A POLICY MULTIPLIER MODEL OF BANGLADESH JUTE IN THE WORLD MARKET

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While there exists an extensive econometric model building tradition for commodity markets [14] [15], few studies have been made to cast commodity models in the framework of multiplier simulations analysis. Policy multipliers convey useful information about the magnitudes and time patterns of the effect of macroeconomic policy instruments. The objective of the present study is to derive quantitative information about various government policy instruments operating in the Bangladesh jute market. This information may serve as the basis for policies of both growth and stabilization. Another objective of the analysis is to examine possible time paths of the target variables for specified time paths of the instruments allowing for inter-temporal feedback effects.

Jute is an important foreign exchange earner for the major producing countries—Bangladesh, India, and Thailand. In the case of Bangladesh, jute is the mainstay of the economy, accounting for 70 per cent of the total foreign exchange earnings. Its dominance in the economy makes it vulnerable to national and political pressures. A high proportion of world production of jute enters international trade either in the raw or manufactured form. In the world market, it is in direct competition with synthetic substitutes—a factor which may represent the greatest threat to jute and implies concerted policy actions by the jute producing countries.[1] In the case of Bangladesh, the government—through its Ministry of Jute—implements a set of production, manufacture, and export objectives with the use of a set of policy instruments.[2]

Jute is used in the manufacture of a diverse set of products which find applications in industry, agriculture, transportation, construction, and home furnishings. The fiber's end uses are classified into four major groups: sacking, hessian, carpet backing, and a fourth miscellaneous group consisting mainly of cordage and felting. Jute is exported in two forms, firstly, as raw jute and secondly, as jute goods. Bangladesh dominates the world raw jute export market, followed distantly by Thailand, Burma, Nepal, Brazil, and China. In the case of export of jute goods, Bangladesh is usually bracketed with India and has only recently emerged as the major exporter. Besides Bangladesh and India, countries like

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[1] IBRD documents the crisis posed by synthetics [8].

[2] See Ahmad et al. [2] for descriptions of government intervention in the jute market.

the United Kingdom, Federal Republic of Germany, Belgium, and France also engage in the export of jute goods.

I. ECONOMIC MODEL FOR JUTE

The world raw jute and jute goods market represent oligopoly situations. As mentioned previously, there are only a few exporting countries in the world market for these commodities. (One of the lesser objectives of this paper is to determine the market power that Bangladesh might wield through its oligopolistic position in the world raw jute and jute goods markets.) This feature of world jute trade is accounted for, first, by modeling in terms of residual demand and supply functions, obtained by subtracting the supply and demand curves of competing producers and exporters from the world demand and supply curves, respectively; and second, by restrictively focusing on the pricing and quantity decisions of Bangladesh as a reflection of similar decisions by other producers and exporters grouped together in a "rest-of-the-world" category.[3] These procedures result in a two-region spatial model for jute which facilitates analysis of the key relationships and market power of the dominant world jute exporters. However, one of the problematics of the study is the extent to which such dichotomization of the world market for jute is adequate for gaining an insight into the Bangladesh component of world trade in jute. The model encompasses the main aggregative flows in the jute market, and one of its interesting features is the explicit analysis of raw jute and jute goods as separate commodities.

The basic framework for the analysis is a simultaneous equations model with thirty-six endogenous variables pertaining to the world jute economy. Structural equations are estimated for each region to explain annual jute acreage, yield, production, mill consumption, and export using ordinary least square techniques. Prices are determined from the solution of identities, and stocks are given as residuals. The structural equations for Bangladesh are specified to include the policy environment in which her jute market exists. The Ministry of Jute wields a set of policy instruments for the purpose of attaining domestic objectives. Annual acreage and production objectives are promoted by announcing a fixed statutory minimum price of jute at the grower's level prior to the growing season, with the minimum price depending on an evaluation of the supply and demand conditions for jute, and the price of the competing crop, rice, as well as the targeted level of production. The important governmental instruments for controlling jute goods production and raw jute exports are credits given to jute mills and raw jute exporters. The amount of credit to be allotted to jute mills and traders is decided before the beginning of the fiscal year and depends on, among other things, the target levels of jute goods production and raw jute exports aimed by the government. The tax-subsidy policy is another governmental means of influencing jute exports by way of changing export prices.

[3] The case of a two-region spatial model is illustrated by MacLaren [17]. Alaouze et al. [3] bring out the importance of residual demand and supply analysis.

II. ECONOMETRIC ESTIMATION OF JUTE MODEL

A. *Jute Acreage*

A number of econometric studies exist in which estimates are given of the jute supply function [4]. With few exceptions [9], these studies have omitted producer's responsiveness to changing risk. Given that jute cultivation is a risky venture in Bangladesh, with prices fluctuating at the farmgate level, incorporation of the risk factor is most pertinent. The methodology[4] utilized here is an extension of the adaptive expectations model as developed by Nerlove [18]. In this formulation, area harvested is made dependent on a subjective variance factor of prices in addition to a subjective expected value of prices. Both the variance factor and the expected values depend on stable adjustment parameters (z_1, w_1, w_2), and can be regarded as geometrically weighted sums of observations on prices and variance. The four equations presented below are simultaneously estimated, the estimation procedure being to search the feasible space $0 \leq w_1, w_2, z_1 \leq 1$, for those values of the adjustment parameters that give the minimum sum of squares in the *OLS* equation for (4). The estimation is similar to Dhrymes' truncation remainder procedure [5]. (Definitions of the variables are given in Appendix.)

