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FORECASTING WITHOUT THEORY:
Pakistan's Export of Cotton and Rice

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The paper analyses the behaviour of Pakistan's commodity exports over time and makes medium term projections about the quantity and value of basmati, other rice and raw cotton. Our results, based upon careful statistical analysis and detailed study of the individual commodities reveal an impressive trend in the growth of these exports. It is projected that during the next five years the quantitites exported of basmati, 'other' rice and raw cotton will grow at an annual rate of 11 per cent, 9 per cent and 4 per cent respectively. Our forecasts are relatively more optimistic than some alternate projections made so far.

I. Introduction

The importance of Pakistan's commodity exports as a traditional source of foreign exchange can hardly be overemphasized. In 1980-81, rice and raw cotton accounted for about one-third of all exports. Their forecasting is thus not only analytically interesting but also of relevance to the policy maker.

The simplest economic model of export demand would relate exports to the international prices of the exportable commodity, prices of other related goods and real incomes of the importing countries.[1] For reasons discussed in section two, we opt for simpler statistical forms, not grounded in economic theory, but follow up with careful analysis to generate medium term forecasts for Pakistan's commodity exports.

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[1] See for example Khan (1974).

There is no doubt that it is difficult to forecast accurately and it would be risky to attach exaggerated importance to the precision of numbers. We believe however that some kind of forecasting is necessary in framing economic policies; and that it is better done systematically than by hunch.

The paper is divided into six parts. The next section on methodology contains a description of the models and a discussion of their relative merits for forecasting purposes. Sections three, four and five are devoted to the forecasting of quantities and value of basmati rice, 'other' rice and raw cotton exports respectively. The last section is for concluding comments.

II. Methodology

The starting point of our analysis is the Revised Minimun Standard Model (RMSM) of the World Bank[2]. The basic assumption underlying RMSM is that the quantity of export grows exogenously at some fixed rate. The particular equation used is simply:

$$X_t^i = (1 + g_x^i)\, X_{t-1}^i. \tag{2.1}$$

Here X_t^i is the exports (in quantity or constant price terms) of the i-th commodity (or commodity group) during time period t. One could estimate the growth rate by, for example, regressing past exports on lagged past exports (as in 2.1), setting the constant equal to zero.

The Spartan simplicity of formulation (2.1) is not due to any compelling theoretical arguments, but rather because it is well suited to estimation in situations where the data is very sparse. Even without much reliable data, it is possible to guess at reasonable values for g_x^i, enabling the model to function.

In the ensuing work, we have used two simple growth models to forecast exports. One is a simple autoregressive model analogous to (2.1) but with a nonzero constant:

$$X_t^i = a + b\, X_{t-1}^i. \tag{2.2}$$

The advantage of this specification over (2.1) is, of course, that it provides better fit to the data. There is a minor disadvantage in that the growth rate, given by:

$$\frac{X_t^i}{X_{t-1}^i} = \frac{a}{X_{t-1}^i} + b. \tag{2.3}$$

[2]For a detailed description of RMSM, see IBRD (1980).

cannot be read directly from the coefficients, and indeed is variable, depending on X^i_{t-1}. It is our judgement that this disadvantage is more than compensated for by the additional flexibility of (2.2).

In addition to (2.2), we have used a model of simple exponential growth, $X^i_t = A \exp(bt)$. Taking logs to linearize, we get:

$$\ell n\, X^i_t = a + bt. \tag{2.4}$$

It should be noted that (2.4) implies the relationship[3]:

$$X^i_t = (e^b)\, X^i_{t-1}. \tag{2.5}$$

Thus the growth rate implicit in (2.4) can be easily calculated as (exp b) − 1. [A simple approximation adequate for most purposes is (exp b) − 1 ≃ b + ½b²].

Since there is a fair amount of data available in the case of Pakistani exports, one can certainly try more complex variations of growth models. For example, higher order autoregressive schemes or more flexible growth curves may be fitted. However, such experimentation tends to invalidate the usual significance tests, and runs into the danger of generating spurious fits, valid only on the particular sample and not for forecasts.

A more useful line to pursue is the investigation of outliers in (2.2) and (2.4). The ordinary least squares estimator is notorious for its poor performance in the presence of outliers. Thus it is useful to introduce dummies for years where export performance was unusually good or unusually bad. This will make the estimates more stable, and also produce better fits.

The intorduction of *ad hoc* dummies to account for outliers protects the OLS estimates from instability, but has unknown theoretical properties. Accordingly, we wrote a program to compute the Least Absolute Error (LAE) estimator which is known to be robust to outliers. This procedure was also used to estimate (2.2) and (2.4). The best model was used to generate forecasts.

