to produce two crops, food (rice) and cash (jute) crops. Rural households are assumed to maximize utility, by consuming food, manufactures (produced in the urban manufacturing sector), and leisure. The household's consumption choices are constrained by its income which depends on the sale of cash crop (jute), on sale or purchase of labor services (depending on whether the household is a net supplier or purchaser of labor services), on the return from land (if it has any) or some combination of each.

This procedure was followed to identify the relevant explanatory variables for the aggregate relations of the model. This suggests that the demand functions for food, leisure, and manufactures depend upon the prices of food, manufacture, and labor (as the prices of final goods and leisure), and the prices of capital, land, and cash crop (the determinants of household income). The output supply functions have been obtained by using the input demand functions and the relevant production functions. The variables in the supply functions are similar to those in the input demand functions.

The demand and supply functions that can be estimated depend upon the availability of data. In particular, acceptable data on land and capital prices were not available. Rather than ignore capital and land entirely, these two inputs were included in the aggregate equations and treated as exogenous inputs. Since capital expenditures for irrigation schemes, food-grain warehouse, and other major capital inputs are controlled to a large extent by various government agencies, such as the Agricultural Development Corporation, the Agricultural Development Bank, and the Bangladesh Water Development Board, rather than by individual farmers, increases in agricultural capital investment may be properly treated as exogenous changes in the sector's resource endowments. Viewed this way, direct allocation of capital resources into agriculture is a feasible activity of the government. Agricultural capital as assumed to be common to both food and jute production, and its stock is allocated to different activities depending upon the farmers' production decisions. The capital series which is used is described in Ahmed [1].

Since changes in the stock of land are affected through public (government) action, the relevant variable in the aggregate rural supply and demand functions may be the quantity of land rather than its price. The land used for the major rice crop in Bangladesh can also be used to grow jute. The use of land in one activity or the other will reflect the relative profitability of the crops. The price of land will reflect the expected stream of income which can be produced by the land. This price may not be necessary for the estimation of the aggregate supply and demand functions which will be used in this paper as long as the quantity of land available, the prices of the food and cash crops, and variable inputs are included. The quantity of land available will be sufficient to reflect the production constraints on producers and provide a proxy for rental income.

In addition to replacing land and capital prices with land and capital stocks, fertilizer is introduced into the demand function for labor used in food production, the supply of food and labor functions and the rural demand functions for final goods. During the period for which these equations are estimated, the use of fertilizer was encouraged by the government. The government generally had a surplus of fertilizer to distribute, and the price of fertilizer grossly underestimated the market price of this input. This variable is positively related to the adoption of high-yielding varieties of rice (and to both physical and intellectual accessibility of farmers to new technologies), and may serve as a proxy for technical change in food production. Since jute is not particularly responsive to fertilizer, it is not included in the jute equation. Furthermore, two dummy variables are introduced into all of the equations to account for any disruptions which may have occurred in the rural economy in the three years following the war of liberation in 1971.

The lagged price of the cash crop is used in the supply function for jute as a proxy for the expected price of jute. This procedure is suggested both by the crop cycle and by the role of expected prices in supply behavior. *Aus* and *aman* rice are usually planted in May, and *boro* rice is planted in December. Jute, the cash crop, is usually planted in April and May. If jute is planted, *aus* or *aman* can only be planted on land with double-cropping capabilities, only about 7 per cent of total cultivable land. Therefore, for the bulk of Bangladesh rice production (*aus* and *aman*), jute is a substitute crop. The decision to plant jute will depend upon the relative price of jute to rice in the previous period; it is assumed that the past period's price is the farmers' expected current price.

B. *Manufacturing (Urban) Sector*

The urban manufacturing firms and laborers are expected to follow profit and utility maximization principles. Implicit in the urban sector derivation of the relationships, is the assumption that the returns to capital are not directly derived by the households. They are reinvested by the government and financial intermediaries and appear as exogenous expenditures in later periods or spent outside Bangladesh through the foreign trade sector. Therefore, capital in manufacturing sector is not included in the final demand for manufacture and urban labor supply relationships.

In the production of output, labor, capital, and the cash crop are used as inputs. Ideally, the demand for labor and capital would depend upon the prices of manufacture goods and the prices of labor, capital, and the cash crop. However, as with agricultural capital, acceptable data on the price of capital in manufacturing was not available. However, even with price data, government control of capital imports into Bangladesh constrains the extent to which a demand function for capital can be estimated. For this reason capital is treated as an exogenous variable in the sector's aggregate demand for labor and supply of output functions. The wage rates of the urban sector were with respect to the workers of major cities and industrial centers. These refer to mainly the unskilled laborers who are comparable to rural workers (including those engaged in agriculture).

As in the rural sector equations, dummy variables are added to all the urban sector equations to reflect any structural displacement which may have occurred during the three-year period following the internal disruptions due to the war of liberation of 1971. Two additional terms are added to the demand for manufacturing labor and the supply of manufactures equations. In each of these equations a time trend is introduced in an attempt to identify structural changes associated with the economies of scale which may have occurred as the result of the expansion in industrial activities in Bangladesh.