Expected farmgate jute price in Bangladesh:

$$PEDJ_t = w_1 PDJ_t + (1 - w_1) PEDJ_{t-1}, \qquad (1)$$

$$(w_1 = 0.4)$$

or equivalently

$$PEDJ_t = w_1 \sum_{m=0}^{\infty} (1 - w_1)^m PDJ_{t-1-m}. \qquad (1a)$$

$$(w_1 = 0.4,\ m = 0, 1, 2, \cdots, \infty)$$

Expected farmgate rice price in Bangladesh:

$$PEDR_t = w_2 PDR_t + (1 - w_2) PEDR_{t-1}, \qquad (2)$$

$$(w_2 = 0.1)$$

or equivalently

$$PEDR_t = w_2 \sum_{m=0}^{\infty} (1 - w_2)^m PDR_{t-1-m}. \qquad (2a)$$

$$(w_2 = 0.1,\ m = 0, 1, 2, \cdots, \infty)$$

Variance of farmgate jute price in Bangladesh:

$$PVDJ_t = z_1 (PDJ_{t-1} - PEDJ_{t-1})^2 + (1 - z_1) PVDJ_{t-1}, \qquad (3)$$

$$(z_1 = 0.2)$$

or equivalently

$$PVDJ_t = z_1 \sum_{m=0}^{\infty} (1 - z_1)^m (PDJ_{t-1-m} - PEDJ_{t-1-m})^2. \qquad (3a)$$

[4] The new methodology is advocated by Just [11] [12] [13].

$$(z_1=0.2,\ m=0, 1, 2, \cdots, \infty)$$

Bangladesh jute acreage:[5]

$$BAJ_t=1059.77+\underset{(5.98)}{1.08}PEDJ_t-\underset{(-5.92)}{2.66}PEDR_t-\underset{(-3.12)}{0.0025}PVDJ_t$$

$$-\underset{(-3.80)}{294.13}(1-z_1=0.8)^t. \qquad (4)$$

$$\bar{R}^2=0.64, \quad DW=1.65.$$

The rest-of-the-world sector of the model is a conglomerate of various jute producing regions other than Bangladesh. A single acreage equation is postulated, with the c.i.f. import price of raw jute deflated by a world price index deflator as one of the explanatory variables. Adjustment lags are assumed that give a traditional Nerlovian form to the rest-of-the-world acreage equation,

$$RAJ_t=1250.63+\underset{(1.57)}{0.137}(PMJ/UNI)_{t-1}+\underset{(1.57)}{222.63}DUM15$$

$$+\underset{(0.68)}{0.2002}RAJ_{t-1}. \qquad (5)$$

$$\bar{R}^2=0.55, \quad DW=1.97.$$

B. *Jute Yields*

The yield response function for jute comprises the second link in the study. The separate modeling of yield leads to multiplicative risk specification [7]. The yield behavior in Bangladesh is modeled by combining a structural equation of a relevant factor and a time series analysis of the following form:

$$BJW_t=1.552-\underset{(-3.9)}{0.00075}BAJ_t+\underset{(1.02)}{0.01272}T-\underset{(-1.59)}{0.00059}T^2$$

$$-\underset{(-4.29)}{0.256}DUM5. \qquad (6)$$

$$\bar{R}^2=0.53, \quad DW=1.65.$$

In the rest of the world, yield has increased over time and the following function is estimated to capture the increasing rate of yield.

$$RJW_t=1.052+0.035T. \qquad (7)$$

$$\bar{R}^2=0.42, \quad DW=2.38, \quad \rho=0.396.$$

C. *Raw Jute Production*

Raw jute production is obtained by way of multiplying jute acreages in Bangladesh and the rest of the world by their corresponding yield rates.

$$BQJ_t=BAJ_t \cdot BJW_t, \qquad (8)$$

$$RQJ_t=RAJ_t \cdot RJW_t. \qquad (9)$$

[5] The term $(1-z)^t$ is introduced to correct for the pre-sample period variance, see Just [11]. The values below the regression coefficients show t-ratios.

D. *Mill Consumption of Raw Jute*

Jute mills in Bangladesh and in the rest of the world consume raw jute for processing into jute goods. In the case of Bangladesh mills, the profitability of jute goods production as expressed by the ratio of jute goods to raw jute prices partly determines quantities of raw jute consumed. The position of the Bangladesh jute ministry is incorporated in the model through the policy option of credit to the jute mills.

$$BCJ_t = -39.05 + \underset{(1.19)}{0.359KRJ_t} + \underset{(0.52)}{7.878(PXG/PNJ)_t} \\ \underset{(-4.65)}{-190.11DUM7} + \underset{(7.43)}{0.887BCJ_{t-1}}. \qquad (10)$$

$$\bar{R}^2 = 0.93, \quad DW = 2.58.$$

Raw jute demand by rest-of-the-world jute mills is a derived demand. Jute goods manufactured by these mills compete with synthetic substitutes in various end-product markets. The following equation is estimated taking this into account.

$$RCJ_t = 5132.62 \underset{(-1.52)}{-361.678(PMG/PSUB)_t} + 292.02T \\ \underset{(-2.49)}{-0.823RCJ_{t-1}}. \qquad (11)$$

$$\bar{R}^2 = 0.92, \quad DW = 2.07.$$

E. *Export Flow of Raw Jute and Jute Goods from Bangladesh*

Both supply and demand considerations influence the export flow of Bangladesh jute. In the case of raw jute, the ratio of the f.o.b. export price to the millgate price determines the responsiveness of supply. The demand considerations are covered by introducing the possibility that change in income in the importing countries directly affects the level of exports. The role of the Bangladesh jute ministry is incorporated in the model through the policy instrument of credit to raw jute exporters.