Before turning to the forecasts, it is important to discuss the problem

[3] $\ell n\, X_t = a + bt$ and $\dfrac{d\ \ell n\ X_t}{dt} = b$

or $\ell n\, X_t - \ell n\, X_{t-1} = b$

Taking exponent:

$$\frac{X_t}{X_{t-1}} = e^b$$

$$X_t = e^b X_{t-1}$$

alluded to in the title, namely that forecasts based on the naive models discussed above are not grounded in economic theory. Paradoxically, the simplicity of the growth models discussed above is their major strength and at the same time their most important weakness. A proper economic model to forecast exports must utilize a large number of variables to capture supply and demand aspects, and government policy variables. Since these factors clearly have an impact on exports, no model neglecting them (and in particular, the simple growth models above) can be theoretically correct. The problem is that the data requirements for a correct model are large, and often data is unavailable on some of the key variables required. Also, for purposes of forecasting, it is necessary to obtain projections for the values of all exogenous economic variables introduced in the model, a process which is subject to errors in itself. In contrast, the naive model requires a minimum amount of data, and forecasts do not need extrapolated values of extraneous variables. The jury is still out on the question of which method works better in practice. Naive models often give as accurate or better forecasts than their sophisticated economic counterparts. The major advantage of the economic models lies in the fact that they can be used for policy analysis, and not necessarily in superior forecasting abilities. Since the naive models do not incorporate any economic variables, they cannot be used to forecast changes in exports as a result of economic policy.

III. Modelling Basmati Exports

As the two varieties display entirely different characteristics, it is essential to separate basmati and coarse rice for any but the crudest of analysis. We first consider basmati rice, for which a long annual time series is available. Pakistan (in fact, Punjab) has enjoyed a monopoly on the production of this commodity for over 20 years. The bulk of our exports go to the oil producing countires of the Middle East.

In contrast, coarse rice is exported to poorer countries and costs less than half as much as basmati. These considerations dictate separate consideration of basmati and coarse rice. The closest competitor to basmati appears to be American long grain #2 rice. The price of this substitute as well as data on the income of the OPEC countries would be appropriate variables to include in a model based on economic theory. As discussed in the introduction, we confine our efforts to obtaining the best possible forecasts from a statistical model.

Glancing at Table 1, the annual time series of basmati exports, we can discover a clear upward trend. We also note that there have been considerable fluctuations around that trend. The behaviour of exports in the recent past has been especially erratic. This enables us to tell in advance of any

TABLE 1

Basmati rice

Year	Exports (thousand metric tons)	Value (million US $)	Production (thousand metric tons)	Acreage (thousand acres)	Yield (tons/ acres)
1958-59	11.059	2.27	—	—	—
1959-60	28.995	5.96	—	—	
1960-61	21.735	4.26	—	—	—
1961-62	66.224	17.08	—	—	—
1962-63	68.638	19.69	—	—	—
1963-64	57.097	14.29	—	—	—
1964-65	55.200	12.94	—	—	—
1965-66	92.158	18.93	—	—	—
1966-67	166.366	34.43	—	—	—
1967-68	109.369	28.36	—	—	—
1968-69	103.940	26.98	—	—	—
1969-70	81.652	18.38	—	—	—
1970-71	161.454	33.82	—	—	—
1971-72	179.669	42.12	384	820	0.468
1972-73	61.461	16.24	400	835	0.479
1973-74	178.129	94.13	486	926	0.525
1974-75	153.427	119.28	602	1220	0.493
1975-76	236.461	124.08	642	1323	0.485
1976-77	401.974	138.79	660	1309	0.504
1977-78	246.613	111.25	560	1272	0.440
1978-79	180.727	134.28	878	1674	0.524
1979-80	314.880	225.07	887	1924	0.461
1980-81	409.653	292.02	980	2035	0.482
1981-82	261.808	188.84	1055	2095	0.503

curve fitting that naive growth models of the sort under consideration may not yield accurate year-to-year forecasts. Nonetheless, on an average basis, we can confidently expect a moderate degree of accuracy in a medium range forecast. This is bacause the year-to-year forecast errors should cancel out, and the overall forecast should be close to the underlying trend. After these preliminary remarks, we present the results of the formal analysis.

The result of fitting our two basic growth models to the data on basmati exports in given below in (3.1) and (3.2): (Here, and elsewhere, figures in parentheses are the standard errors).

$$\underset{}{RBA_t} = \underset{(29.89)}{58.767} + \underset{(0.16)}{0.686}RBA_{t-1} \quad (R^2 = 0.48). \tag{3.1}$$

$$\underset{}{\ell nRBA_t} = \underset{(0.17)}{3.578} + \underset{(0.01)}{0.102}t \quad (R^2 = 0.77). \tag{3.2}$$

The expontential growth model fits better than the autoregressive model, and indicates that basmati exports have grown at 10.74 per cent per annum [calculated as exp $(0.102 - 1)$]. As pointed out in the Introduction, it is necessary to be careful about outliers distorting results when Ordinary Least Squares is used to estimate parameters. Accordingly, an analysis of residuals was carried out which indicated that the export of 61,461 tons in 1972-73 is unusually low. Introducing this as a dummy variable RBAD, which is 1 in 1972-73 and 0 elsewhere, we obtain the equation:

$$\underset{}{\ell nRBA_t} = \underset{(0.15)}{3.597} + \underset{(0.01)}{0.104}t - \underset{(0.35)}{0.930}RBAD_t \quad (R^2 = 0.83) \tag{3.3}$$