Jute is an input in domestic manufacturing and it is the major export crop. The demand for the cash crop, jute, comes from both domestic and foreign users. Not only will the price of jute be important to users of raw jute, but the price of jute substitutes will also be important. All of the equations in which the price of the cash crop enters as a variable will contain the relative price of the cash crop to the price of the substitute. In addition, two variables which are included in the equation representing the demand for the cash crop, but in no other equations, are an index of incomes of the major jute importing countries and the lagged value of jute production. The former variable is to account for any foreign income effects which could affect the demand for the cash crop. The latter variable is introduced to account for technological or institutional rigidities or future uncertainties (it may also pick up inventory demands for jute).

III. THE MIGRATION FUNCTION

The process of migration is considered in a simultaneous equation general equilibrium model in this study and as such the direct policy variables are not restricted to wages and employment only. A set of other exogenous variables, namely capital investment by the government in the rural and urban sectors, are taken as feasible policy variables and their effects examined. This approach gives a broader dimension to policy analysis for economic development.

In this paper, the policy of injecting capital into the urban manufacturing sector to stimulate employment is analyzed by examining the case of Bangladesh. Blomqvist [3] in this article has emphasized the need to incorporate dynamic interactions between the rural-urban sectors, especially between migration and urban labor market. Blomqvist [3] argues that a piece-meal policy, such as urban job creation, may not be the optimal one. The present empirical analysis may bring into light some of the issues raised by his paper and as such this paper may be an empirical test of such arguments.

An important economic factor for rural-urban migration is the urban-rural income disparity. However, the wage differential is not the only determinant of migration. To formulate the "aggregate" migration function used in the present study, two important variables have been used; one is the urban-rural wage ratio (W^*_m/W^*_a) and the other is land-man ratio ($\bar{R}/N^*_R$) in the rural sector.

Some empirical studies on migration in Bangladesh suggest that the population density, apart from the wage gap, is an important variable which affects rural-urban migration [5] [6]. They also found that about 80 per cent of the rural-to-urban migrants were landless. The findings of the studies suggest that those who have some land are less likely to move out from the rural areas. This finding is not entirely unexpected when we consider the fact that the skills of farmers would be less acceptable or would be of the most limited applicability for work in the urban areas.

Following Sen [15] the density variable ($\bar{R}/N^*_R$) can be incorporated along with the labor-leisure choice and migration decision into our model of the peasant household. It may be assumed that in the utility function of a person, leisure, the amount of food and the manufactured good consumed, and a parameter reflecting the population density of his location enter as the arguments. Then, the ratio of the utility an individual receives if he remains in the rural area to the utility he would receive if he migrates to the urban area, is a function of the sectoral wage rates and the population densities.[3] Ratios less than one would result in migration to the city. This inclusion of the density variable into the utility function of the peasant household, will result in its appearance in a reduced form migration equation. The definitions of symbols are given in Appendix.

Thus, the "aggregate" migration function is written as

$$\log NM = a_1 + a_2 \log\left(\frac{W^*_m}{W^*_a}\right)_L - a_3 \log\left(\frac{\bar{R}}{N^*_R}\right)_L + a_4 D\ ,$$

where NM is the number of people migrating from the rural to urban areas, $(R/N^*_R)_L$, is the land-man ratio in the rural sector and $(W^*_m/W^*_a)_L$ is the urban-rural wage rate ratio, both lagged one year. The coefficient of the lagged ratio of wage, $(W^*_m/W^*_a)_L$, is expected to be positive. The coefficient of the lagged ratio of rural density, $(\bar{R}/N^*_a)_L$, is expected to be negative.

Note that the rural population is defined as $N^*_R = N_{RL}(1+g) - NM$, because in the model, population in the rural sector at a particular period consists of population of the previous period (N_{RL}), additions due to the natural growth (g) of population, less the number of people migrating to the urban areas. The number of people migrating (NM) in a particular time period (period 1) is affected by the flow of people between a specified interval (between period 0 and 1).

In the absence of more direct information of the place of birth of the migrants, an indirect measure of net internal migration known as "vital statistics method" is used.[4] An empirical study by Chaudhury and Curlin [4] done for a period of five years from 1968–69 to 1972–73 for 101 villages of Bangladesh provides useful information on internal migration in Bangladesh. The values of migration

3 It is assumed that the urban population density does not affect the migration decision of the rural people, for the densities in the urban areas are already so great that marginal changes are not perceivable to the rural people.

4 For details see [17].

calculated in the present study seem consistent (for the same period of time) with other studies.

