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Macroeconometric Policy Modeling for India: A Review of Some Analytical Issues

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1. INTRODUCTION

Macroeconomic modelling is generally motivated by two objectives: forecasting and more significantly, policy analysis. In pursuit of both these objectives, every model must ideally satisfy four criteria. *First* and foremost, it must fit into a theoretical framework. *Second*, the actual specification of the model must reflect a clear understanding of the contextual framework within which policies are formulated and executed along with an envisaged process of adjustment. *Third*, it is essential that the model is built on a firm and rich data base and, *finally*, the estimated structural model must adequately utilise the rigors and sophistications of econometric methodology.

Unfortunately this is a tall order which can seldom be met. Typically refinements in one direction can often be achieved only at the cost of those in some other direction. For instance, it may be possible to devise small models that are theoretically neat and manageable enough to be subjected to econometric refinements these would seldom be able to deal with actual policy issues in a meaningful way. Clearly, an operationally useful model has to go well beyond simple illustrative caricatures of the economic system. How far one may go will depend on the nature of compromise between competing requirements. Given his objectives, ingenuity of the model builder lies in his ability to hammer out the optimal compromise.

Experience shows that models that can deal with policy issues need to be eclectic rather than exclusively pure in their structure. Since these have to be considerably disaggregative imposing a uniform mode of adjustment across markets and sectors may be unrealistic. Similarly, the ground realities may not be strictly consistent with one single paradigm over time and across markets. Moreover, there is always the difficulty posed by the nonavailability of reliable data on top of the fact that certain phenomena

may not even be quantifiable. This is not to argue for the abandonment of theoretical considerations. Far from it, models without a clearly spelt out analytical frame are useless because results based on such models can never be interpreted. A model is first and foremost, an assertion of a process of adjustment rather than an unstructured description of the course of economic movements. The plea is only for the necessity to depart from pure and prototype textbook models.

2. MACROECONOMIC THEORY

Before we proceed further it would not be out of place here to point out that model builder's difficulties have been additionally compounded over a good part of the last three decades by the fact that macroeconomic theory itself has been in a state of flux[1]. What was described by Samuelson as a concensus during the sixties broke down even before the decade had closed. Developments during the seventies have had far reaching implications not only for theory but also for how a model may be specified, estimated and analysed. At the theoretical level the choice for empirical modelling is no longer, as it used to be in earlier days, between a Keynesian and a classical/neoclassical model. It is about the way one introduces such things as information, expectations, and contracts. One may indeed assert that it is these things that a good deal of macroeconomic theory today is all about. The current interpretation of the central theme of Keynesian theory is that information is imperfect and costly to acquire. Further, macroeconomic adjustments are governed by contracts which cannot be redrawn in the short run. The new classical economics asserts that expectations are not only endogenous (rather than exogenous as Keynes assumed) but also rationally formed. One common motive underlying (recent) developments in macroeconomics has been the provision of acceptable microtheoretic foundations to the various building blocks of an overall macroeconomic model rather than reliance on stylised facts. The result has been a considerable proliferation in the variety of alternative models.

[1] Tobin (1984)

As mentioned above the new developments in macroeconomic theorising have had far reaching implications both for policy formulation as well as for modelling methodology. In addition to the policy ineffectiveness implied by the new classical economics which is now widely known these developments have mounted a frontal attack on the "Structural macromodelling" methodology associated with the Cowles Commission. The culmination of this attack has lead to the emergence of an alternative methodology pioneered by Sims (1980) as vector autoregression (VAR) modelling[2]. The main thrust has been that structural models are not theoretically well specified in so far as few, if any, parameter restrictions are imposed across equations. One serious implication of this relates to the identification of structural parameters. This being the case, Sims argues that we may directly use the dynamic reduced form in which each of the chosen variables is regressed on its own lagged values as well as on the lagged values of all other variables.