This improves the fit in (3.2) considerably while confirming our result on the growth rate, which is 10.96 per cent in this equation. To check that the dummy does not cause difficulties, we re-estimated (3.3) using a robust method of regression, viz. least absolute error estimation. This leads to:

$$\ell nRBA = 3.6 + 0.106t. \tag{3.4}$$

We are led to conclude that the volume of basmati exports has had an impressive trend rate of increase of about 10½ to 11 per cent. If we assume last year's disastrous performance was due to transient factors which will not arise in the future our forecasts for basmati exports based on (3.3) are:

Forecasts of volume of basmati exports
(thousand metric tons)

1982-83	1984-85	1985-86	1986-87	1987-88
439,492	487,519	540,795	599,892	665,448

A closer look at country-wise exports of basmati reveals that last year sales declined to most oil producing countries, e.g. Abu Dhabi, Bahrain, Dubai, Kuwait, Iran, Iraq and Qatar, suggesting that the lower incomes to the oil producing countries may have led to a slight decrease in Demand. Moreover, Iran, which imported 101,000 metric tons of Basmati in 1980-81 did not import any in 1981-82. This decline is attributed to measures of austerity on the part of an Iranian government faced with lower oil revenues and the expenses of Iran-Iraq War.

It may be more prudent to assume that the factors responsible for the dismal performance of last year will persist. On this basis, we should correct our forecasts to assume that while the growth rate will remain the same, we will start with low base figure of 216,808 tons of basmati achieved in 1981-82.

The forecast thus becomes:

Corrected forecast for basmati exports
(thousand metric tons)

1981-82 (Actual)	1982-83	1983-84	1984-85	1985-86	1986-87
261,808	290-418	322,154	357,359	296-410	439,730

This forecast may prove unduly pessimistic if incomes rise rapidly in the importing countries, or if new channels are found for basmati exports. In such an event, we expect the basmati exports to rise more in accordance with our first forecast than with the corrected forecast above.

Because our forecasted rate of growth of 10.9 per cent is considerably high we felt it necessary to carry out some further cross checks on the data available, to ensure the soundness of our figures. Basmati exports and log of basmati exports are graphed against time in Figures 1 and 2. The exploratory data analysis technique of "Ersatz Regression" , suggested by John Tukey for obtaining a model-free and robust fit to the data, has been used to fit a curve to these points. Careful examination of these graphs does confirm our original impression that the data indicate a growth rate of about 10 per cent or more. The regression line in Figure 1 shows clear curvature, indi-

cating that a logarithmic model is appropriate. It may be thought that the last portion of the graph is nearly linear, suggesting linear growth over the recent past. However, it should be noted that the fit in this segment is particularly poor, and the overall error structure appears heteroskedastic, again indicating the appropriateness of the logarithmic model. Figure 2, which plots log of basmati exports against time, clearly appears to show linear growth. Fitting a line by eye leads to about a 10 per cent growth rate.

Yet another source which suggests our analysis of basmati exports is sound, is the study of the time series on the acreage devoted to basmati rice. A simple exponential growth model fitted basmati acreage (BACRE) gives:

$$\ell n\ BACRE_t = 6.579 + 0.104t \quad (R^2 = 0.94). \tag{3.5}$$

The growth rate of acreage under basmati coincides exactly with our forecasted growth rate of exports of basmati. The fit is remarkably good enabling us to confidently assert that the growth rate of basmati exports has been approximately 10.9 per cent over the past.