IV. ESTIMATION OF PARAMETERS OF THE MODEL

The functional forms of the model are taken to be loglinear, primarily for convenience of estimation. The only restriction imposed is that it should satisfy the appropriate homogeneity property in terms of prices. In this general equilibrium model, one way to satisfy the restriction is to express all prices relative to a *numéraire* and in this case food price is chosen as the *numéraire.*

The model has fourteen equations with eighteen endogenous, thirteen exogenous, and three lagged endogenous variables as indicated below.

Endogenous variables:

$\bar{L}_f$, $\bar{L}_c$, $\bar{R}_f$, $\bar{R}_c$, $\bar{Q}_f$, $\bar{Q}_c$, $\bar{L}_a{}^S$, $\bar{Q}_c{}^D$, $\bar{Q}_f{}^D$, $W^*{}_a$, $P^*{}_c$, $\bar{L}_m$, $\bar{L}_m{}^S$, $\bar{Q}_m$, $\bar{Q}_m{}^D$, $P^*{}_m$, $W^*{}_m$, NM.

Exogenous variables:

$\bar{K}_f$, $\bar{K}_c$, $\bar{R}$, N_R, N_U, Y_F, P_c/P_s, $\bar{K}_m$, F, D, TT, D_m, $N^*{}_R$.

Lagged endogenous variables:

$\bar{Q}_{cL}{}^D$, $P^*{}_{cL}$, $(W^*{}_m/W^*{}_a)_L$.

The model has five market clearing conditions:

(i) $\bar{Q}_f=\bar{Q}_f{}^D$, (ii) $\bar{Q}_c=\bar{Q}_c{}^D$, (iii) $\bar{L}_f+\bar{L}_c=\bar{L}_a{}^S$,

(iv) $\bar{Q}_m=\bar{Q}_m{}^D$, and (v) $\bar{L}_m=\bar{L}_m{}^S$.

With fourteen equations and five identities, this simultaneous model has nineteen relations in eighteen unknowns. Since all prices are expressed in terms of the price of food, it follows from Walras Law, that one of the market clearing conditions is redundant. We have chosen arbitrarily, the market clearing identity (iii) as redundant and so $\bar{L}_f$, $\bar{L}_c$, $\bar{L}_a{}^S$ are all estimated in terms of other variables. The model is estimated using the data for the Bangladesh economy[5] for the period 1947 to 1975. The estimated equations are presented in Table I.

The method of two-stage least squares (2SLS) was first used for estimation. The residuals in equations (1), (2), (4), (5), (7), and (12) were highly autocorrelated, when estimated by this method. These six equations were reestimated by two-stage Cochrane-Orcutt iterative technique to reduce the extent of autocorrelation of residuals and to get the parameter values.

In order to be satisfied with the model's predictive power, we have calculated Theil's inequality coefficient U for each equation. The values of U for all equations suggest adequate predictive ability of the model.[6] To supplement the U statistic, historical simulation was carried out over the data period. In historical simulation, the interactions of all the estimated equations were allowed and it

[5] The nature of data and its sources have been given in detail in [1].

[6] The values of U coefficient are restricted to the closed interval between 0 and 1, with 0 showing perfect forecasts and 1 bad forecasts. For details see [16].