Although the first attempts at building macroeconometric models was made by Tinbergen as early as 1939, serious and sustained activity in this direction was initiated only during the fifties by Klein (1950) and Klein and Goldberger (1955). However, it was over the sixties that macroeconometric research blossomed fully and remained an integral part of the research agenda of economists for many years. It is interesting to note that the fortunes of macroeconometric research have remained tied with those of Keynesian economics across both time and space. The early seventies witnessed the decline of Keynesianism as a dominant paradigm both amongst the policy makers as well as amongst academics in the United States. It was about the same time that macroeconometric modelling, at least in the Keynes-Klein or Cowles foundation tradition ceased to be on the serious academic research agenda and became commercialised. In contrast Keynesian economics still remains a serious subject to the academic as well as to the policy maker in United Kingdom and Europe. Nor has commercialisation been a problem to structural macroeconometric modelling as a fruitful research activity outside North America. We shall explain later that the need in LDCs is to get started with a serious macroeconometric modelling agenda not only to help policy formulation but also

[2] See Fischer (1994)

to uncover the structure of such economies and to build the appropriate theoretical framework. The need is even greater in the wake of the current regime of policy reforms.

In any case macro-econometric modelling has attained a new stage of evolution drawing upon the new paradigms in macroeconomic theory, emergence of more refined econometric methodology, and more recently, the structural shifts and changes in policy regimes that have occurred in both the international economy as well as in the individual national economies. Does this mean that the old is dead and out? Commenting on the present situation in this context Diebold (1998) says :

> "The reports of the death of large scale macroeconomic forecasting models are not exaggerated. But many observers interpret the failure of the early models as indicative of a bleak future for macroeconomic forecasting more generally. *Such is not the case.* Although the large-scale macroeconomic forecasting models did not live up to their original promise, they nevertheless left a useful legacy of lasting contributions from which macroeconomic forecasting will continue to benefit. They spurred the development of powerful identification and estimation theory, computational and simulation techniques, comprehensive machine-readable macroeconomic data-bases and much else..... We learn from our mistakes. Just as macroeconomics has benefited from rethinking since the 1970s, so too will macroeconomic forecasting".

Paying tributes to the work done at the Cowles Commission Diebold goes on to say:

> "The intellectual marriage of statistics and economic theory was beautifully distilled in the work of the Cowles Commission at the University of Chicago in the 40s and early 50s. The intellectual focus and depth of talent assembled there were *unprecedented in the history of economics.* Cowles researchers included T.W. Anderson, Kenneth Arrow, G. Debreu, T. Haavelmo, L. Hurwitz, L.R. Klein, T.C. Koopmans. H. Markowitz, J. Marschak, F. Modigliani, H. Simon, A. Wald and many others."

3. EVOLUTION OF MACROMODELLING IN INDIA

Macroeconometric modelling in India has had one of the longest histories amongst all countries, particularly those in the developing world.[3] While it is not our intention to go into this history a few observations on the nature of this work would be in order. Nearly all macroeconometric models for India have had a policy focus, sometimes sharp sometimes hazy and, sometimes well formulated and sometimes not so. Most of the models have had only short to medium run character. With varying emphasis and success models have been concerned with the level of economic activity, price behaviour, fiscal and monetary policies, intersectoral linkages, investment, saving and consumption, resource mobilisation and public sector capital formation, trade flows and balance of payments. Each of these has posed serious problems of analytical significance, many of these remained unresolved even today. To these we turn in the next section.

Broadly speaking the sequence of available models can be seen as belonging to four phases. In the first we have a set of exercises during the late fifties and the sixties which were highly aggregative, simple and exploratory; almost all of them having been undertaken as doctoral dissertations. In fact it was these that paved the way for studies belonging to the second phase most of which were also undertaken as doctoral dissertations. But these were somewhat disaggregative and better focussed on policy issues. The third phase has ushered in models which were undertaken independently and many of these built on earlier experience by the same author. These were, as expected, much more disaggregative, with a clearly improved policy content and focus. The current fourth phase has ushered in much larger models that are comparable to those in developed economies and are maintained on an on-going basis.