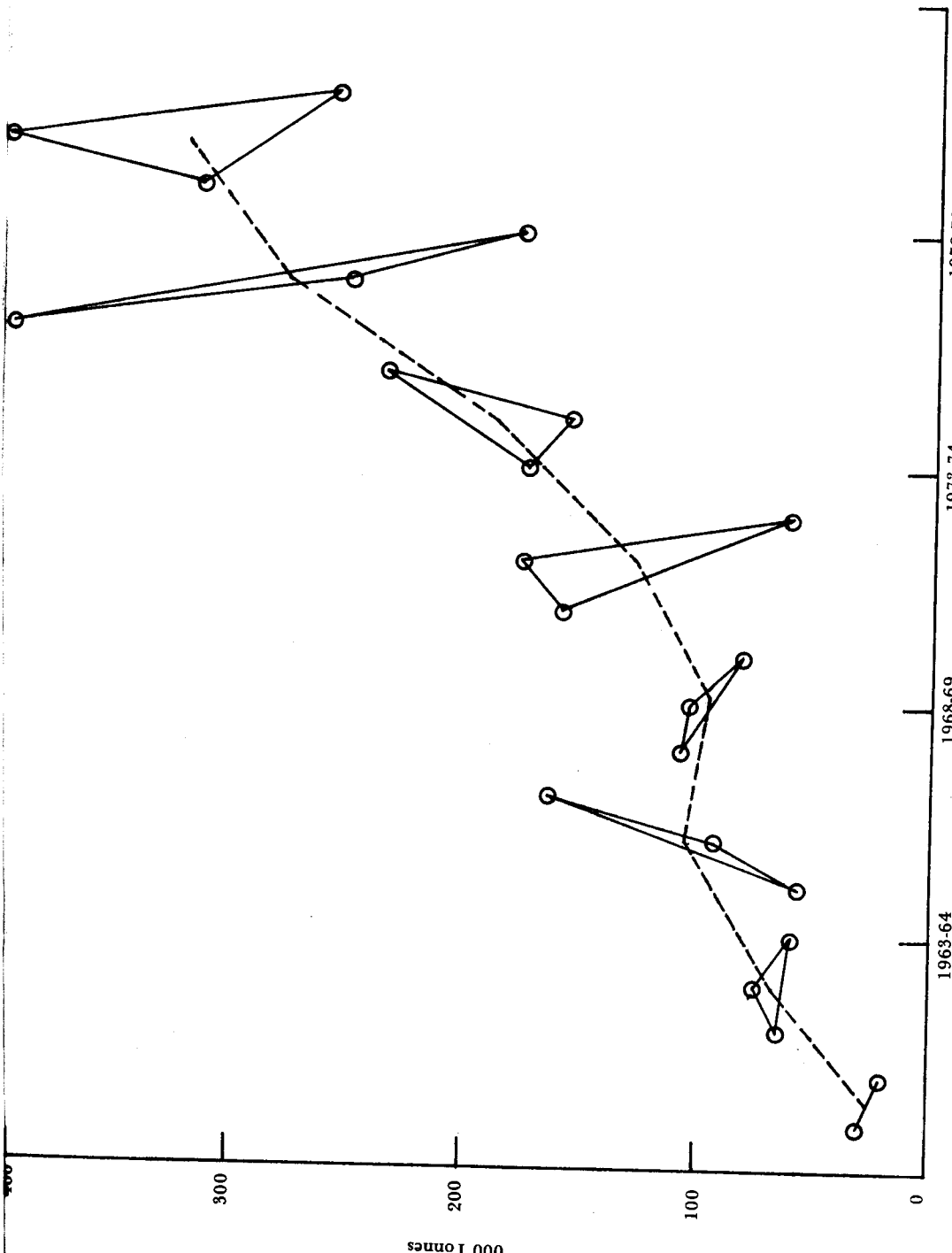
Of course, the figure of main interest is not only the volume of exports but also export earnings. To arrive at projections for export earnings, it is necessary to project the behaviour of prices of basmati. The World Bank Commodity Price Projections show the price of rice as increasing by 11.1 per cent per annum over the period of concern to us. To double check, we ran an exponential growth regression on the available data for price of basmati (PB) with the following result:

$$\ell nPB_t = 5.085 + 0.059t + 0.629PDUM \quad (R^2 = 0.75). \tag{3.6}$$

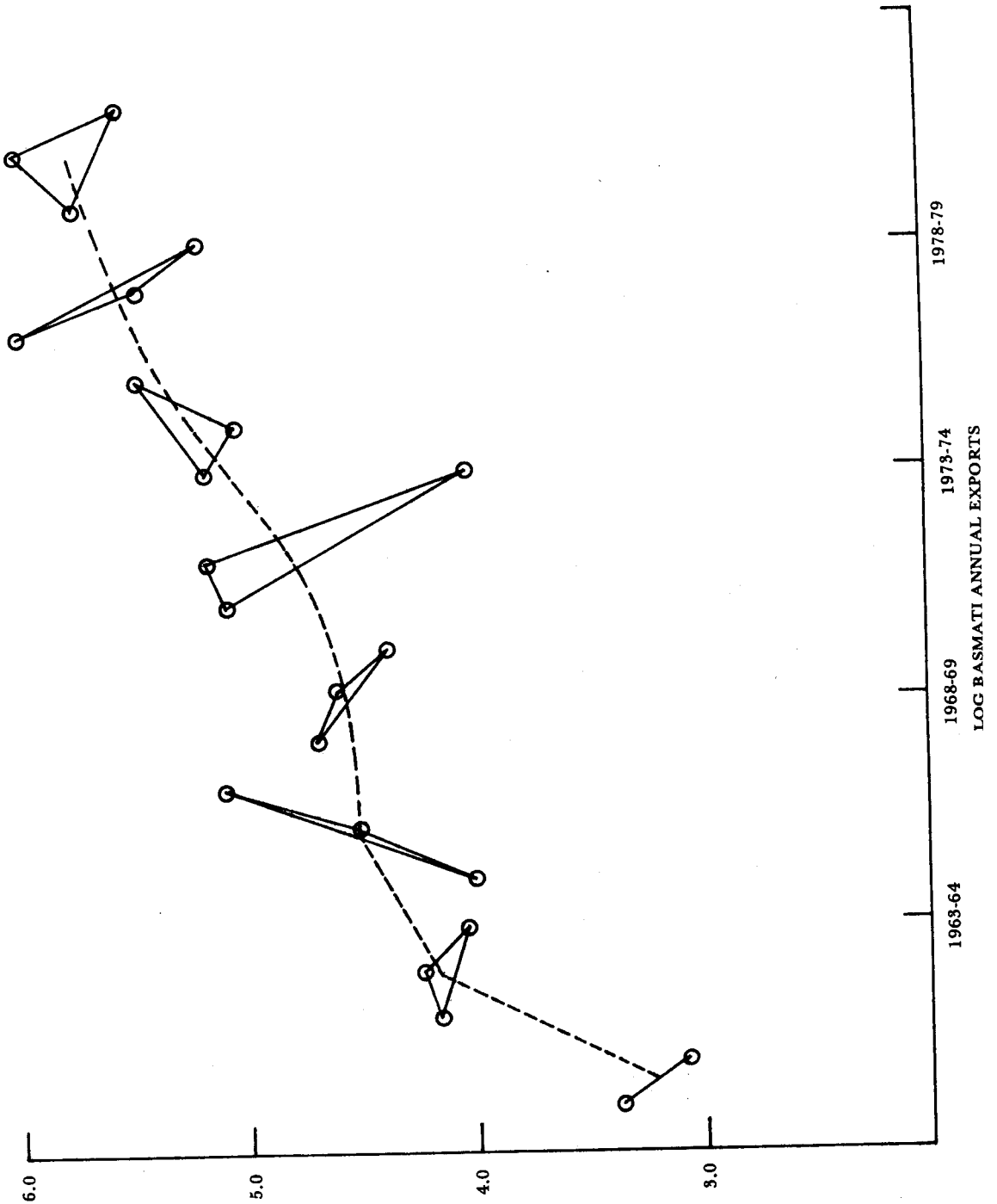
The dummy (PDUM) was introduced to account for an unusually high price of basmati in 1974-75, detected both by observation and by residual analysis. This regression suggests that basmati prices have risen at only 6.1 per cent in the past. As a compromise, we have used an 8 per cent rate of growth for basmati prices in our projections. This leads to export earnings projections, based on the corrected forecasts of Figure 2, as follows:

Projected export earnings from basmati
(million US dollars)

1982-83	1983-84	1984-85	1985-86	1986-87
226.29	271.16	324.93	389.36	466.58



RICE BASMATI ANNUAL
Figure 1


6.0
5.0
4.0
3.0
1963-64
1968-69
1973-74
1978-79
LOG BASMATI ANNUAL EXPORTS

A few concluding remarks are in order. For various reasons, the quarterly export series for basmati rice, available from 1973 onwards did not fit any of the growth models very well. For this reason, we have not presented any quarterly forecasts.

Also the pricing of basmati exports is an interesting question, deserving a detailed study. Whereas the price of other exportables is determined on the world market, Pakistan has a degree of market power in basmati. The appropriate price to charge depends on the demand and supply aspects, which we hope to study at a later stage with a more sophisticated model.

IV. Exports of Other Grades of Rice

For a more refined analysis, it would perhaps be useful to disaggregate the category of 'other' rice into coarse and IRRI. However, these varieties are much closer to each other than to basmati, and the aggregation error is likely to be small. These grades of rice, subsequently referred to as 'other', are traded freely by a large number of countries. Thus, Pakistan does not have much market power, and cannot significantly influence the price.

The time series of annual 'other' rice exports, given in Table 2, is fairly short. Both East and West Pakistan were producers of this commodity, and it has, apparently, not been possible to partition the exports between the

TABLE 2

'Other' rice

Year	Exports (thousand metric tons)	Value (million US $)	Production (thousand metric tons)	Acreage (thousand acres)	Yield (tons/ acre)
1972-73	655.527	83.16	1930	2821	0.684
1973-74	318.216	105.99	1970	2837	0.694
1974-75	273.403	90.19	1712	2740	0.625
1975-76	526.480	98.59	1975	2899	0.681
1976-77	481.322	86.76	2078	3010	0.690
1977-78	556.737	129.10	2389	3417	0.699
1978-79	829.021	204.46	2395	3328	0.720
1979-80	771.794	196.80	2329	3101	0.751
1980-81	835.019	271.97	2130	2743	0.776
1981-82	689.278	205.27	2185	2726	0.801

two wings prior to 1972. Glancing at the time series, it seems apparent that the exports of 655,527 metric tons in 1972-73 and those of 273,493 metric tons in 1974-75 are unusually high and unusually low respectively, in relation to the general trend of the rest of the time series. This impression was confirmed by an analysis of the residuals from preliminary regressions. Thus we have incorporated the dummy variable RODUM which is +1 in 1972-73, -1 in 1974-75, and 0 elsewhere, in the growth equations estimated below:

$$RO_t = \underset{(167.19)}{337.027} + \underset{(0.27)}{0.427}\ RO_{t-1} + \underset{(114.27)}{224.998}\ RODUM \quad (R^2=0.60) \qquad (4.1)$$

$$\ell nRO_t = \underset{(0.329)}{4.647} + \underset{(0.018)}{0.088t} + \underset{(0.094)}{0.454}\ RODUM \quad (R^2=0.87) \qquad (4.2)$$