TABLE I

ESTIMATED STRUCTURAL EQUATIONS OF THE MODEL

	R^2	S.E.	d	U
(1) Labor demand in the food crop production				
$\log \bar{L}_f = 1.2915 + 0.0053 \log P^*_{cL} - 0.0528 \log W^*_a + 0.0307 \log \bar{K}_f$				
(0.57) (0.27) (1.01) (2.05)				
$-0.1177 \log \bar{K}_c + 0.2091 \log \bar{R} + 0.0585D + 0.0699 \log F$	0.98	0.03	1.68	0.026
(1.90) (2.09) (0.75) (7.75)				
(2) Labor demand in the cash crop production				
$\log \bar{L}_c = 2.8967 + 0.0038 \log P^*_{cL} - 0.0196 \log W^*_a - 0.9139 \log \bar{K}_f$				
(1.95) (0.47) (0.74) (12.50)				
$+0.8838 \log \bar{K}_c + 0.0328 \log \bar{R} + 0.0039D$	0.99	0.01	1.81	0.011
(15.60) (2.85) (0.09)				
(3) Land allocation in the food crop production				
$\log \bar{R}_f = 0.4657 - 0.0335 \log P^*_{cL} - 0.0111 \log W^*_a + 0.0613 \log \bar{K}_f$				
(0.81) (4.20) (1.91) (2.31)				
$+0.0481 \log \bar{K}_c + 0.8550 \log \bar{R} + 0.0129 \log F + 0.1382D$	0.99	0.01	2.08	0.017
(1.06) (17.16) (7.90) (5.68)				
(4) Land allocation in the cash crop production				
$\log \bar{R}_c = -13.1341 + 0.4959 \log P^*_{cL} - 0.3059 \log W^*_a - 0.5043 \log \bar{K}_f$				
(1.02) (4.01) (1.00) (1.31)				
$+0.9673 \log \bar{K}_c + 1.4836 \log \bar{R} + 0.4291D$	0.67	0.17	1.64	0.014
(2.20) (2.46) (0.09)				
(5) Output of the food crop				
$\log \bar{Q}_f = -6.8813 + 0.1891 \log \bar{K}_f + 0.2767 \log \bar{K}_c - 0.1928 \log W^*_a$				
(1.58) (3.05) (1.05) (2.03)				
$-0.0575 \log P^*_{cL} + 1.3553 \log \bar{R} + 0.0456D + 0.0391 \log F$	0.89	0.07	1.95	0.040
(1.80) (3.62) (0.26) (2.73)				
(6) Output of the cash crop				
$\log \bar{Q}_c = -4.8211 - 0.6888 \log \bar{K}_f + 0.9384 \log \bar{K}_c - 0.3302 \log W^*_a$				
(0.77) (1.59) (2.31) (1.79)				
$+0.4108 \log P^*_{cL} + 0.7586 \log \bar{R} - 0.2040D$	0.47	0.16	2.06	0.045
(3.37) (2.52) (0.59)				
(7) Rural labor supply				
$\log \bar{L}_a{}^S = -1.8936 - 0.0691 \log \bar{K}_f + 0.0413 \log \bar{K}_c + 0.1566 \log \bar{R}$				
(2.34) (1.01) (0.79) (1.79)				
$-0.1096 \log P^*_m - 0.0016 \log P^*_c + 0.1095 \log W^*_a$				
(2.28) (0.29) (2.78)				
$+0.8763 \log N^*_R + 0.1586D$	0.99	0.02	1.40	0.012
(20.07) (2.49)				
(8) Food demand				
$\log \bar{Q}_f{}^D = 10.9561 - 0.6540 \log W^*_a + 0.9156 \log W^*_m - 0.2442 \log P^*_m$				
(1.80) (1.02) (3.16) (0.55)				
$-0.5335 \log \bar{K}_f + 0.1506 \log \bar{K}_c + 0.0977 \log \bar{R} + 0.0566 \log N^*_R$				
(1.24) (0.48) (0.17) (2.89)				
$+0.4018 \log N_U - 0.0176 \log NM + 0.0049D$	0.95	0.09	1.75	0.015
(5.67) (0.23) (0.02)				
(9) Cash crop demand				
$\log \bar{Q}_c{}^D = 3.6333 + 0.5196 \log \bar{Q}_m - 0.1403 \log (P_c/P_s) + 0.0766 \log Y_F$				
(3.26) (2.62) (2.50) (1.16)				
$+1.0411D + 0.1888 \log \bar{Q}_{cL}{}^D$	0.52	0.16	2.20	0.012
(1.78) (1.50)				

TABLE I (continued)

		R^2	$S.E.$	d	U
(10)	Urban labor demand				
	$\log \bar{L}_m = -18.2019 - 0.8217 \log P^*_m - 0.9037 D_m \log P^*_m + 0.3266 \log W^*_m$				
	(3.28) (0.90) (1.90) (0.35)				
	$+2.4604 \log \bar{K}_m - 0.3077 \log TT + 0.4458 D$	0.82	0.26	2.19	0.060
	(3.15) (1.34) (1.87)				
(11)	Output of the manufactured good				
	$\log \bar{Q}_m = 1.2302 + 0.7847 \log \bar{K}_m - 0.2065 \log P^*_m - 0.1825 D_m \log P^*_m$				
	(0.55) (2.51) (0.79) (0.31)				
	$-0.0714 \log W^*_m + 0.0950 \log TT - 1.7800 D$	0.93	0.10	2.19	0.018
	(0.73) (1.09) (6.09)				
(12)	Urban labor supply				
	$\log \bar{L}_m{}^S = 2.2141 + 0.1009 \log W^*_m - 0.1268 \log P^*_m + 0.1860 \log N_U$				
	(4.54) (2.21) (1.26) (2.96)				
	$+0.1510 \log NM + 0.0200 D$	0.99	0.05	1.44	0.065
	(2.85) (0.32)				
(13)	Demand for the manufactured good				
	$\log \bar{Q}_m{}^D = 7.7368 - 0.5728 \log W^*_a + 0.7363 \log W^*_m - 0.0881 \log P^*_m$				
	(1.83) (1.08) (3.03) (1.23)				
	$+0.0454 \log \bar{K}_f + 0.0542 \log \bar{K}_c - 0.4971 \log \bar{R} + 1.1056 \log N^*_R$				
	(1.24) (0.21) (1.27) (2.89)				
	$+0.4076 \log N_U + 0.0110 \log NM - 0.2809 D$	0.93	0.08	1.84	0.042
	(3.40) (0.54) (0.79)				
(14)	Rural-urban migration function				
	$\log NM = 0.0004 + 0.5588 \log (W^*_m / W^*_a)_L - 0.2186 \log (\bar{R}/N^*_R)_L$				
	(0.56) (2.39) (5.28)				
	$+1.3047 D$	0.55	0.74	2.61	0.250
	(1.92)				

