Macroeconomic Policies and the Pakistan's Economy

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1. INTRODUCTION

For forecasting and policy analysis, large simultaneous equation econometric models are routinely used today in many developing countries. In the beginning there was growing enthusiasm about the effectiveness and relevance of Keynesian Macroeconometric models. However, the development of macroeconometric models with Rational Expectations has created much suspicion regarding the validity of the *a priori* restrictions [known as Lucas (1976) critique] used to identify Keynesian macroeconometric models. The response to this dissatisfaction led to the development of macroeconometric models proposed by Sims (1980, 1982 and 1986); Doan, Litterman and Sims (1984) and Litterman (1984), which use the modern time series techniques known as vector autoregression (VAR) models. The VAR modelling avoids imposing potentially spurious *a priori* restrictions on the model. In fact, the VAR model does not require any explicit economic theory to estimate a model. Moreover, it allows one to capture empirical regularities in the data and thereby provide insight into channels through which the different policy variables operates.

Pakistan is relatively a latecomer in the field of macro-models. The only large-scale model is the *PIDE Macroeconometric Model of 1983* which is a refinement of its earlier version of 1982. This model consists of 33 behavioural and 25 definitional equations with 58 endogenous and 35 exogenous variables. Almost all price variables are exogenous. The production and expenditure block (the largest of the three blocks of the model), consisting of 34 equations is completely static. The use of a large number of exogenous variables in the macroeconomic model has rendered the forecasting capability seriously limited.

Motivated with these considerations, in this paper we develop and estimate an annual macroeconometric model for the economy of Pakistan over the period 1960 to 1986 using the innovative VAR technique proposed by Litterman (1979, 1984) and Sims (1980, 1982 and 1986). The primary focus of this study is to empirically

analyze the strength of short-run and long-run impacts of anticipated and unanticipated monetary and fiscal policies and external resources and remittances shocks (or innovations) on Pakistan's macroeconomy.

The VAR macroeconometric model estimated in this paper includes nine variables [i.e., real GDP (RGDP), consumer price index (P), unemployment rate (UEM), real investment (RINV), remittances (REM), real exports (REXP), real external resources (REXR), money stock (M) and real government expenditure (RGEX)]. The anticipated policy analysis is conducted using an *F*-test on the estimated coefficients while the unanticipated policy shocks are analyzed with impulse response functions obtained from the moving-average representations of the VAR model.

Some of the major findings of the *PIDE Macroeconometric Model of 1983* are rather tenuous and, at times, may seem to contradict some of the standard theoretical propositions of the *new neoclassical* models. For instance, the empirical results of the PIDE model conclude that deficit financing does not contribute to the monetary expansion and that monetary expansion does not explain changes in the general price level. The results of our study, in the context of the VAR model, however, found a moderate impact of fiscal policy shocks on the monetary expansion at least in the short-run and a strong delayed effect of monetary expansion on the general price level.

The organization of the paper is as follows. In Section 2, we discuss the methodologies of the VAR estimation procedure, the impulse response functions and the variance decompositions. Section 3 presents the data, model specification and the results. Concluding remarks appear in Section 4.

2. VAR METHODOLOGY

In order to analyze the impact of policy variables on the macroeconomic targets, a standard complete structural macro model is probably more desirable. However, such a model can be extremely tightly structured with numerous arbitrary *"exclusion restrictions"* imposed on the coefficients of the variables in the model. These very strong restriction on the model may inhibit researchers in revising the macro model even when the data or historical evidence does point to such a possibility. Consequently, many model builders are likely to find these exclusion restrictions in the structural models too extreme and inflexible. Faced with these problems, many researchers have recently adopted an alternative method pioneered by Doan, Litterman and Sims (1984) which uses the modern time series technique known as the *Vector Autoregression* (VAR) method.