The second regression fits much better and indicates that the growth rate of 'other' rice exports has been 9.2 per cent [= exp (0.088) − 1] .

The quarterly observations fit very poorly to the growth models tested.[4] A number of different variations and use of dummies failed to give good results. Thus the quarterly data failed to confirm or to cast doubt on our estimated growth rate of 9.2 per cent. Graphical techniques of exploratory data analysis appeared to confirm weakly our anlaysis of equation (4.2), but the results were not entirely clear. Robust regression techniques also indicate growth rates of approximately 10 per cent in coarse rice exports.

Unlike the case of basmati rice, the estimated growth rate does not appear to be stable. Estimating trend rate of growth for both production and acreage of rice gave figures of 3½ to 4½ per cent, suggesting that an increasing percentage of the output is exported. It seems unlikely that such a trend can continue in the long run since rice is a basic foodgrain, and the domestic requirement of rice is large and grows with the population. However, it is quite plausible especially given the low share of exports in total production in the base year of 1981-82, that a 9.2 per cent rate of growth will be maintained during the period of our forecast. Applying this rate of growth, we get five year forecasts for volume of 'other' rice exports of:

Forecasts for volume of 'other' rice exports
(thousand metric tons)

1982-83	1984-85	1985-86	1986-87	1987-88
752,692	821,939	897,558	980,133	1070,305

[4]The quarterly series was calculated from the Monthly Statistical Bulletins of the Government of Pakistan.

These forecasts are not as reliable as the basmati forecasts, which were robust under changes of model. Here we feel that perhaps further disaggregation of the category "other" rice may improve results. Unfortunately, we were unable to obtain complete time series on the breakdown by categories of other rice.

Turning to price, the World Bank Commodity Price Projections are for 11.2 per cent inflation in rice prices over the projected period. Our attempts to obtain growth rates of prices by regression did not give good fits. Cruder data analysis methods, as well as robust regression methods suggested a trend growth rate in prices of about 7 per cent in the past. Because of the special features of basmati rice, we were more inclined to use our own estimates for price projections of basmati. In the case of 'other' rice, the World Bank projections are undoubtedly made on the basis of a more thorough study of the world market conditions for rice than is possible by us. Thus we have used the figure of 10 per cent for rate of price increase of coarse rice in the following projections. The 10 per cent figure represents a compromise between our own estimates and those of the World Bank's with greater weight attached to the World Bank estimates. Forecasts based on this figure are:

Projected export earnings from 'other' rice
(million US dollars)

1982-83	1983-84	1984-85	1985-86	1986-87
246.51	296.10	355.70	427.24	513.21

Summing up the forecasted values of exports from basmati and 'other' rice we get the projected earning from total rice exports:

Forecasted "value" of total rice exports
(million US dollars)

1982-83	1983-84	1984-85	1985-86	1986-87
472.80	567.26	680.63	816.60	980.06

We conclude the rice export forecasts section with a few comments. The rate of growth of acreage devoted to basmati corresponds to the rate of growth in exports. Yields have remained clearly constant over the past decade. The rate of increase in the production of other varieties of rice has only been around 4 per cent at most, whereas the growth in volume of

exports has been 9 per cent. Thus the ratio of exports to production has been rising. If production of rice can be accelerated, then we may be able to boost exports above the levels forecast. The low yield figures suggest that efforts in the direction of research to imporve yields may produce quick payoffs.

V. Raw Cotton Exports

Raw cotton exports present a challenging task for the forecaster. Both simple and sophisticated regression techniques are doomed to failure in advance. The reason for this can readily be perceived by inspection of the data presented in Table 4. The export figures for the years 1979-80, 1980-81 and 1981-82 are completely out of line with the remainder of the series. The earlier exports are generally considerably lower, and also display extreme fluctuations. There is other evidence from related time series, for example, production, which points towards the possibility of a shift that has occured in 1979-80 and which continues to operate upto the present time. Under these circumstances, it is sometimes still possible to obtain useful regressions, if some portion of the structures remains unchanged. Then the previous data can be utilized to give information on that part of the structure which has not changed. The simplest example of this is the dummy variable techniques, which assumes, in effect, that differences result from changes in the constant only, and not in the coefficients of the independent variables. We attempted a number of variations on this theme and did not obtain any presentable results. The conclusion is that no structure has been preserved which can be detected by the naive methods we are using at present. Thus in effect we have to make our forecasts from the very short time series consisting of the three observations recorded in 1979-80, 1980-81, and 1981-82. Even these three data points are too erratic to permit estimation of a growth rate. Thus it is necessary to look deeper at the sources determining cotton exports, in order to arrive at a reasonable figure to use for a growth rate.