Notes: 1. Absolute t values are in parentheses.
2. R^2 = coefficient of multiple determination.
$S.E.$ = standard error of the estimate.
d = Durbin-Watson statistic.
U = Theil's inequality coefficient.
3. Definitions of all the variables are given in Appendix.

was observed that the percentage deviations of the simulated values of the endogenous variables from its actual values were not significant.[7] Therefore, it shows that the equations of the model fit the data well and as such can be used for forecasts and policy simulations. Since the main purpose of this paper is to analyze policy implications in the face of rural to urban migration of population in Bangladesh, the estimated migration function is presented below:

$$\log NM = \underset{(0.56)}{0.0004} + \underset{(2.39)}{0.5588} \log \left(\frac{W^*_m}{W^*_a} \right)_L - \underset{(5.28)}{0.2186} \log \left(\frac{\bar{R}}{N^*_R} \right)_L + \underset{(1.92)}{1.3047} D,$$

$$R^2 = 0.55, \quad d = 2.61, \quad S.E. = 0.74, \quad U = 0.25.$$

The variable NM is the total number of people migrating from the rural to

[7] Ahmed [1] provides with detailed results of historical simulations.

TABLE II

PROJECTED VALUES OF SOME ENDOGENOUS VARIABLES UNDER THE STATUS QUO SITUATION IN THE MODEL

Year	WAO	WMO	NMO
1976	0.810000	0.910010	0.720000
1977	0.811620	0.912457	0.730008
1978	0.807327	0.954954	0.749952
1979	0.815913	0.977795	0.759960
1980	0.824337	0.987987	0.769968
1981	0.823608	1.01966	0.779976
1982	0.825228	1.04750	0.799984
1983	0.833895	1.07353	0.810000
1984	0.835920	1.08754	0.830016
1985	0.842400	1.11875	0.840024

Notes: 1. WAO and WMO are the indices of the rural and urban wages relative to the food price with 1959/60 as the base year, under the status quo assumptions.
2. NMO is the number of people migrating from the rural to the urban sectors under the status quo assumptions.

the urban sector (net migration). The migration decision in the current period is influenced by the lagged ratio of the wage rates and the land-rural population ratio.

The coefficients of the relative wage rates and the land-man ratio are positive and negative, respectively, in accordance with the a priori expectation given earlier. Both coefficients are statistically significant.

As was discussed earlier, the continuous migration from the rural to the urban areas in Bangladesh has serious implication on the provision of urban social services. The urban areas of Bangladesh are already facing shortages in housing, employment, electricity, pure drinking water, and sewerage services. The various policy implications of the model will now be discussed.

V. POLICY SIMULATIONS EXERCISE

The model presented here can be used for two purposes: (1) forecasting of the endogenous variables and (2) policy analysis. However, these two purposes are related. In forecasting per se, economists try to make the best possible guess about all the exogenous variables including the policy variables. Policy analysis is a sort of conditional forecasting in which forecasts under alternative conditions of the exogenous variables are made.

For the purpose of the present study, forecasts for the period 1976 to 1985 were carried out for the variables in which we are interested, namely, the wage rates in both the sectors and the number of people migrating from the rural to urban areas. The values of the exogenous variables for the period 1976 to 1985 were derived from various sources [1]. The projected values of these endogenous variables are given in Table II and represent projections based on a continuation of status quo government investment policies. Given these projections of the endogenous variables the effects of several different government policy options are now analyzed.

In the present study, the effects of three potential government strategies on the levels of internal migration and wage rates in both the rural and urban sectors are examined. The three basic strategies are discussed below:

Strategy I: In this strategy, the major impetus is given to the rural sector in the form of higher additional capital. In order to be realistic, the availability of the additional capital is considered. The First Five-Year Plan (1973–78) of the Bangladesh government gives the year-to-year phasing of the foreign capital inflow up to 1977–78. On the basis of that, the foreign capital inflow has been projected up to 1985. In this policy option, these funds are allocated in the proportion, 50 per cent to the food crop ($\bar{K}_f$), 10 per cent to the cash crop ($\bar{K}_c$), and the rest in the manufacturing sector ($\bar{K}_m$) in each year from 1976 to 1985. Thus, capital in the agricultural sector ($\bar{K}_f$, $\bar{K}_c$) increases by 60 per cent of the foreign-capital inflow and in the manufacturing sector (K_m) increases by 40 per cent of the foreign capital in each year under this strategy.[8]

Strategy II: This strategy puts greater emphasis on the manufacturing sector. The same amount of capital envisaged for strategy I is now allocated in the different proportions: 20 per cent to the agricultural food crop ($\bar{K}_f$), 5 per cent o the cash crop ($\bar{K}_c$), and 75 per cent to the manufacturing sector ($\bar{K}_m$) in each year from 1976 to 1985.