[3] Critical account of this is available in several places. See for example Desai (1973), Krishnamurty and Pandit (1985), Krishna, Krishnamurty, Pandit and Sharma (1990), Krishnamurty (1995) and Marwah (1995). For a more detailed history of macroeconometric modelling see Bodkin, Klein and Marwah (1986).

Needless to point out here that modelling an economy has to be a continuous on-going activity not merely because of the need for forecasting but also more importantly because it is only a live model that can (a) incorporate new information by way of data (b) reflect changes in the perception of contemporary economic issues (c) reflect, as far as possible, new developments in theory and in quantitative methodology. One disturbing aspect however, of macromodelling in India has been that each model turned out to be a one time exercise. Thus, despite a relatively early start, unlike all developed and many developing countries, India did not have a maintained macroeconometric model till very recently. The only macromodel of this type during the eighties, built by the National Council of Applied Economic Research (NCAER) with support from the Ministry of Finance has largely been of the CGE variety. Only a few parts of the model are econometrically estimated. Though some models have been built and maintained by the Reserve Bank of India and some other government institutions these have been used only as in-house enterprises. Neither their structure nor any results based on these have been publicly discussed. It is only since the early nineties that sustained on-going work on a macroeconometric model began jointly at the Institute of Economic Growth (IEG) and the Delhi School of Economics (DSE). The structure of the model has been discussed at various fora and results based on it frequently presented[4]. It is gratifying that some more models have now come into existence as an on-going activity.

4. MODELLING THE LEVEL OF ECONOMIC ACTIVITY

Before we consider some of the analytical issues let us underline that following the advice of Klein (1965) models for India have in one way or the other and for their own credibility explicitly highlighted agriculture, existence and growth of a large public sector, the role of planning and associated policy regime, and, a relatively closed economy. While all of these structural characteristics of the Indian economy are no

[4] Besides several papers published as chapters in books and journal articles one sets of papers (including those published) was widely circulated in 1996 to elicit comments, criticisms and suggestions for further work. Another similar set was circulated at a conference on the Project in September 1997. (IEG-DSE, 1996,1997).

longer as important today as they were during the sixties or even the seventies they still need to be borne in mind in the formulation of meaningful models.

From a theoretical view point the central question in modelling the Indian economy, though seldom explicitly posed, has been about the determination of the level of economic activity. All other questions are either relatively unimportant or hinge on how one deals with this one. This is so because an answer to this questions sets out the dominent mode of adjustment. Most of the models appear to be Keynesian in so far as components of effective demand are carefully modelled on Keynesian lines. But a closer probing reveals that in most cases the level of activity is supply driven. As a word of caution here it be noted that one is primarily talking about the level of activity outside agriculture. Very rightly, there is a concensus that in this (agricultural) sector the level of output is determined by available natural resources, particularly land area and water, capital stock and of course, technology. Again, quite justifiably, unlike in developed countries, capacity (or full employment) in the nonagricultural sectors is taken to be determined by the available capital stock rather than labour force. Following this and the implicit assumption of full employment (of capital) production function relating output to capital stock has featured prominently in most models. Labour is implicitly taken to be in excess supply at the prevailing wage[5].

Along with this, prominence is given to the consumption function, mostly following the Keynesian absolute income hypothesis as well as private investment behaviour mostly on the lines of the accelerator hypothesis. Government expenditure on consumption and capital formation are taken to be exogenously policy determined. Thus, we have in most cases, simultaneously a modelling of aggregate demand and aggregate supply. Aware of the likely mismatch between the two, researchers (e.g. Bhattacharya, 1984) have used different closure rules to overcome the problem. One has been to use inventory changes as the equilibrating variable. Clearly, this is done by treating inventory investment as a residual. This poses some theoretical and empirical problems.

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5. This may turn out to be unwarranted in specific sectors of the economy that require high level of skills.