The Vector Autoregressive model provides a simple means of explaining or predicting the values of a set of economic variables at any given point in time. VAR

is a straightforward, powerful statistical forecasting technique which can be applied to any set of historical data. Like the structural model, the VAR system also generates systems of equations that can project the future paths of the economic variables extrapolating from their past historical values. However, the main difference between the VAR system and the structural models is that, unlike the standard model, the VAR system is based entirely on empirical regularities imbedded in the data. While the structural model is tied closely to the economic theory and has to follow the assumptions and the *a priori* restrictions imposed therein, the VAR model does not have to resort to the theory *per se* as, in fact, the data determines the final system.

An *n* variable VAR system can be written as:

$$A(l) Y_t = A + U_t; \qquad \dots \qquad \dots \qquad \dots \qquad (1)$$

and

$$A(l) \quad = I - A_1 l - A_2 l^2 - \dots A_m l^m; \qquad \dots \qquad \dots \qquad (2)$$

where Y_t is an $n \times 1$ vector of macroeconomic variables, A is an $n \times 1$ vector of constants, and U_t is an $n \times 1$ vector of random variables, each of which is serially uncorrelated, with constant variance and zero mean. Equation (2) is an $n \times n$ matrix of normalized polynomial in the lag operator l ($l^k Y_t = Y_{t-1}$) with first entry of each polynomial on A's being unity.

Since the error terms (U_t) in the above model are serially and contemporaneously uncorrelated, a simple ordinary least squares (OLS) technique would be appropriate to estimate the model. However, before estimating the parameters of the model $A(l)$ meaningfully, one must limit the length of the lag in the polynomials. If l is the lag length, the number of coefficients to be estimated is $n(nl+c)$ where c is the number of constants.

In the VAR model presented above the current innovations (U_t) are unanticipated but become part of the information set in the next period. This implies that the anticipated impact of a variable is captured in the coefficients of lagged polynomials while the residuals capture unforeseen contemporaneous events. Hence, even though a direct interpretation of the estimated individual coefficients from the VAR system is very difficult [e.g., see Sims (1980), p. 20], a joint F-test on these lagged polynomials are, nevertheless, useful in providing information regarding the impact of the *anticipated* portion of the right hand side variables.

In order to analyze the impact of unanticipated policy shocks on the macro variables in a most convenient and comprehensive way, Sims (1980) proposed the use of impulse response functions (IRFs) and variance decompositions (VDCs) and they are obtained from a moving average representation of the VAR model Equa-

tions (1) and (2) as shown below:

$$Y_t \quad = \quad \text{Constant} + H_t(l)U \quad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (3)$$

and

$$H(l) = \quad I + H_1 l + H_2 l + \qquad \qquad \ldots \qquad \ldots \qquad \ldots \qquad (4)$$

where H is the coefficient matrix of the moving average representation which can be obtained by successive substitution in Equations (1) and (2) The elements of the H matrix trace the response over time of a variable i due to a one standard deviation shock given to variable j. In fact, these impulse response functions will enable us to analyze the dynamic behaviour of the target variables (RGDP, P, UEM or RINV) due to unanticipated shocks in the policy variables (RGEX or M).

3. DATA, ESTIMATION AND THE VAR RESULTS

Data and the Model Specification

Our macro model consists of nine key macroeconomic variables (as mentioned in Section 1) and they are obtained from the *Data Bank of the AERC Macroeconometric Model.* We believe that these key macroeconomic variables should cover the broader aspects of the economy of Pakistan. All the variables, except UEM, in natural logarithm form. The raw data for all variables have been adjusted for seasonality by employing the *method of dummy variables* [e.g., see Maddala (1977)].

Estimation

Choosing Lag Length: Following Doan (1988) and Sims (1980), an appropriate *likelihood-ratio* is used to determine the lag length for the VAR model.[1] Using the sample period 1960–1986, and based on the significance of the *Chi-square* (X^2) value, a lag length of two was adopted in this study.