Strategy III: This strategy is designed to assess the impact of improvement in tagricultural technology, which tends to relax the land constraint. It will be quite interesting to examine the effects following a 10 per cent increase in the effective supply of land resources of Bangladesh.[9] Thus land ($\bar{R}$) is increased by 10 per cent under this strategy. The results of such increase may be underestimates because not all the possible effect of new technologies could be incorporated in our equations. However, our results will suggest what would happen if effective land supply in Bangladesh increased by 10 per cent, ceteris paribus.

In each simulation experiment, all other exogenous variables except the ones to be changed were maintained at the levels assumed under the status quo situation for the period 1976.[10] The change in the policy is assumed to occur in

8 The total amount of the foreign capital inflow over ten years, 1976–85, is estimated to be about 27,650 million taka (U.S.$1=4.75 taka in 1959 prices). It should be pointed out that the profits in the manufacturing sector which is assumed to be reinvested are included in the capital stock under the status quo situation.

9 The adoption of modern technology of using improved seeds, large amount of fertilizers, irrigation and flood control, land reclamation all are believed to have the essentially equivalent effects on removing extreme scarcity of land. It has been calculated that strategy III will require approximately the same amount of fund as envisaged under strategies I and II.

10 It is assumed that the change in the aggregate policy of the government does not have any impact on the distribution of capital and land between the farms in the rural sector as well as capital between the industrial enterprises in the urban sector. The effects of various policies on rural-urban migration are examined where the redistribution in the rural-urban populations are analyzed through the process of internal migration.

each case at the beginning of 1976 and the predicted impact of the policy change is measured as the percentage difference between the solutions with and without the change in the policies.[11] The results are presented in Table III.

VI. EVALUATION OF POLICY SIMULATION

The simulation approach is an important method by which various government policies can be evaluated. In this study, policy simulation has been undertaken within the framework of an econometric model and the parameters were estimated by econometric methods, employing data for a particular economy, Bangladesh. Thus the approach of first estimating the parameters of an economic model and then doing simulation exercises is a novel feature of the present study.

Much has been said of the wage differential between agriculture and industry. In the model in which the rural and urban populations are "mobile" through the process of migration, we notice differentials in the wage rates in the rural and urban sectors that remain throughout the period covered in this study.

In the past, there were several reasons for more rapid increase in the urban wage rate in Bangladesh. Rapid capital accumulation was taken as the key to economic development during the Pakistani period. The government policies of overvalued exchange rates, accelerated capital depreciation allowances and tax holidays led to the adoption of capital-intensive techniques in the manufacturing sector. Because of the increase in the marginal productivity of labor in the manufacturing sector, the urban wage rate has increased. On the other hand, due to the lower priority given to the agricultural development, rural incomes and wages did not increase appreciably, resulting in an increasing gap between the rural and urban wages. It may be argued that the urban wage is often above the competitive level due to the pressure from the labor unions and due to various government policies.

In the model, the absolute and relative wage gaps both increase overtime in the status quo situations. For example (in Table II), in 1976 the urban wage (W^*_m) was 12.3 per cent higher than the rural wage (W^*_a) and in 1985 this difference increased to about 33.3 per cent. These results are in contrast to Jorgenson's framework [10] where he assumes that the absolute differential is

[11] The design of experiments in the present study is based on non-stochastic simulation approach in the sense that the stochastic disturbances are not generated by a computer subroutine. In the simulation exercise, an initial period (t) is chosen for which a solution is desired. Then, for the next period ($t+1$) the solution value of the initial period (t) is used as the lagged endogenous variable for the solution of period ($t+1$). The interaction goes to the next period ($t+2$) and so on, until for each of the endogenous variables, the terminal period (the year 1985 in our case) is reached. Thus, in the general equilibrium model used in the present study, the endogenous variables are interlinked within the simulation period, through the lagged endogenous variables, although the market clearing conditions are satisfied at each period. It is postulated here that, given some dynamic adjustment mechanisms, statis equilibrium values at different periods of time are determined for the endogenous variables. This conception of the growth process as a movement of the economy through a series of short-run equilibria is similar to the positions taken by various economists who argue that economic development consists of some disequilibrium processes. For example see [8].

TABLE III

SIMULATION RESULTS OF THE MODEL: PERCENTAGE CHANGES IN SOME ENDOGENOUS VARIABLES UNDER VARIOUS POLICIES

Year	PCWA1	PCWA2	PCWA3
1976	2.09506	−0.24691	2.47938
1977	2.04283	1.52534	3.09272
1978	3.09329	1.96703	3.83649
1979	2.51093	0.99116	3.25243
1980	2.45310	1.90007	2.49934
1981	2.79769	2.23319	2.79162
1982	3.34114	2.75943	2.84128
1983	2.75374	1.93130	2.51890
1984	3.98124	2.98066	3.86489
1985	4.64150	3.32384	2.71546