With regard to the former it has to be noted that all changes in stocks cannot be taken to be unintended. At the same time separation of the intended and the unintended inventory investments is hard. At the empirical level there are two issues. *First* the magnitude of this variable is usually small so that to place the burden of economy-wide adjustment entirely on this variable is asking for too much. *Second*, what if the required decumulation of stocks is large and well in excess of the existing level of stocks. Moreover, it is well known that data on inventory investment are amongst the least reliable of all data in the national accounts.

On the other hand Pani (1977) and Ahluwalia (1979) try to explicitly model capacity utilisation to reconcile supply to demand. However, capacity utilisation is sought to be influenced by imports, raw material availability and public investment which represent different capacity constraints. Consequently, since variations in the aggregate demand have no influence on capacity utilisation, the level of activity remains supply (or more correctly, capacity) driven. It may also be noted here that quality of the data on capacity utilisation is hardly encouraging. In any case the series that Reserve Bank of India used to compile and publish stands discontinued since the mid seventies mainly because of its unsatisfactory quality.

As far as we are aware the only model which is strictly Keynesian with regard to the level of activity, somewhat with a vengeance, as it were, is the one I formulated nearly three decades back (Pandit, 1973). However, later studies [Pandit, 1985b, 1995] sought to restore the balance between supply and demand by permitting the level of output to be determined by either the capacity (what often gets wrongly termed as supply) or by demand using the short side rule. This study was intended to experiment with a rationing equilibrium interpretation of Keynesian methodology. But, the difficulty here is that one has to be careful about the appropriateness of the econometric methodology. Many, researchers have erred in using the same data set to model both demand driven as well as capacity driven output. This is clearly unwarranted. In any case, how short run supply should be modelled is to date an unsettled issue. A comparison between Agenor and Montiel (1995), sec. 3.4 and Taylor (1988), Ch.3 reveals not only the divide that

exists in macroeconomic theory but also between alternative perceptions of the way less developed economies function.

5. PRICE BEHAVIOUR

The next most important macroeconomic issue for modelling has been that of price behaviour. This has often been taken to be equivalent to inflation rate determination. But this is not strictly correct. The notion of an equilibrium price level in a comparative static context needs to be distinguished from that of inflation rate in a dynamic model. In the latter case one may talk of an equilibrium rate of inflation in steady state context or alternatively of a disequilibrium rate out of steady state. However the way models have been used and interpreted the difference has not been too serious because neither labour nor asset markets in their relation to inflation have figured prominently in any of the models so far. In fact most models have dealt with the price level and derived the implied inflation rate expost. Two notable exceptions to this have been Pandit (1978) and Bhattacharya (1984). In a paper exclusively concerned with inflation the former directly models the annual rates of change in sectoral price levels. The latter, focussed on public expenditure, specifies most variables including prices in terms of first differences of variables in logarithmic scale (e.g. $\Delta \log x_t$) which is the continuous version of discerete rate of change.

One major issue with which professional economists as well as policy makers have been equally concerned has been the relationship between money supply and the price level. The tradition has strongly favoured validity of the quantity theory of money amongst both academics as well as policy makers. An alternative formulation was suggested by Raj (1966) but well within the demand pull framework. Many studies during seventies have highlighted the role of cost-push factors, without ruling out the importance of the monetary factor. Some of these (Pandit, 1973, 1978) in fact suggest a structuralist explanation with a considerable emphasis on the price of food and raw materials originating from the agricultural sector. This mixed model has been further corroborated by many other studies like Bhattacharya (1984) , Krishnamurty (1985),

Pandit (1985a, 1985b), and , more recently Krishnamurty, Pandit and Palanivel (1995). At another extreme Balakrishnan (1992) has argued that monetary growth has no impact on inflation while not ruling out demand pull inflation. It is, in fact, the link between monetary expansion and demand which is questioned.