Results

F-test Results: As mentioned earlier, the significance of *F*-tests on a group of coefficients estimated using the VAR provides a convenient summary to analyze the

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[1]It should be noted that the traditional *likelihood-ratio* test used to test the lag lengths suffers from the criticism of not adequately taking into account the sample size. Sims (1980), however, has proposed an alternative formula which appropriately corrects for such a sample size problem. The recent version of RATS (3.02) programme which provides such subroutine has been used in this paper to determine the lag length [for the exact formula and the procedure, see Doan (1989)].

impact of the anticipated policies on the target variables. The significance levels of the *F*-tests, based on the hypothesis that all lags of a given variable for a particular equation are zero, are reported in Table 1. The results in Table 1 clearly indicate that the monetary (M) and fiscale (RGEX) policy variables and two other variables of interest i.e., external resources (REXR) and remittances (REM) are purely exogenous and they are, in general, not influenced by other variables. This can be seen by looking at the significance level of the relevant policy variables across a given row in Table 1. For instance, in the case of RGEX, all the values of significance level of *F*-test (across the row) are greater than 0.263. Table 1 also reveals that the target variable (RGDP) is strongly influenced by the anticipated fiscal (RGEX) and monetary (M) policies and remittances (REM) [significant *F*-test value in the last row column (0.01, .002 and 0.023)] while the impact of the external resource (REXR) variable is insignificant.

Impulse Responses: The results presented so far only enable us to analyze the impact of anticipated policies. Furthermore, it has been argued that the distributed lag coefficients estimated using VAR do not provide a clear understanding of the implied long-run behaviour of the model. Sims (1980), therefore, suggested the use of impulse response coefficients which will enable us to analyze the long-run

Table 1

Significance Levels of F-tests

Variable	M	RGEX	REXR	REXP	REM	RINV	UEM	P	RGDP
M	169	.739	.444	.223	.124	.523	.504	.084	.674
RGEX	.851	.046	.628	.722	.798	.941	.753	.489	.263
REXR	.121	.041	.378	.305	.337	.082	.420	.363	.078
REXP	.578	.222	.094	.0423	.083	.235	.023	.294	.519
REM	.617	.798	.963	.952	.565	.462	.140	.157	.899
RINV	.956	.134	.291	.171	.578	.560	.527	.592	.335
UEM	.425	.247	.031	.219	.227	.188	.003	.078	.129
P	.062	.482	.689	.860	.327	.273	.341	.079	.594
RGDP	.002	.010	.277	.069	.023	.001	.003	.013	.000

Note: The null-hypothesis tested is that all lags of indicated variable is zero.

behaviour of a variable due to random shocks given to other variables.[2] In fact, the graphs of the impulse response coefficients provide a better device to analyze the shocks and, therefore, the following discussion is devoted to the analysis of those graphs.

In order to capture the medium and long-run effects, we considered responses over five years to a one standard deviation shock in each variable. Since the primary focus of this study is to analyze the impacts of fiscal (RGEX) and monetary (M) policies and, to a lesser extent, the external resources (REXR) and remittances (REM), we have only presented the graphs of impulse responses to shocks of these policy variables and they are shown in Figures 1, 2, 3 and 4, respectively. The following is a summary of the results of impulse responses:

(a) Inspection of Figure 1 reveals that a one standard deviation shock given to M produces a strong positive delayed impact on RGDP and RINV, and it takes about two years before reaching the peak. While the economy is in the expansionary phase the impact of an initial increase in the nominal balances (M) does not significantly influence the unemployment rate (UEM). However, as the economy reaches the peak after two periods and starts to slow down, the UEM and remittances (REM) start to rise steeply. One can provide the following economic explanation for the above result. Due to a given shock in the money supply, initially the aggregate demand of the economy is stimulated thereby causing RGDP and RINV to increase. However, in the long-run when the nominal money stock is held constant (because of a one period shock) and concurrently prices continuously rising (with lag), the real money balances will start to decline which then are expected to cause a slowdown in the economy resulting in the decline in RINV, GNP and employment and probably emigration of workers. The emigration of workers may cause an increase in the remittances in the long-run;

(b) A one standard deviation shock given to the fiscal variable also produces some interesting results as shown in Figure 2. Unlike monetary policy, the