Year	PCWM1	PCWM2	PCWM3
1976	2.10929	5.14256	1.30110
1977	3.24651	5.86800	2.08700
1978	1.13744	1.63840	1.15670
1979	1.80457	2.08684	1.61639
1980	1.96490	2.43050	1.49931
1981	1.95605	2.67787	1.77560
1982	3.28582	3.41756	2.53928
1983	1.12461	1.12461	1.21831
1984	1.64831	1.93639	1.51341
1985	1.80612	1.97859	1.39494

Year	PCNM1	PCNM2	PCNM3
1976	−2.78900	−2.20000	−2.00000
1977	−2.75175	−2.59618	−2.85838
1978	−2.65937	−2.07373	−2.18294
1979	−2.62435	−2.55813	−2.79014
1980	−2.88947	−2.65568	−2.88947
1981	−3.48011	−2.96163	−2.93163
1982	−2.73423	−2.29676	−3.52461
1983	−3.76667	−2.41778	−2.13333
1984	−3.61728	−2.75250	−3.71270
1985	−3.57418	−2.47707	−2.93134

Notes: 1. PCWA1, PCWM1 are the percentage changes from the status quo situation of the rural and urban wages respectively under policy I and so on.

2. PCNM1 and PCNM2 are the percentage changes in the number of people migrating (from the status quo situation) from the rural areas to the urban areas under policies I and II respectively and so on.

constant over time so that the wages grew at the same rate in each sector, implicitly assuming that the rate of migration is sufficiently responsive to prevent a widening of the wage gap in a developing economy.

We have already noted some of the causes of such continuing gaps in the wages. It has already been pointed out that migration as an automatic adjustment mechanism may not be effective in closing the gap. The wage gap is sensitive to parameters and variables exogenous to the labor market itself; for example, changes in investment, cultivable land in the rural sector, and changes in the rate of technical progress all play important roles in influencing the magnitude of the wage gap and the migration as well.

In the model studied here, different strategies reduce the wage gap by different amounts. For example, if strategies I and III are taken, then in 1976, the urban wage rate is about 11.8 per cent and 10.6 per cent higher respectively than the rural wage rate, which means that the gap is reduced by 0.5 per cent and 1.7 per cent respectively. On the other hand, under strategy II, the gap increases from 12.3 per cent to 20 per cent, that is the urban wage is about 7.7 per cent higher compared to the status quo situation. In 1985, the urban-rural wage gap is reduced to 29 per cent and 31 per cent under strategies I and III respectively; and under strategy II, this gap is reduced to 31.2 per cent in 1985.

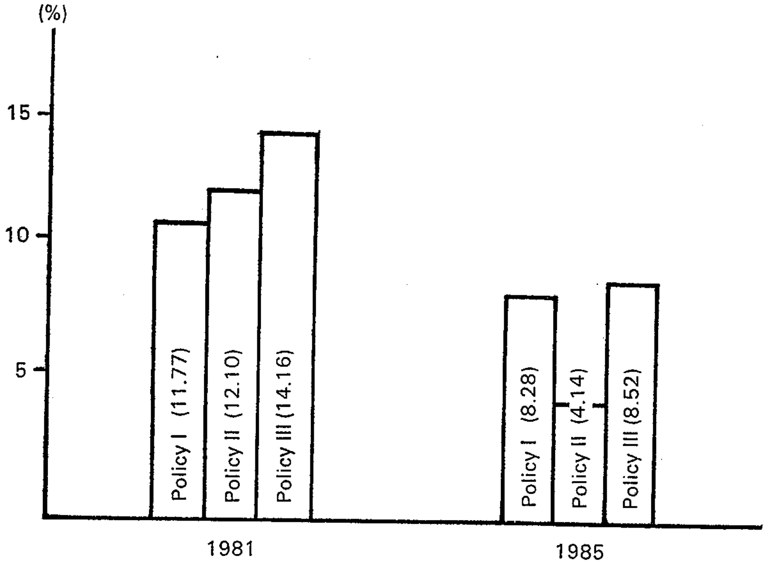
The policy simulation in this study was done only for ten years which was not long enough to close the gap between the sectoral wages totally. However, an aggressive rural development program for a long period of time, may reduce the wage gap to a great extent and significantly lower the rates of the rural-to-urban migration.

The policy simulation results in this study suggest that the rural development efforts will make the rural sector more attractive, reducing migration of people from the rural to the urban areas (as represented by Figure 1). Thus, rural development policy may reduce the problem of urban unemployment resulting, to a great extent, from large-scale migration of people from the rural areas. Appropriate rural development strategy in Bangladesh will in fact result in positive effects for both output and price of agricultural (specially food) products. There are several empirical evidences that rate of increase in food price has been higher than that of other prices. Increased output has not resulted in negative price effect in Bangladesh. In his paper, Blomqvist [3] has argued that instead of adopting the policy of urban job creation (by wage subsidy to the manufacturing sector), higher investment in the rural sector may result in the reduction of rural-to-urban migration and thus reduce urban unemployment. The results of this study confirm the validity of Blomqvist's argument in the context of the economy of Bangladesh.