Typically, money supply per unit of real output has been used as a proxy for excess liquidity in the economy. The cost factors that have selectively been introduced in different models include, wage rate relative to productivity, administered prices of critical intermediate inputs as well as final consumer goods produced or marketed by the public sector. Though results have by no means been uniform, yet there has been a measure of concensus in favour of a mixed model. The exclusive structuralist explanation of inflation as used for many less developed countries particularly those in Latin America has, in fact not been found to fit India in view of its politico-economic structure. This has in fact been also the case with other Asian countries. A modified and milder version however appears to be relevant. It may be noted here that central bank authorities have remained committed to a monetarist position regarding price behaviour. The world view which has in recent years increasingly regarded price stability not only as the main target but also well within the achievement zone of central bankers has added further credibility to this position.

Two early attempts to get away from the standard quantity theory framework are those by Weintranb (1965) and Raj (1966). The former, in line with his earlier views used a pure mark-up on wage costs approach in case of India. Raj however took the alternative route of relating price changes to a measure of Keynesian inflationary gap. It is interesting to note that both of these approaches are well within the standard Keynesian set up except that one applies to a situation in which the effective demand is below the full employment level of output and the other to the opposite situation when effective demand exceeds full employment level of output. Two later studies which shifted the emphasis to the food sector besides following Weintranbs' mark-up model for the price of manufacturer have been those by Pandit (1973) and Chakraborty (1977). Both of these tended to de-emphasize the role of money without ignoring it altogether.

At this stage one must underline that this mixed supply-demand model of price changes and inflation cannot be easily fitted into any of the standard theoretical models. All the same the formulation can be justified in an economy where many prices are not market clearing due to their administered character. For instance, if interest rates are fixed below their equilibrium levels, as they have been in India till recently, to posit that the equilibrating process will work through the general level of prices is not entirely out of place. We may for example consider a rudimentary aggregate supply demand model as follows

$$M^d = f(Y, r, P)$$
$$Y^d = \phi(A, r, M/P)$$
$$Y^s = \phi(R, K, P, Q, W)$$

where Y is output, M is money supply, p is the general price level, r is the interest rate, A is autonomous expenditure. K, is the available capital stock, Q are administered priceswhich influence unit costs of production. W is the wage rate and R are the natural factors like rainfall. With given supply of money M the reduced forms for p and y can be expressed in terms of the exogenous variables : R, K, A, r, Q, W and M. Which of these variables may turn out to be significant is an empirical question. However, one exercise that tried to follow such analytics was undertaken in an unpublished paper (Pandit, 1986).

6. MONETARY AND FISCAL POLICY

Short run determination of the levels of output and prices bring into sharp focus the role of monetary and fiscal policies. Analytically the main and interdependent issues have been (a) modus operandi (b) linkage between the two policies (c) channels of causation and (d) degree of effectiveness. The extent to which these issues have received attention in the macroeconometric modelling has, as expected, varied with the size of the model. For developed industrial economies the most widely used fiscal policy instrument relates to direct taxes and typically to tax rebates which influence effective demand. But

given the predominence of the public sector in this economy as a corollary of the process of planned development the policy variable usually in focus happens to be government's current consumption expenditure and capital formation. Another distinctive feature of most developing economies including India's is the greater reliance on indirect taxation for revenue generation. This is of some analytical significance because the impact of direct taxes is more directly on the level of activity whereas indirect taxes would have a greater visible effect on the price level.

Some of the studies e.g., Bhattacharya (1984) and Bhattacharya et.al. (1994) which are exclusively focussed on government finances and related issues have a detailed model of government receipts and expenditures with most of the items endogenously determined[6]. This is to an extent necessary in the Indian context because government is a broad umbrella covering not only administrative departments but also departmental enterprises e.g. railways and public sector undertakings. In addition, government itself is not only the one at centre but also those in the states and union territories. Consequently it is hard to think in terms of one single well defined budget constraint. Analytically what is important is the public sector borrowing requirements resulting from a complex set of interactions and constraints[7].