$$BXJ_t = -319.93 + \underset{(2.86)}{201.9(PXJ/PNJ)_t} + \underset{(2.91)}{1.19LON_t} + \underset{(1.07)}{24.27\Delta YFW}. \qquad (12)$$

$$\bar{R}^2 = 0.54, \quad DW = 1.46.$$

In Bangladesh, nearly all of the production of jute goods is for export and since the jute mill authorities are themselves the principal negotiators of export, it follows that export supply will depend on the profitability of jute goods production by domestic mills. Hence, the ratio of the f.o.b. export price of processed jute goods to the millgate price of raw jute is chosen as one of the explanatory variables. As in the case of raw jute, a variable reflecting change in world income is introduced. Finally, it is assumed that input substitution in the end-products industry involves a certain lag, thereby giving a dynamic form to the export flow function.

$$BXG_t = -388.23 + \underset{(3.10)}{139.69}(PXG/PNJ)_t + \underset{(3.90)}{20.32}\Delta YFW_t$$
$$-\underset{(-6.91)}{180.88}DUM12 + \underset{(4.88)}{0.97}BXG_{t-1}. \qquad (13)$$
$$\bar{R}^2 = 0.88, \quad DW = 2.25.$$

F. *Jute Goods Production*

A fixed input-output coefficient is used to determine the production of jute goods in Bangladesh and the rest of the world as a function of the level of raw jute consumption in the mills.

$$BQG_t = k_1(BCJ_t), \quad (k_1 = 0.94) \qquad (14)$$

$$RQG_t = k_2(RCJ_t). \quad (k_2 = 0.935) \qquad (15)$$

G. *Millgate and Growers' Prices of Jute in Bangladesh*

In Bangladesh, the millgate price of raw jute is an administered price related to the price of raw jute prevailing in the world market. Besides world price, we also attempt to determine whether domestic market forces have any independent influence on millgate price.

$$PNJ_t = 109.81 + \underset{(17.65)}{0.63}PXJ_t + \underset{(0.12)}{88.05}SDBJ_t. \qquad (16)$$
$$\bar{R}^2 = 0.94, \quad DW = 1.79.$$

The grower's price is in turn related to the millgate price. The difference accounts for "marketing costs" involved in moving jute from farm to millgate.

$$PGJ_t = 73.87 + \underset{(45.87)}{0.87}PNJ_t. \qquad (17)$$
$$\bar{R}^2 = 0.99, \quad DW = 2.21.$$

H. *World Price of Raw Jute and Jute Goods*

World c.i.f. import prices of raw jute and jute goods are related to f.o.b. prices by linear functions of the following form:

$$PMJ_t = -33.51 + \underset{(52.09)}{1.25}PXJ_t. \qquad (18)$$
$$\bar{R}^2 = 0.99, \quad DW = 2.27.$$

$$PMG_t = -15.3 + \underset{(38.29)}{1.36}PXG_t. \qquad (19)$$
$$\bar{R}^2 = 0.75, \quad DW = 2.02.$$

The difference between f.o.b. and c.i.f. prices is made up by transportation costs, insurance fees, etc.

I. *Rest-of-the-World Consumption of Jute Goods*

The current and lagged consumer prices of jute goods and their synthetic substitutes in the destination market is considered to be the main determinant of demand for jute goods in the rest of the world. Input substitution in response to changes in relative price is assumed to take place with a certain lag, as technical constraints as well as price expectations slow the process. This lag gives a dynamic form to the mill consumption equation.

$$RMG_t = 1364 - \underset{(1.57)}{1080.66}(PMG/PSUB)_t + \underset{(1.80)}{957.25}(PMG/PSUB)_{t-1}$$
$$+ \underset{(1.50)}{113.17}\Delta YFW_t + \underset{(2.17)}{0.57}RMG_{t-1}. \tag{20}$$
$$\bar{R}^2 = 0.67, \quad DW = 2.60.$$

J. *Identities to Close the Model*

The model is closed by means of sixteen identities.

$$BMJ_t = BXJ_t. \tag{21}$$
$$BMG_t = BXG_t. \tag{22}$$
$$BXJ_t = RCJ_t + RIJ_t - RQJ_t - RIJ_{t-1}. \tag{23}$$

Identity (23) is used to generate the world price of raw jute by substituting for the current endogenous variables their corresponding structural equations, and evaluating the variables contained in these equations at the mean values. Together with equation (21), this gives us:

$$BMJ_t = 1263.08 - 767.83(PXJ/PSUB)_t. \tag{23a}$$

The short-run import price elasticity of Bangladesh raw jute as derived from the above equation is -1.17. This result seems more plausible and contradicts the findings of low elasticities derived from a single estimated equation [16] [19].