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[2] It should be noted that before computing the impulse response functions one should first orthogonalize the innovations. In this paper, we used the Choleski decomposition method, as suggested by Doan (1989), to orthogonalize the variance-covariance matrix of the innovations. It is true that the Choleski decomposition is not unique with respect to the ordering of the variables, except in cases where the VAR covariance matrix is diagonal. Following Sims (1980), we have triangularized the system. Based on macroeconomic theory, we tried several ordering of the variables with policy variables appearing first and the target variables at the bottom. Since changing the ordering does not substantially alter the results, we have reported the results of only one ordering in this paper. [For a detailed explanation of this technique see Doan (1989)].
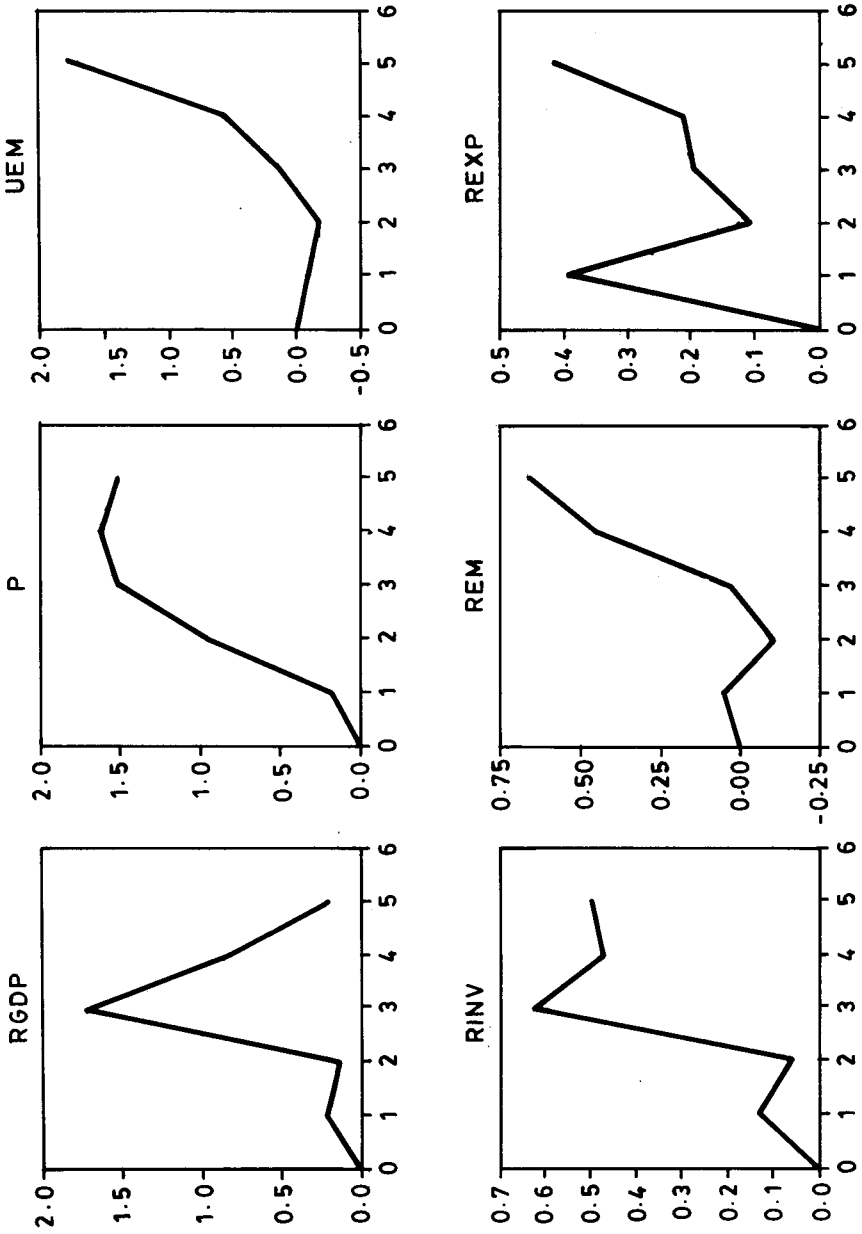
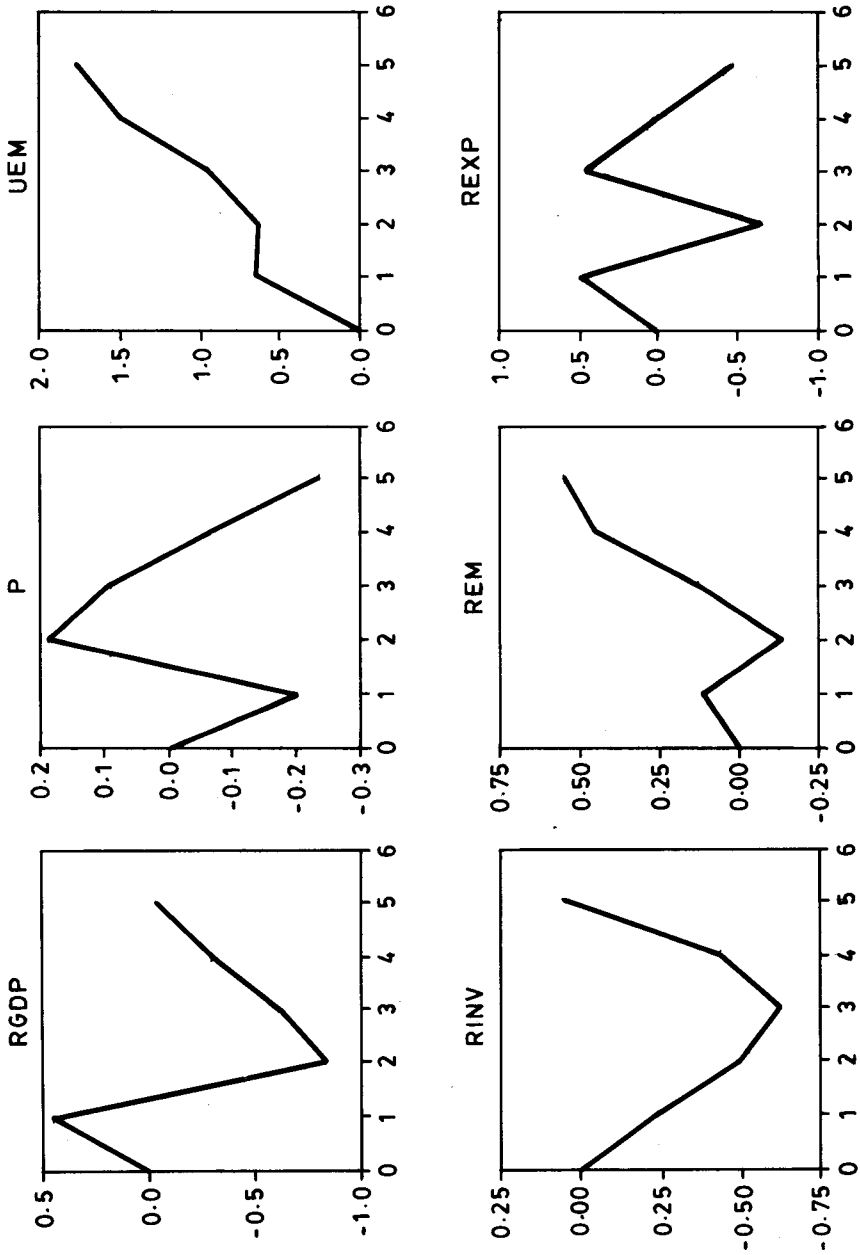Fig. 1. Impulse Responses to a Shock in M
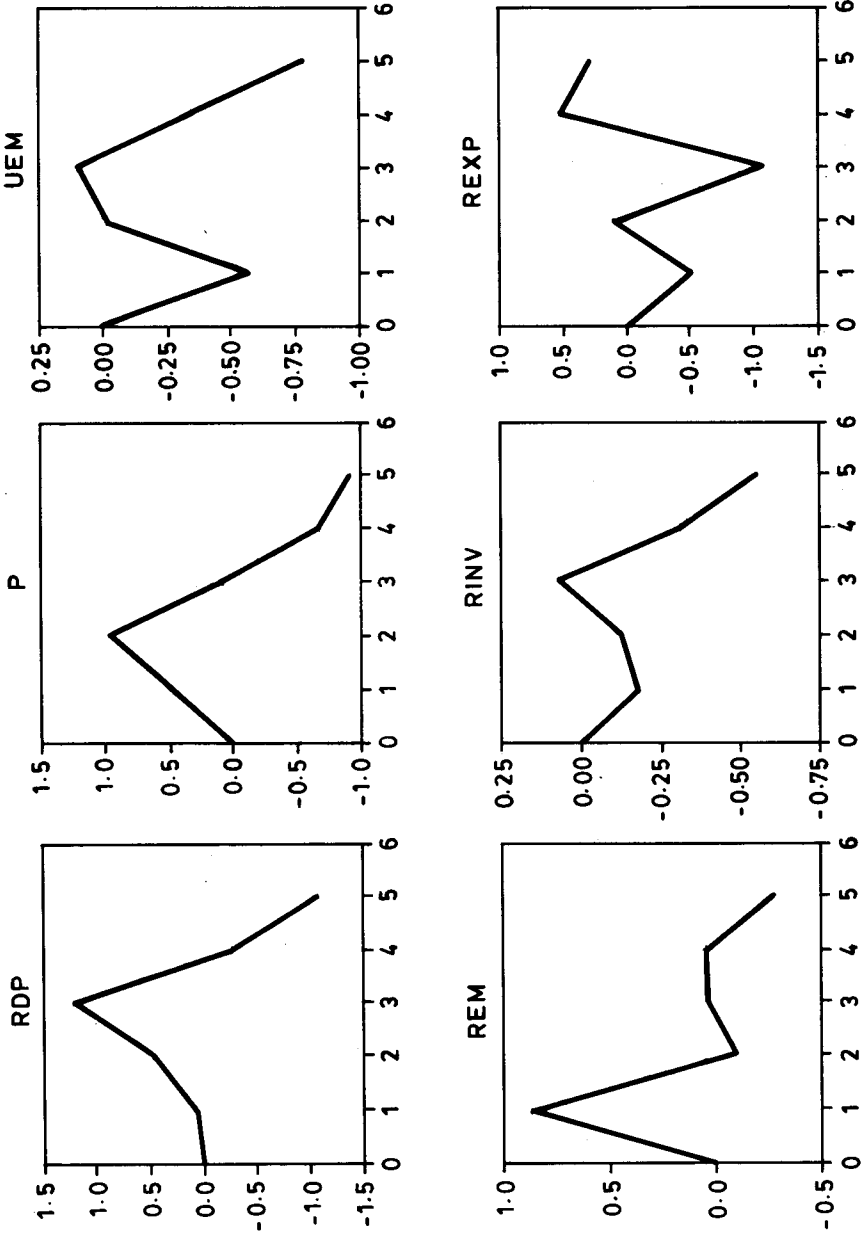
Fig. 2. Impulse Responses to a Shock in RGEX
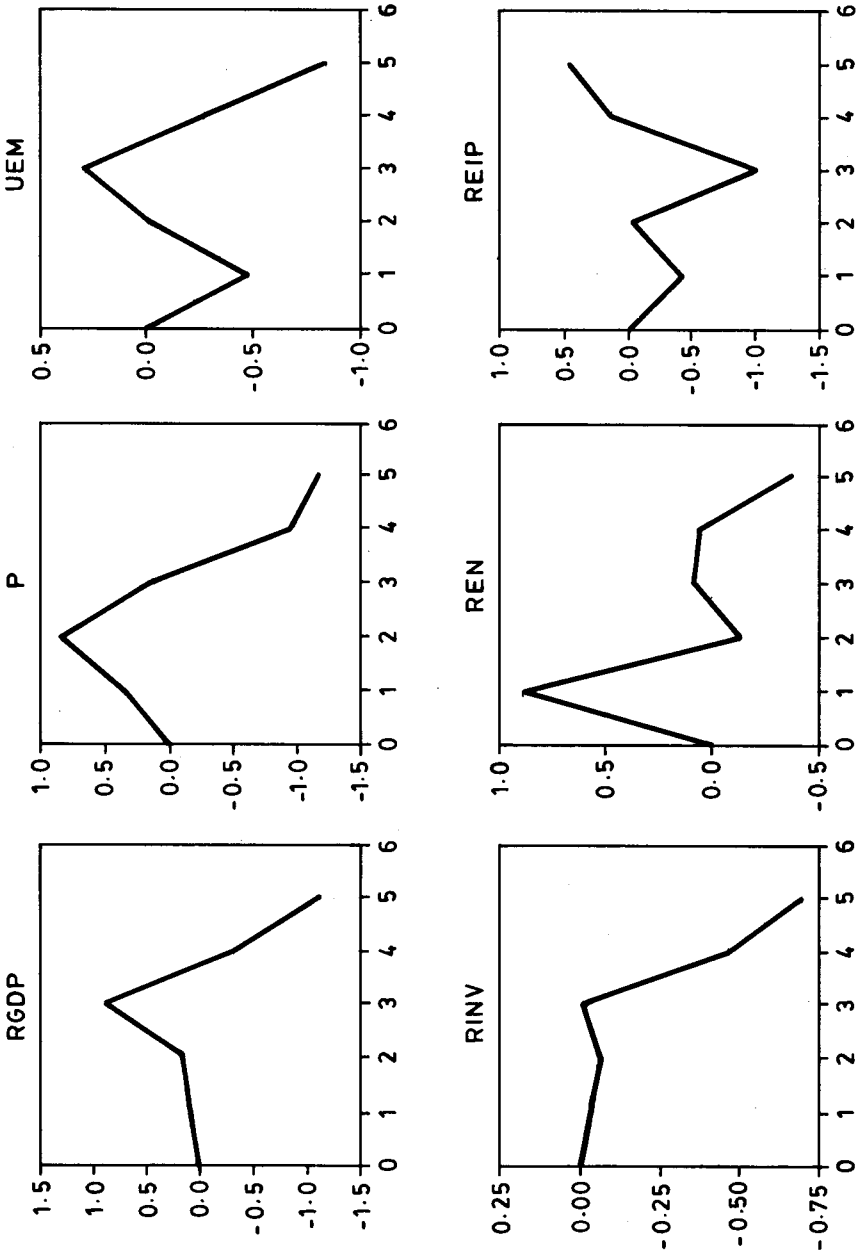
Fig. 3. Impulse Responses to a Shock in REXR