Researchers have typically focussed on the central government budget and its monetised deficit. The latter feeds into the monetary base, along with the stock of foreign currency assets, providing a link to the money supply growth. The presumption, very right till recently has been one of monetary policy being subservient to the government's fiscal policy. It is only during the last few years that we have witnessed the emergence of a measure of autonomy for monetary policy. The IEG-DSE model which will be taken up later reflects this to some extent. It is important to draw attention here to the phenomenon of crowding-in associated with public investment in India. Following the evidence in favour of this by Krishnamurty (1985) the phenomenon has

[6] Pandit and Bhattacharya (1987) specifically developes a model to deal with a possible trade-off between inflation and growth.
[7] See Bhattacharya (1984) and Pandit and Bhattacharya (1987).

attracted attention in a proper understanding of the trade-off between growth and inflation.

By far the most elaborate treatment of India's money and credit markets has been by Pani (1977). The chief merit lies in his rich treatment of various institutional details which have been glossed over by most others. Since the monetary base has till recently hinged largely on fiscal operations and money multiplier has remained nearly constrant money supply has been subject to little control. In addition, if interest rate is administered monetary policy gets reduced to credit rationing. The way macroeconometric models have handled monetary submodel is a saga of frustration. The rate of interest in the money demand function either turned out to be statistically not significant or not of the right sign and frequently both. This is not at all surprising because there has never been a satisfactory proxy for the user cost of liquidity in the formal money market. At the same time lack of data has prevented researchers from pursuing modelling of interlinked formal and informal money markets. Some of us (Ahluwalia, 1979, Bhattacharya, 1985 and Pandit, 1973) relied on the bazar bill rate prevailing in informal urban markets half way between the intractable rural money/credit markets and the formal money markets. But this has only been a patchy solution to the real problem. Though Pani has a plausible endogenous explanation of a number of interest rates like the call money rate, bank rate, deposit rate, rate of return on variable dividend industrial securities and the average rate of return on commercial bank loans and advances, the equilibrium process in individual segments of and in the overall money market remains unclear.

7. EXTERNAL SECTOR

Finally, before we conclude this part of the discussion let us turn to the treatment of the external sector. While a large number of the early models argued that the economy could be treated as almost closed many of the later ones too had only a sketchy treatment of this sector. In fact, most of them only went as far as to explain merchandise trade flows. Flow of services and other invisibles needed to complete the balance of payments

story were hardly dealt with. Even in some otherwise good models only import values were endogenised. In some sense this is neither entirely wrong nor surprising. Under a regime characterised by fixed (usually overvalued) exchange rates, quota restrictions, heavy tariff barriers on imports, perceived export pessimism and so called rupee trade agreements, the scope for modelling the external sector was fairly limited. Nonetheless the recent years have seen the emergence of some detailed modelling of the external sector. (Virmani, 1991, and, Krishnamurty and Pandit, 1995). This aspect of the economy has assumed a considerable importance under the new policy regime.

From an analytical view point the major weakness of the earlier treatments of the external sector has been their failure to highlight the adjustment process. Typically, they succeeded fairly well in describing export trade flows and some times export unit values. One could very well argue that it is far fetched to think of equilibrium in the external sector. The question here is not whether equilibrium is attained but of how disequilibrium in the external sector exerts itself on the domestic economy. Moreover even policy makers in charge of administered prices and planned activities would have to keep an eye on the magnitudes of disequilibrium. There is reason to think that they have done so. That is in fact why even policy determined variables can, in a rough and approximate way be modelled empirically. It is necessary to state here that the problem in this sector has its roots in the fact that the overall level of economic activity does not obey an acceptable and clearly specified equilibrating adjustment process.