Just as equation (23a) replaces identity (23) in the model to generate a new variable, for jute goods the identity,

$$BXG_t = RMG_t - RQG_t + RIG_t - RIG_{t-1} - BING, \tag{24}$$

is used to generate the world price of jute goods in terms of the following equation:

$$BMG_t = 1012.8 - 1034.1(PXG/PSUB)_t. \tag{24a}$$

The short run import price elasticity of Bangladesh jute goods appears to be -2.65. The remaining identities are:

$$BDJ_t = BCJ_t + BXJ_t + BIJ_t + BINJ_t, \tag{25}$$
$$BSJ_t = BQJ_t + BIJ_{t-1}, \tag{26}$$
$$BDJ_t = BSJ_t, \tag{27}$$
$$BDG_t = BXG_t + BIG_t + BING_t, \tag{28}$$
$$BSG_t = BQG_t + BIG_{t-1}, \tag{29}$$
$$BDG_t = BSG_t, \tag{30}$$
$$RDJ_t = RCJ_t + RIJ_t, \tag{31}$$
$$RSJ_t = RQJ_t + RIJ_{t-1} + BXJ_t, \tag{32}$$

$$RDJ_t = RSJ_t, \tag{33}$$
$$RDG_t = RMG_t + RIG_t, \tag{34}$$
$$RSG_t = RQG_t + RIG_{t-1} + BXG_t, \text{ and} \tag{35}$$
$$RDG_t = RSG_t. \tag{36}$$

K. *Estimation Procedures*

The model has thirty-six equations of which twenty are behavioral, two are derived equations obtained from the solution of identities, and the rest are technical or market identities to close the system. Most of the equations were estimated with annual data covering the period 1959/60 to 1977/78, using the *OLS* method. The necessary data have been collected from different public agencies of the Bangladesh government engaged in the jute business. It is recognized that in a simultaneous equation model, *OLS* is an unsatisfactory estimating technique, but with so few observations (nineteen) it seemed uncertain whether the additional computational burden of 2*SLS* would be rewarded by improved estimates. The Cochrane-Orcutt procedure was used wherever the autocorrelation problem was encountered.[6] We may note here that the standard t and DW tests are not valid for structural estimates of simultaneous equation models, especially in the presence of lagged values of dependent variables. Nevertheless, these statistics were included as a systematic means of evaluating the estimated equations. Because of this limitation of the standard tests, greater emphasis was placed on the a priori specifications and sample period performance of the model, and the model proves quite satisfactory in this respect.

III. POLICY MODEL

A. *Validation and the Policy Multiplier Analysis*

The structural relationships of the model, consisting of thirty-six equations, are combined and expressed in matrix notation as:

$$A_t Y_t = B X_t, \tag{37}$$

where

A_t = (36×36) matrix of coefficient of endogenous variables,
Y_t = (36×1) vector of endogenous variables,
B = (36×32) matrix of coefficient of the exogenous variables, and
X_t = (32×1) vector of exogenous variables.

The reduced form equations are

$$Y_t = A_t^{-1} B X_t = P_t X_t,\text{[7]} \tag{38}$$

where $P_t = A_t^{-1} B$.

The model is validated by using equation (38) to generate predicted values for

[6] Durbin's h statistic [10] for testing autocorrelation in the presence of lagged dependent variables is appropriate only for large samples ($n > 30$) and is not used here.

[7] The estimated residuals of the derived reduced form equations are ignored.

TABLE I

PREDICTIVE PERFORMANCE OF THE MODEL: R^2

	Variable	R^2		Variable	R^2
1.	*PEDR*	0.99	19.	*RMG*	0.71
2.	*PNJ*	0.97	20.	*RIJ*	0.68
3.	*PMJ*	0.97	21.	*BDJ*	0.68
4.	*PMG*	0.96	22.	*BSJ*	0.68
5.	*PXJ*	0.96	23.	*BXG*	0.64
6.	*PXG*	0.94	24.	*BMG*	0.64
7.	*RCJ*	0.94	25.	*BDG*	0.59
8.	*RQJ*	0.91	26.	*BSG*	0.59
9.	*RJW*	0.90	27.	*RDJ*	0.53
10.	*RDG*	0.89	28.	*RSJ*	0.53
11.	*RSG*	0.89	29.	*BIJ*	0.38
12.	*BAJ*	0.86	30.	*BJW*	0.30
13.	*BCJ*	0.85	31.	*RQG*	0.30
14.	*BQG*	0.85	32.	*PGJ*	0.23
15.	*PEDJ*	0.82	33.	*PVDJ*	0.09
16.	*RAJ*	0.77	34.	*RIG*	0.08
17.	*BXJ*	0.73	35.	*BQJ*	0.06
18.	*BMJ*	0.73	36.	*BIG*	0.00

each of the endogenous variables with the actual values of the exogenous variables entered in vector Y_t for each time period. The sample period performances of most of the important variables are quite satisfactory and generally reinforce our confidence in the use of the model presented in the previous section. Quite satisfactory results are obtained for Bangladesh and rest-of-the-world jute acreage, production, consumption, and prices of raw jute and jute goods. Poor results are obtained for Bangladesh and rest-of-the-world stocks of raw jute and jute goods, partly because the values of stocks in the model are determined by identities used to close the system rather than by structural relationships. It may be noted that in policy simulation analysis, absolute levels of variables are not of particular interest. What needs to be known is only how change in one instrument variable affects other endogenous variables in the system. In this respect, R^2 is the most appropriate measure of predictive performance of the model (Table I). The R^2 are obtained by regressing the actual values of the variables against their respective values from the restricted reduced form equations. The R^2 values for most of the variables are reasonable.