Fig. 4. Impulse Responses to a Shock in REM

short-run effect of fiscal policy results in a weak response of RGDP and a strong crowding effect on RINV. Concurrently, the prices (P) tend to decline due to a net increase in the RGDP. In the long-run, however, the support provided by the increased government expenditure (RGEX), in terms of the development of infrastructure, induces the real private investments (RINV) to increase. This increase in the RINV consequently enhance the RGDP and lead a reduction in the price level (P). The initial crowding out of RINV seems to generate UEM in the short-run as well as in the long-run. It is interesting to note that such a result is also produced by the monetary policy; and

(c) The impulse response functions of external resources (REXR) and remittances (REM) produce very similar results, as shown in Figures 3 and 4. In both cases, the impact on RGDP is gradual with a sharp increase in the price level in the short-run. The short-run impact of REXR and REM on RINV seems to be very subdued. In fact, the results in Figures 3 and 4 seem to support the hypothesis that the role of remittances and external resources has been to stimulate private consumption (thereby causing some increase in RGDP) but without significantly enhancing the private investment of the economy either in the short-run or in the long-run.

The summary results of impulse responses discussed so far seem to suggest that fiscal policies have moderate short-run effects on the RGDP. However, in the long-run, monetary policy seems to be more potent than fiscal policy in affecting RGDP and prices in the economy. On the other hand, the external resources and remittances are largely used for consumption and do not significantly influence private investment.

4. CONCLUSIONS

Despite some sharp criticisms by Cooley and LeRoy (1985) and Eichenbaum (1985) on the usefulness of VAR to the macroeconometric model building, they all, nevertheless, agree that there are important uses of the VAR models. For instance, [McMillin (1988), p. 320] pointed out that these models are particularly useful in the case of "forecasting, analyzing the cyclical behaviour of the economy, the generation of stylized facts about the behaviour of the elements of the system which can be compared with existing theories or can be used in formulating new theories, and testing of theories that generate Granger-causality implications". As suggested by Litterman (1979), the VAR procedure not only provides greater forecast accuracy than earlier standard structural models, but it can also be suitable to analyze the impacts of policy shocks on the target variables. This study, therefore, examined the annual response of Pakistan's key macroeconomic variables to anticipated and

unanticipated shocks in policy variables using the VAR innovation-accounting technique proposed by Litterman (1979) and Sims (1986). A nine variable annual macroeconometric model for the economy of Pakistan was estimated within the context of a VAR procedure over the period 1960 to 1986.

Unlike some of the results of the large *PIDE Macroeconometric Model of 1983* which seem to contradicts some of the standard theoretical propositions of the standard *new neoclassical* model, the overall results of this study support the pro-position of the later model. The impact of fiscal policy shocks on real GDP and the general level of prices seem to very weak at least in the short-run. On the other hand, monetary policy shocks seem to drive-up both real GDP as well as the price level in the economy in the long-run. Another interesting result of our study is that the external resources and the remittances shocks do not significantly generate real private investment.

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Comments on
"Macroeconomic Policies and the Pakistan's Economy"

Macro economics is a complex subject and the number of macro models is so large that one cannot be sure as to which particular model is suitable to describe a certain economy. The idea of performing a VAR exercise is first to study the observed pattern of interrelationships among various variables and then to decide which macro model closely resembles the empirical reality. The VAR macro model estimated by Chishti, Hasan and Mahmud has many attractive features. The model includes only nine key macro variables but it captures many of the theoretically established results. The model is useful for short-term predictions and the study of cyclical variations in the economy.

The presentation of the results is precise and elegant. The estimation of VAR models involves advanced quantitative techniques. In spite of this any reader not comfortable with these techniques can also appreciate the results. In particular, the graphic exposition of the results makes it easier to understand the final conclusions. The authors can highlight many interesting features of the economy with the help of their model and broaden its scope in future research.

A VAR model is the reduced form of a structural model in which the current value of an endogenous variable is dependent not only on the lagged values of all the variables but also on the current values of some of the endogenous and exogenous variables. For example, the price level does not have to wait for a whole period to respond to an increase in money supply. In the reduced form (VAR) model one can explore causality only in the narrow Granger sense which is based upon the final impact taking into account the simultaneous interrelationships among variables. The insignificance of the coefficients of a variable in one of the equations of a VAR system implies the absence of causality in the reduced form model but it does not necessarily imply the absence of causality in the structural model. To determine causality in a more meaningful way one has to estimate the structural model which, therefore, must be identified. Thus the authors' fear that macroeconometric models are 'tightly structured' due to 'arbitrary', 'extreme and 'inflexible' identifying restrictions equally applies to the VAR models.

The nine macroeconomic variables used in the VAR model do not include some key variables like the rate of interest. Since the VAR technique "does not require any explicit economic theory to estimate a model", there is no strong reason

to exclude any variable from the model. In the spirit of the VAR technique one may like to include all the potential macro variables in formulating a model and then follow some backward elimination criterion to drop out the insignificant variables.

The authors suggested that macroeconometric models have proved to be disappointing as a guide to development and that VAR techniques have some promise to fill the gap. In my opinion none of the two models can be taken too seriously as a guide to development. The gap between macroeconomics and development economics is obvious and the choice of statistical techniques has little relevance in this context.

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