VII. CONCLUDING REMARKS

In this paper, policy simulation was undertaken within the framework of an econometric dual economy model of Bangladesh and the parameters were estimated by using real world data. The work of Kelley, Williamson, and Cheetham

Fig. 1. Reductions of Simulated Rural-Urban Migration Increases under Three Investment Policy Strategies as a Percentage of the Simulated Rural-Urban Migration Increases in the Status Quo Situation



Note: These percentage reductions are calculated as indicated below: $\{[(1981\text{ migration})-(1976\text{ migration})]_{\text{status quo}}-[(1981\text{ migration})-(1976\text{ migration})]_{\text{policy I}}\}/[(1981\text{ migration})-(1976\text{ migration})]_{\text{status quo}}$.

[13] is a major contribution to the literature on dualistic economic development, in that it introduces, to the development literature, the use of simulation for policy analysis and evaluation. However, the parameter values of their model were not obtained by econometric estimation of model with data of a particular economy. Various works on rural-urban migration have not utilized an aggregative general equilibrium model of the economy and as such were not suitable for broad policy analysis.

The type of simultaneous equation model used here has been constructed for the first time for the Bangladesh economy. Thus, the approach of first estimating the parameters of an econometric model and then doing simulation exercises is a novel feature of the present study.

To examine the effects of the various government policies on migration, the model with its adjustment mechanism via rural-urban migration was devised. It was found that the reduction in the gap between the rural and urban wage following from an emphasis on agricultural development reduces migration to the urban areas. Thus, the implications of the analysis run counter to the "growth center" policies which emphasize large-scale industrial development and its "spread effects" on various other sectors of the economy. In a predominantly agrarian economy like Bangladesh, this trickling down of the effects of industrial development has not been successful in the past and our simulation results show that it is not likely to be the most successful policy alternative in the future either.

These results are important in the formulation of the government development policy. Thus, to avoid the high social cost of continuous rural-to-urban migration, an effective method is to make the rural sector more attractive by increasing economic opportunities in the rural sector through overall rural development.

The period for which the model was estimated in this study is a long one. In order to check whether the structure of the economy has substantially changed or not, the model could be estimated for a relatively short period of time taking the data of recent periods. However, in view of the large number of variables in the model, reducing the time period to a great extent may reduce the degrees of freedom in the empirical estimation of the parameters.

It should be recognized that the impact of various policies may depend on the sensitivity of the system to changes in the parameter values, exogenous variables, and sometimes on the specification of the model.[12] For further insights into the policy implications, sensitivity analysis with varying parameter values, exogenous variables, new sets of assumptions, alternative specifications and with alternative policy options can be undertaken.

12 Some sensitivity analyses were carried out and the basic results were unchanged; for more details see [1].

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APPENDIX

LIST OF NOTATIONS

$\bar{Q}_f^D$ = aggregate demand for the food crop.
$\bar{Q}_c^D$ = aggregate demand for the cash crop.
$\bar{Q}_f$ = aggregate output of the food crop.
$\bar{Q}_c$ = aggregate output of the cash crop.
$\bar{L}_f$ = aggregate labor demand in the food crop production.
$\bar{L}_c$ = aggregate labor demand in the cash crop production.
$\bar{R}_f$ = total land allocation in the food crop production.
$\bar{R}_c$ = total land allocation in the cash crop production.
$\bar{K}_f$ = total capital used in the food crop production.
$\bar{K}_c$ = total capital used in the cash crop production.
$\bar{R}$ = aggregate amount of land for the agricultural production.
$\bar{L}_a$ = total rural labor supply.
Y_F = weighted average index of the total real national income of major jute importing countries.
F = total amount of fertilizers used in the food crop production.
P_s = price of jute substitutes in the world market.
P_c = price of the cash crop.
P^*_c = price of the cash crop relative to the *numéraire*.
P^*_m = price of the manufactured good relative to the *numéraire*.
W^*_a = rural money wage rate relative to the *numéraire*.
W^*_m = urban money wage rate relative to the *numéraire*.
P^*_{cL} = lagged relative price of the cash crop.
$\bar{Q}_{cL}^D$ = lagged aggregate demand for the cash crop.
$\bar{Q}_m$ = aggregate production of the manufactured good.
$\bar{L}_m$ = aggregate demand for labor in the manufacturing sector.
$\bar{Q}_m^D$ = aggregate demand for the manufactured good.
$\bar{L}_m^S$ = aggregate supply of labor in the manufacturing sector.
$\bar{K}_m$ = aggregate amount of capital used in the manufacturing sector.
N_U = total number of people in the urban sector.

TT = time trend.
D = dummy variable to capture the effects of war in 1971.
D_m = dummy variable for the price in the urban labor demand and output supply functions.
g = annual rate of growth of population in the economy.
NM = number of people migrating from the rural to the urban sector.
$N^*_R = N_{RL}(1+g) - NM$.
N_{RL} = total number of people in the rural sector, lagged one year.