B. *Policy Multiplier Analysis*

For carrying out policy multiplier analysis, variables in the reduced form equations (38) are classified into lagged endogenous, current controlled exogenous (current policy instruments), lagged controlled exogenous (lagged policy instruments), and uncontrolled exogenous or data variables. The matrix P_t[8] is evalu-

[8] The matrix P_t depends on time because of the presence of fluctuating jute yields in matrix A_t. 1972/73 is chosen as representing a normal year.

TABLE II
IMPACT MULTIPLIERS

Policy Instrument	Period	Variable							
		BQG (MT)	*BCJ* (MT)	*BIJ* (MT)	*BXJ* (MT)	*PGJ* (Taka)	*PNJ* (Taka)	*PXJ* (Taka)	*PMJ* (Taka)
*KRJ**	1	337	359	−359	0	0.18	0.02	0	0
*LON**	1	0	0	−600	600	0	−2.6	−5.2	−4.2

* Taka 1 million increase.

ated using 1972/73 values and furthermore, partitioned conformably[9] with vector X_t to become

$$Y_t = P_1 Y_{t-1} + P_2 X_t + P_3 X_{t-1} + P_4 Z_1, \qquad (39)$$

where

Y_t = (36×1) vector of current endogenous variables.

P_1 = (36×26) sub-matrix of P, with elements relating to the lagged endogenous variables.

Y_{t-1} = (36×1) vector of lagged endogenous variables.

P_2 = (36×2) sub-matrix of P, with elements relating to the current instrument variables.

X_t = vector of current instrument variables (KRJ_t, LON_t).

P_3 = (36×3) sub-matrix of P, with elements relating the lagged instrument and lagged explanatory variables.

X_{t-1} = (3×1) vector of lagged instrument and explanatory variables (PGR_{t-1}, PGJ_{t-1}, ΔYFW).

P_4 = (36×16) sub-matrix of P, with elements relating to the explanatory variables and the intercept.

Z_1 = vector of data variables.

1. *Impact multipliers*

The impact multipliers give the contemporaneous response to an exogenous change of a "one-shot" nature. The impact multipliers of the model are restricted to the variables *KRJ* and *LON*, and can be ascertained from the P_2 matrix. The multipliers are presented in Table II.

The impact of a Taka 1 million increase in credit availability to jute mills is to raise current jute goods production by 337 metric tons. Mill consumption of raw jute in Bangladesh simultaneously responds to this credit increase by an expansion of 359 metric tons. As the table shows, the effect of the instrument on millgate and farmgate prices is negligible. Its effect on the domestic stock of raw jute is to reduce its level by 359 metric tons. It thus appears that in the current period the entire increase in demand for raw jute by mills would be met by stock depletion.

[9] Matrices P_1, P_2 and P_3 are made conformable for addition and multiplication by augmentation with rows and columns of zeros where necessary.

Similarly, the impact of a Taka 1 million increase in loan availability to jute exporters (the *LON* instrument) would be to increase exports by 600 metric tons, while decreasing stocks by the same amount. The rise in exports inflates world supply and thereby lowers f.o.b. and c.i.f. prices by Taka 5.2 and Taka 4.2 per ton (in real terms), respectively. The domestic millgate and farmgate prices decline by Taka 2.6 and Taka 2.2 per ton, respectively.

2. *Interim multipliers*

As compared to impact multipliers, interim or delay—τ multipliers involve cross-temporal feedbacks among themselves. They give the values of the endogenous variables corresponding to different future time periods when an instrument is raised by one unit in a period and then restored to its original level. The interim multipliers are obtained by an additional manipulation of equation (39). The direct effect of changes in policy instruments at time $(t-1)$ upon the endogenous variables at time t is given by the elements in the matrices P_2 and P_3. However, there are the additional indirect effects to be accounted for, generated through the lagged endogenous variables. It is this inter-temporal linkage which makes the model a dynamic one and which necessitates the use of the final form[10] of the reduced form equation. In essence, they are obtained by successive substitution of $Y_{t-\tau}\ (\tau=1, 2, \ldots)$ into equation (39) to yield:

$$Y_t = P_2X_t + \sum_{\tau=1}^{\infty} P_1^{\tau-1}(P_1P_2+P_3)X_{t-\tau} + \sum_{\tau=0}^{\infty} P_1P_4Z_{t-\tau}, \quad (40)$$

assuming that the latent roots of P_1 lie within the unit circle. This is the stability condition of dynamic econometric models. The latent roots of sub-matrix P_1 are calculated. The largest real root is found to be 0.88, corresponding to variable *BCJ* (mill consumption of jute in Bangladesh). Furthermore, all roots are found to be real and positive, except one which is negative, -0.82, corresponding to *RCJ* (mill consumption of jute in rest of the world). Each of the positive real roots a_i of P_1 contributes a monotonic component a_i^t, while each negative real root $-a_j$ introduces a saw tooth component $-a_j^t$. The interim multipliers associated with a change in policy instruments at time $(t-\tau)$ on Y_t are given by the vector $P_1^{t-\tau}(P_1P_2+P_3)X_{t-\tau}$. Limiting ourselves to a five-year time horizon, the effect corresponding to each time period is given by the matrices:

Periods	1	2	3	4	5
Matrices	P_2X_t	$(P_1P_2+P_3)X_t$	$P_1(P_1P_2+P_3)X_t$	$P_1^2(P_1P_2+P_3)X_t$	$P_1^3(P_1P_2+P_3)X_t$

The interim multipliers corresponding to *KRJ*, *LON*, PGR_{t-1}, PGJ_{t-1}, ΔYFW, and *DUM* 12 are presented in Tables III–V.