Two recent studies mentioned earlier put together fairly disaggregative models which face the problem of equilibrium directly by incorporating supply and demand functions for merchandise trade flows. While the structure in both is similar, Krishnamurty and Pandit (1995) offer a more comprehensive treatment. Employing a small open economy assumption import supply function is specified to be infinitely elastic at fixed import price in international currency. Exchange rate then determines the price in local currency. The demand for imports is determined by the domestic level of economic activity (gross domestic product and capital formation). For exports there is a downward sloping demand curve and an upward sloping supply curve. While demand

depends on world GDP and relative prices, supply is affected by both relative prices in international curency and domestic level of output. The model allows for a pass through effect and the effect of exchange rate on invisibles. This is in fact a part of a larger economy wide model which we shall describe subsequently.

8. THE PLANNING PERSPECTIVES

It is very pertinent to recall what two amongst India's most eminent economists had to say three decades back

> "... The question of fiscal policy also raises the entire question of short term planning ... which takes narrower horizon than five years, is essential in a country like India... Unfortunately there has been no serious attempt so far at building a relevant short term model for the Indian economy, which would permit the policy makers to take informed decisions ..." (Bhagwati and Chakravarty, 1969)

More recently, however Desai (1997) revives the question with an entirely opposite view that we shall take up subsequently.

Prima facei it does appear rather odd that planning which has, in fact, characterised the Indian economy till very recently and formally continues to do so, does not explicitly figure in virtually any of the econometric models. It is, however, important to recall that planning was largely concerned with investment allocation across sectors, carried out with the help of input-output models. A corollary of this, and an important one, was the gamut of price and quantity controls of different types.

Nevertheless, Desai (1997) is right in his criticism, with ample hindsight, that econometric models available so far are not of much use in dealing with planning issues. The fact that policy variables like investment levels and administered prices appear as exogenous variables in these models is not of much help. More specifically, Desai makes the point that since planning policy instruments and targets are set well in advance, these should have a bearing on the way in which the final outcomes materialise. The argument is suggestive of the rational expectations hypothesis but formulated quite differently. Apart from this it is true that most of the models did not adequately take congnisance of

the behavioural implications of a large number of price, investment and distributional controls that were in place in all sectors of the economy over the relevant sample period. It should however be quite clear that a proper specification and estimation of such a modes is by no means easy. A prototype extended model suggested by Desai for application to planning problems is as follows.

$$B_o\underline{y} + (B_1 - B_o)\underline{y}^* + C_o\underline{x} + (C_1 - C_o)\underline{x}^* = \underline{u}$$

which combines in itself a structural model $B_o\underline{y} + C_o\underline{x} = \underline{u}$ and a planning model $B_1 y^* + C_1 x^* = \underline{o}$. Dynamics can be introduced into both the models with no additional complication. y^* and y denote the target and actual values of the endogenous variables, whereas $\underline{x}^*$ and $\underline{x}$ are policy values and actual values of the exogenous variables. For some variables the starred and nonstarred values may be identical if these are not targeted or chosen policy instruments. The extended model would be the same as the familiar structural model if $B_1 = B_o$ and $C_1 = C_o$ or if $\underline{x}^* = \underline{y}^* = \underline{o}$. Both of these are perceptive. The first implies that planners do not have a separate model so that targets are indeed set on the basis of the known structural model. The second implies that there is indeed no planning in the sense that no targets or policy instruments are set. Setting out an agenda for econometric models that would be useful for planning purposes Desai likes such models to be able to help understand how

(a) planned targets affect the economy,

(b) differences arise between targets and realisations

(c) shortfalls in targets themselves influence the realised magnitudes.

Desai also argues for smaller models which focus on a dozen of strategic variables including, GNP, foodgrains output, wholesale price level, public and private capital formation, budget deficit, current account balance, foreign direct and portfolio investments, exchange rate, money supply and interest rate. The list is, of course, tentative and can be redrawn in view of the emerging economic regime. Since planning is now increasingly going to be confined to provision of infrastructure in the medium and

the long run, investment, productivity and output in this sector must get a high priority in any model with a planning orientation. Similarly, long run situation regarding environment and the structure of growth must find a place in any model with planning as its focus. One thing that is absolutely clear is that any such model built now would have to be vastly different from the one that would have been built even a decade back.