Firstly, it is important to note that raw cotton is exported solely by the Cotton Export Corporation (CEC), a public sector organization which does not operate on a profit maximation principle. Thus the usual supply-demand analysis would not be appropriate for an economic model of cotton export of Pakistan. The exports are certainly priced competitively; the CEC fails to act competitively in its procurement of raw cotton, since it is required by its charter to permit domestic consumers to get the first pick. This means that exports are determined as the surplus of production over the demand of the domestic industry for raw cotton. This mechanism makes the volume of exports much less responsive to world market conditions than would be the case otherwise. It is argued that this arrangement insulates the

domestic producers and the cotton industry from the fluctuations in the world markets. While this may be true, the policy certainly appears questionable on grounds of economic efficiency.

To proceed, we can argue that if we are able to forecast domestic production and also the demand for raw cotton by the domestic industry, we will be in a position to forecast the exports as a difference between the two. Examination of Table 3 encourages the pursuit of this approach, since it shows that production of cotton jumped in 1979-80, and has continued to be high since. If domestic demand has been stable, then this would explain

TABLE 3

Cotton production, acreage and yield

Year	Production (thousand metric tons)	Acreage (thousand hectares)	Yield (tons/hectare)
1960-61	301	1293	0.233
1961-62	324	1396	0.232
1962-63	367	1374	0.267
1963-64	419	1471	0.285
1964-65	378	1467	0.257
1965-66	414	1561	0.265
1966-67	463	1620	0.286
1967-68	518	1785	0.290
1968-69	528	1745	0.302
1969-70	535	1755	0.304
1970-71	542	1733	0.313
1971-72	708	1957	0.362
1972-73	702	2010	0.349
1973-74	659	1845	0.357
1974-75	634	2031	0.312
1975-76	514	1852	0.277
1976-77	435	1865	0.233
1977-78	575	1843	0.312
1978-79	473	1891	0.250
1979-80	728	2081	0.350
1980-81	715	2108	0.339
1981-82	748	2167	0.345
1982-83	789*	2257*	0.350*

* Provisional

the sudden increase in exports. Closer analysis, undertaken in Table 4 reveals the necessity of taking inventories of the CEC into consideration in explaining the bahaviour of cotton exports. The data presented in Table 4 is the basis for our projections of cotton exports. We turn to a detailed explanation of Table 4.

Colunm (1) is the total production of raw cotton while column (2) is simply the total purchases of the Cotton Export Corporation. Adding Column (3), the previous year's stock remaining with the CEC, we arrive at (4), the holdings of the CEC. From (4) we deduct (5), raw cotton exports, and (6), local sales by the CEC, to arrive at (7), the year-end inventory of the CEC. The domestic demand for raw cotton is determined as total production minus CEC purchases plus domestic sales by CEC. The final column (9) simply gives the ratio of exports to total holdings of the CEC, which appears to have been remarkably stable.

With the aid of this table, we can explain the pattern of exports over the recent past. The year 1979-80 was doubly unusual in that a sudden jump in production coincided with a sharp drop in domestic demand. This led to record purchase by CEC, and a large exportable surplus. Less than 60% was exported and since domestic sales were low, huge stocks remained with CEC at the beginning of 1980-81. In 1980-81, production changed only slightly, but there was a major recovery in domestic demand, leading to a 25% reduction in CEC purchases. Due to large stocks, CEC holding reached a peak in 1980-81, and the ratio of exports to holdings was highest ever at 69%, leading to record exports of 339,000 metric tons, 25% more than the previous maximum exports. Further recovery of domestic demand in 1981-82 led to even lower purchases by CEC. Since inventories were no longer as high, there was a sharp drop in exports.

Based on the mechanism described above, and further considerations to be reported, we make the following assumptions to generate forecasts:

(a) Cotton production will grow at 3.1% per annum.
(b) Domestic demand for raw cotton will increase at 2% per annum.
(c) Domestic sales by CEC will also increase at 2% per annum.
(d) CEC will continue to export 65% of its total holdings every year.

To justify (a), we note that most of the fluctuations in output can be attributed to fluctuations in the yield. The acreage under cotton (COTACRE) has grown fairly smoothly. This is evident from visual inspection of Table 3, and confirmed by the following regression:

$$\underset{t}{\ell n COTACRE} = \underset{(0.026)}{7.224} + \underset{(0.002)}{0.021}t \quad (R^2=0.85). \qquad (5.1)$$

This equation gives 2.1% as the growth rate of acreage under cotton.