KRJ: The interim multipliers corresponding to the *KRJ* instrument appear in Table III. Thus, the immediate impact of the credit instrument is to raise domestic production of jute goods by 337 metric tons. Its effect declines mo-

[10] An explanation of the derivation of final form equations is given in Goldberger [6, pp. 373–74].

TABLE III

INTERIM MULTIPLIERS

Policy Instrument	Period	Variable						
		BQG (MT)	*BCJ* (MT)	*BXJ* (MT)	*PVDJ* (Taka)	*PEDJ* (Taka)	*PGJ* (Taka)	*RAJ* (Ha)
*KRJ**	1	337	359	0	0	0	0.18	0
	2	298	318	0	1.77	0.0049	0.16	0
	3	265	282	0	2.24	0.0073	0.14	0
	4	234	250	0	2.05	0.0044	0.13	0
	5	212	221	0	2.19	0.0060	0.11	0
*LON**	1	14	15	600	0	0	−2.29	9
	2	11	13	0	0	0	0	−469
	3	9	11	0	0	0	0	−93
	4	7	10	0	0	0	0	−18
	5	5	9	0	0	0	0	3

* Taka 1 million increase.

TABLE IV

INTERIM MULTIPLIERS

Policy Instruments	Period	Variable				
		BAJ (Ha)	*BQJ* (MT)	*PEDJ* (Taka)	*PEDR* (Taka)	*PVDJ* (Taka)
PGR_{t-1}*	1	0	0	0	0	0
	2	176	227	0	0.664	0
	3	143	181	0	0.059	0
	4	128	165	0	0.053	0
	5	114	147	0	0.048	0
PGJ_{t-1}*	1	0	0	0	0	0
	2	243	311	0.265	0	94.56
	3	233	299	0.159	0	40.99
	4	140	179	0.053	0	24.59
	5	84	107	0.048	0	4.91

* Taka 1 increase.

notonically to 298 metric tons in period 2, 265 metric tons in period 3, 234 metric tons in period 4, and 212 metric tons in period 5. The effect of the instrument on growers prices as well as on expected and variance factors of jute prices is negligible. The impact on domestic mill consumption of jute can be read from the same table.

LON: The impact multipliers associated with the *LON* instrument are more interesting (see Table III). The immediate impact in period 1 is an increase of Bangladesh exports by 600 metric tons. However, by changing the farmgate and millgate prices of raw jute, the *LON* instrument affects domestic production of jute goods.

PGR_{t-1}: The impact of interim multipliers associated with lagged value PGR_{t-1} (farmgate rice price) on jute acreage and production begins from period

TABLE V
INTERIM MULTIPLIERS

Policy Instrument	Period	Variable					
		BXG (MT)	*BQG* (MT)	*RQG* (MT)	*RMG* (MT)	*RAJ* (Ha)	*PMG* (Taka)
ΔYFW_t*	1	14,640	−297	6,405	133,470	0	−79.65
	2	11,280	−276	−345	65,280	−9,600	−61.40
	3	8,690	−255	4,077	28,880	−1,920	−47.30
	4	6,705	−233	−428	20,050	−383	−36.47
	5	5,168	−212	2,609	759	−76	−21.67
DUM 12†	1	−130,350	2,646	−57,000	182,250	0	709.4
	2	−100,500	2,468	3,044	−7,780	0	546.7
	3	−77,486	2,283	−36,334	69,580	0	421.5
	4	−59,741	2,100	3,824	96,730	0	324.9
	5	−46,061	2,075	−23,244	99,150	0	193.1

* Unit increase in index.
† Reoccurrence of supply disruptions as depicted by *DUM* 12.

2, when jute acreage is lowered by 176 hectares and jute production by 227 metric tons (see Table IV). In period 3, jute acreage and production decline by 143 hectares and 181 metric tons, respectively.

PGJ_{t-1}: PGJ_{t-1} (farmgate jute price) represents an important instrument in the hands of the government. As in the previous case, here also interim multipliers begin to have an impact from period 2, when domestic jute acreage increases by 243 hectares and jute production by 311 metric tons (see Table IV). The instrument also affects the variability of jute prices. Interestingly enough, it appears that the increase in jute acreage would have been higher by as much as 38 hectares had there not been a disincentive effect on jute cultivation due to increasing risk associated with the increase in price variability.

ΔYFW: ΔYFW is an important explanatory variable of the model. Table V brings out the great sensitivity of Bangladesh export flows, the production of jute goods and rest-of-the-world consumption of jute goods to changes in world income. The reason for the fluctuating time path of rest-of-the-world production of jute goods is the negativity of the latent root.

DUM 12: *DUM* 12 represents supply disruptions of the kind occurring in the 1970s. Table V brings out the disastrous effects associated with supply disruptions originating in Bangladesh. In the first period, it leads to a decline in the export flow of jute goods by over 130 thousand metric tons. The decline in exports causes an increase in the c.i.f. price of jute goods by as much as Taka 709.4 per metric ton in period 1. The rise in prices in turn generates a fluctuating trend for rest-of-the-world production and a declining trend for rest-of-the-world consumption of jute goods.