TABLE 4

Data for projections of raw cotton exports
(thousand metric tons)

	(1) Total Production	(2) CEC Purchases	(3) Inventory from previous year	(4) Total CEC Holdings (2) + (3)	(5) Exports	(6) Domestic Sales by CEC	(7) Year-end Inventory (4)–(5)–(6)	(8) Domestic Consumption (1)–(2) + (6)	(9) Exports/ CEC Holdings (5) / (4)
1974-75	634	387	56	443	195	120	128	367	0.44
1975-76	514	47	128	175	115	51	9	518	0.66
1976-77	435	14	9	23	15	4	4	445	0.65
1977-78	575	194	4	198	104	0	94	381	0.53
1978-79	473	21	94	115	56	28	31	480	0.49
1979-80	728	425	31	456	262	22	172	325	0.57
1980-81	715	334	160*	494	339	65	90	446	0.69
1981-82	748	302	90	392	242	56	96	502	0.62
1982-83	789[e]	358[e]	96	454[e]	295[e]	57[e]	102[e]	512[e]	0.65[e]

*does not match column (7) of 79-80 due to loss through fire damage.
e – estimated.
Data from Cotton Export Corporation.

Turning to yields, we note they have recovered from a period of depression in 1974-75 through 1978-79. They have been high but have not yet reached the former maximum of 0.362 achieved in 1971-72. On these grounds we feel it is reasonable to assume a 1% rate of increase in yields. This rate of growth is in fact somewhat pessimistic, since yields in Pakistan are quite low compared to other developing countries and there appears to be considerable potential for improvement. Together these assumptions lead to a 3.1% growth of output.

Assumption (b) is based on the observation that domestic demand is now nearly at the highest level attained in the past, having shown strong recovery from the low in 1979-80. Further increase should occur at a slow pace due to capacity limitations, etc. We have arbitrarily assumed 2% as the growth rate. In conjunction with this, it is reasonable to assume 2% increase in domestic sales of the CEC also, as in (c).

The final assumption (d) may appear controversial but is strongly supported by the data. In fact, the assumption of 65% is on the optimistic side, since historical levels have been lower. However, this is the average of the ratio of exports to holdings for the last two years, which should be given more weight.

On the basis of these assumptions, our forecasts for the volume of cotton export are as follows:

Forecasts of raw cotton exports
(thousand metric tons)

1981-82 (Actual)	1982-83	1983-84	1984-85	1985-86	1986-87
242	295	309	326	341	358

Before closing, we discuss the sensitivity of our forecasts to the assumptions made. The assumption of 2% growth of domestic demand is very important. Substantially faster growth appears unlikely but, should it occur, it would have a dampening effect on exports. Our assumpiton (a) is probably approximately the right rate of growth, subject to the condition that the weather remains good, as it has been over the past few years. On the basis of (d) we are assuming that CEC will maintain inventories of about 100,000 metric tons over the next few years. The CEC could choose to reduce inventories, and change the ratio assumed in (d). This would only have the effect of a one-shot increase in the level of growth.

Turning to price projections, we note that price increases from 1978-79 to 1980-81 have been in the order of 14% per annum or so. For Pakistan's exports the price has dropped precipitously from 1980-81 to 1981-82. It is expected that this temporary slump will not affect the rate of growth of

cotton prices. The World Bank commodity price projections are for 14.1% per annum increase in prices over the period of concern. Adopting this figure, which appears consistent with our data, we are led to the following forecasts of export earnings from raw cotton:

Export earnings from raw cotton
(million US dollars)

1982-83	1983-84	1984-85	1985-86	1986-87
417	499	600	716	858

Assessing the sensitivity of these projections, we regard the volume forecasts as reasonable on the basis of the data. The emergence of China as a major cotton growing country may disturb market equilibrium. The effect of this would be more to lower the rate of growth of prices than to effect changes in our volume of exports.

VI. Concluding Remarks

It is well known that mechanical application of statistical forecasting techniques can often lead to major blunders. However, judicious choice of technique, combined with careful analysis will produce forecasts which constitute an improvement upon projections that are based on intution alone.

All forecasts are based on some version of the principle that "the future will be like the past". Naive forecasts are weak in that they assume all other factors will remain the same. More sophisticated forecasts based on economic theory control for some additional factors such as behaviour of procurement prices and other government policy variables by including them in the model. No model can control for all eventualities such as war, floods etc. Such caveats are implicit in any forecasting exercise.

It is of interest to note that although quarterly data on exports is available, it proved useless in determining growth rates. In retrospect it is apparent that this will be the case for exports of annual crops such as rice and cotton. The stock obtained from the harvest determines the volume of exports for the year. The pattern of distribution of exprts over four quarters is determind mostly by price expectations, stroage-cost, and other inventory-theoretic cosiderations. As such, it contains little or no information on the underlying growth rate, which is determind on a year-to-year basis by the annual output.

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