3. *Cumulative multipliers*

Cumulative multipliers are concerned with the cumulated effects of a policy change sustained over a number of periods. In this section, cumulative multipliers

TABLE VI

CUMULATIVE MULTIPLIERS

Policy Instrument	Period	Variable					
		BQG (MT)	*BXJ* (MT)	*PGJ* (Taka)	*PNG* (Taka)	*PMJ* (Taka)	*RAJ* (Ha)
*KRJ**	1	337	0	0.018	0.021	0	0
	2	972	0	0.052	0.042	0	0
	3	1,872	0	0.100	0.063	0	0
	4	3,006	0	0.161	0.084	0	0
	5	4,352	0	0.233	0.105	0	0
*LON**	1	14	600	−2.29	−2.63	−5.22	0
	2	39	1,200	−4.58	−5.26	−10.44	−469
	3	73	1,800	−6.87	−7.89	−15.66	−938
	4	114	2,400	−9.16	−10.52	−20.88	−1,611
	5	160	3,000	−11.45	−13.15	−26.10	−2,194

* Taka 1 million sustained increased over the five periods.

TABLE VII

EQUILIBRIUM MULTIPLIERS

Policy Instrument	Variable							
	BCJ (MT)	*BQG* (MT)	*BXG* (MT)	*RCJ* (MT)	*RQG* (MT)	*RMG* (MT)	*RAJ* (Ha)	*PEDJ* (Taka)
KRJ	2,814	2,645	0	0	0	0	0	0.012
LON	117	110	0	0	0	0	586	−1.52
ΔYFW	4,619	4,342	49,240	9,418	8,899	275,280	12,000	−31.02
DUM 12	−41,080	−38,615	−438,780	−34,840	−79,325	1,118,500	0	0.097

* In same units as in Tables I–VI.

are derived for *KRJ* and *LON*, which are apt to be operated in a sustained manner by the government of Bangladesh. The methodology of their derivation is nearly the same as for that of interim multipliers except that the effects are cumulated for each year's policy change. The cumulative multipliers are shown in Table VI.

4. *Equilibrium multipliers*

Equilibrium multipliers give the ultimate response to a "one-shot" exogenous change. In other words, they indicate the sum total of various effects resulting in different time periods, and hence from section 2, they can be derived as

$$\bar{D}=(I+P_1+P_1^2+P_1^3+\ \dots\ +P_1^r)(P_1P_2+P_3) \qquad (41)$$

where $\bar{D}$ is the equilibrium multiplier matrix. The terms in the first parenthesis of equation (41) can be interpreted as the series expansion of $(I-P_1)^{-1}$, so that $\bar{D}=(I-P_1)^{-1}(P_1P_2+P_3)$. The various entries in matrix $\bar{D}$ indicate values of the equilibrium multipliers, shown in Table VII.

Thus, a one time unit change in *KRJ* would ultimately raise the production of jute goods in Bangladesh by 2.6 thousand metric tons and mill consumption of jute by 2.8 thousand metric tons when all inter-temporal effects are accounted for. The *LON* instrument is primarily aimed at exports, but has feedback effects on domestic production of jute goods as well. The ultimate effect of the instrument on domestic production of jute goods is an increase of 110 metric tons. A unit change in world income ultimately raises export of jute goods from Bangladesh by 49.2 thousand tons while lowering jute acreage in the rest of the world by 12 thousand hectares. A supply disruption in Bangladesh of the magnitude depicted by the variable *DUM* 12 has the ultimate effect of lowering Bangladesh production of jute goods by 38.6 thousand tons and rest-of-the-world production of jute goods by 79.3 thousand tons.

IV. CONCLUDING REMARKS

The objective of the study was to derive quantitative values and time paths of various target variables for specified time paths of government instruments, allowing for inter-temporal feedback effects. A two-region, two-commodity equilibrium model of world jute trade was outlined. The study yields numerous conclusions about world jute trade vis-à-vis Bangladesh. Although the frailties of the data base, and the many assumptions thus entailed in deriving results demand some caution in interpreting the results, nevertheless, the broad orders of magnitude of the policy multipliers reinforce our confidence in the major findings.

The set of structural equations brings out interesting features of the relationships between acreage, mill consumption, export and demand functions of raw jute and jute goods. Using mean values of the variables, the short run import price elasticities of Bangladesh raw jute and jute goods appear to be -1.17 and -2.65 respectively. While estimating the acreage equations, the study tested the hypothesis of risk-aversion behavior by jute farmers. The model was validated by using base dynamic simulations and tracking was satisfactory for most of the variables, implying that a two-region positive spatial model of the present type is quite appropriate in describing the dynamic behavior of the world jute economy.

The four kinds of policy multipliers provide quantitative information about the outcomes of different government policies in operation in the Bangladesh jute economy. The loan and credit programs were found to have major impacts on Bangladesh jute goods production, mill consumption and the export flow of raw jute. An increase in the farmgate jute price PGJ_{t-1} by Taka 1 in real terms is found to raise Bangladesh jute acreage by 243 hectares in period 2. The PGJ_{t-1} instrument also affects the variation in jute prices. Interestingly enough, it appears that the increase in jute acreage would have been higher by as much as 38 hectares had not there been a disincentive effect on jute cultivation due to increasing risk associated with an increase in price variance. Supply disruptions of the kind occurring in the 1970s were found to have a disastrous effect on the jute economy, raising the world price of jute goods by as much as Taka 709 per metric ton, and generating in turn a fluctuating time path for rest-of-the-world production of jute goods and a declining trend for rest-of-the-world consumption of such goods.

Commodity markets are complex even in their simplest representation. The present model is in the nature of a prototype which, it is hoped, can provide some guidance for future research. More information about the ways in which the Bangladesh jute ministry perceives its acreage, mill consumption and export strategies, and an improved data base would facilitate elaboration of a more comprehensive model to be used for policy simulation.

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APPENDIX

JUTE MODEL: SYMBOLS USED[a]

$\overline{BAJ}$ = Bangladesh acreage of raw jute (1,000 hectares).
$\overline{BCJ}$ = Bangladesh mill consumption of raw jute (1,000 metric tons).
$\overline{BDG}$ = Bangladesh total demand for jute goods (1,000 metric tons).
$\overline{BDJ}$ = Bangladesh total demand for raw jute (1,000 metric tons).
$\overline{BIG}$ = Bangladesh stock of jute goods (1,000 metric tons).
$\overline{BIJ}$ = Bangladesh stock of raw jute (1,000 metric tons).
$BING$ = Bangladesh internal consumption of jute goods (1,000 metric tons).
$BINJ$ = Bangladesh internal consumption of raw jute (1,000 metric tons).
$\overline{BJW}$ = Bangladesh yield of raw jute (metric tons/hectare).
$\overline{BMJ}$ = Import demand for Bangladesh raw jute (1,000 metric tons).
$\overline{BMG}$ = Import demand for Bangladesh jute goods (1,000 metric tons).
BPI = Bangladesh General Consumer Price Index (1959/60 = 100).
$\overline{BQG}$ = Bangladesh production of jute goods (1,000 metric tons).
$\overline{BQJ}$ = Bangladesh production of raw jute (1,000 metric tons).
$\overline{BSG}$ = Bangladesh total supply of jute goods (1,000 metric tons).
$\overline{BSJ}$ = Bangladesh total supply of raw jute (1,000 metric tons).
$\overline{BXJ}$ = Bangladesh export flow of raw jute (1,000 metric tons).
$\overline{BXG}$ = Bangladesh export flow of jute goods (1,000 metric tons).
$DISBG$ = Discrepancy between theoretical and calculated stocks of jute goods in Bangladesh (1,000 metric tons).
$DUM5$ = Dummy variable to take account of flood and disease that reduced jute yields in 1949/50 and 1960/61.
$DUM7$ = Dummy variable to take into account the effect of nationalization of jute mills since 1972.
$DUM12$ = Dummy variable to take into account supply disruptions in Bangladesh in 1970/71 and 1971/72.
$DUM15$ = Dummy variable to reflect good weather conditions in India for 1969/70 and 1973/74.
KRJ = Government credit to Bangladesh jute mills (million taka at 1959/60 prices).
LON = Government credit to jute exporters and trades (million taka at 1959/60 prices).
PDJ = Farmgate price of raw jute (taka/metric ton) deflated by general consumer price index (1959/60 = 100).
PDR = Farmgate price of rice (taka/metric ton) deflated by general consumer price index (1959/60 = 100).
$\overline{PEDJ}$ = Bangladesh expected deflated price of raw jute (taka/metric ton).

[a] Bars indicate endogenous variables.

$\overline{PEDR}$ = Bangladesh expected deflated price of rice (taka/metric ton).

$\overline{PGJ}$ = Bangladesh farmgate price of raw jute (taka/metric ton).

PGR = Bangladesh farmgate price of rice (taka/metric ton).

$\overline{PMG}$ = U.S. c.i.f. import price of jute goods (taka/metric ton).

$\overline{PMJ}$ = U.K. c.i.f. import price of raw jute (taka/metric ton).

$\overline{PNJ}$ = Bangladesh millgate price of raw jute (taka/metric ton).

$PSUB$ = Price of jute substitute (polypropylene products: taka/metric ton).

$\overline{PVDJ}$ = Bangladesh variance of deflated price of raw jute (taka/metric ton).

$\overline{PXG}$ = f.o.b. Bangladesh export price of jute goods used as world price (taka/metric ton).

$\overline{PXJ}$ = f.o.b. Bangladesh price of raw jute used as world price (taka/metric ton).

$\overline{RAJ}$ = Rest-of-the-world raw jute acreage (1,000 hectares).

$\overline{RCJ}$ = Rest-of-the-world mill consumption of raw jute (1,000 metric tons).

$\overline{RDG}$ = Rest-of-the-world total demand for jute goods (1,000 metric tons).

$\overline{RDJ}$ = Rest-of-the-world total demand for raw jute (1,000 metric tons).

$\overline{RIG}$ = Rest-of-the-world stock of jute goods (1,000 metric tons).

$\overline{RIJ}$ = Rest-of-the-world stock of raw jute (1,000 metric tons).

$\overline{RJW}$ = Rest-of-the-world raw jute yield (metric tons/hectare).

$\overline{RMG}$ = Rest-of-the-world consumption of jute goods (1,000 metric tons).

$\overline{RQG}$ = Rest-of-the-world production of jute goods (1,000 metric tons).

$\overline{RQJ}$ = Rest-of-the-world production of raw jute (1,000 metric tons).

$\overline{RSG}$ = Rest-of-the-world total supply of jute goods (1,000 metric tons).

$\overline{RSJ}$ = Rest-of-the-world supply of raw jute (1,000 metric tons).

$SDBG$ = Bangladesh ratio of demand to supply of raw jute; defined as $(BXJ+BCJ+BINJ)/BSJ$.

T = Time trend variable—increasing monotonically with equal increments from the beginning of the estimation period to the end.

UNI = United Nations export price index deflator for world (1959/60 = 100).

YFW = Index of world GDP (1959/60 = 100).