Desai is more specific in posing questions such as (a) Does public investment have a positive effect on growth (b) Is the current plan target growth feasible and (c) What are the alternative growth scenarios? How far the first two questions continue to be relevant under the present policy regime is a moot question. The third one is considerably important and can only be answered by a model which combines short term and medium term characteristics.

9. IEG-DSE MODEL

It would at this stage be of some interest to illustrate the state of the art with the help of a specific model. The IEG-DSE model that we describe subsequently is by no means the ideal or the best, one can think of. All the same, if we have chosen this model as an illustration it is because the IEG-DSE model, with its underlying database, is the only one we know that has been continuously updated, extended, used frequently for policy analysis, and regularly for forecasting, over the past decade. We also believe that since it has been subjected to frequent revisions its most recent version embodies the cummulative experience of a large number of researchers over the past three decades or more. We also believe that this model serves as a bench mark with reference to which future improvements may be implemented.

In its present form the model consists of 347 equations of which 211 are definitional and accounting identities including equilibrium conditions, 120 are estimated behavioural or technological relationships and 16 are estimated approximate identities intended to link different variables. The most distinguishing features of the model are twofold. *First*, as far as we are aware this is the most comprehensive macro-econometric

model of the Indian economy constructed from a remarkably rich data base consisting of time series on several thousand variables. Most of the equations have been estimated for the period 1970-71 through 1993-94. *Second*, as noted earlier, this is the only econometric model that has been maintained, updated and used regularly for forecasting and policy analyses.

In dealing with the level of economic activity and related variables the model disaggregates the economy into five sectors namely, agriculture, manufacturing, infrastructure, services and public administration. Each block determines endogenously, the corresponding value added, private capital formation and relevant wholesale price level, implicit deflator for value added and capital formation. Production is specified in the form of capital productivity. This is accomplished in five blocks of equations each for one sector.

Block
Agricultur
Manufactu
Infrastruc
Services
Public Administ
Consump Saving Related Variable
Public Fi
Money Interest
Trade &
Macro Aggrega
Total

on food
househ
physica

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Size and Structure of the IEG-DSE Model

Block	Estimated Relationships		Identities	Total
	Technological and Behavioural Equations	*Linking and Trend Equations*	*Definitiomal and Accounting*	
Agriculture	16	2	18	36
Manufacturing	10	1	12	23
Infrastructure	8	0	11	19
Services	8	0	12	20
Public Administration	5	0	6	11
Consumption Saving and Related Variables	9	0	23	32
Public Finance	18	5	20	43
Money and Interest	20	1	5	26
Trade & BOP	25	4	70	99
Macro Aggregates	1	3	34	38
Total	120	16	211	347

In the sixth block real private consumption expenditure is disagregated into that on food beverages and tobacco and durables. Private savings are disaggregated into its households and corporate components. The former are furhter divided into financial and physical shares. The sub model relating to the public sector finances seeks to determine

direct taxes, seperately on households and the courporate sector, components of indirect taxes corresponding to customs duties, union excise and other duties besides other receipts. On the expenditure side the model determines government final consumption expenditure, and the magnitute of interest payments, subsides and current transfers. There is a separate treatment of railways, communications and non departmental undertakings. The purpose is to determine total public sector savings and the overall resource gap (or, public sector borrowing requirement) and real public sector capital formation and the pattern of public sector borrowings and liabilities.

The monetary block is concerned with the determination of money supply, using the money multiplier-high powered money formulation, commercial bank deposit rate, SBI advance rate, average prime rates of major term lending institutions, dividend rate of UTI and a weighted average of interest rate on government borrowing. Other major endogenously determined variables include scheduled commercial banks investments in government and other approved securities, food and nonfood credit by commercial banks, and, sanctions and disbursement by term lending institutions.

The trade block which turns out to be the largest due to the need to include a large number of identities to relate external and domestic variables under different currency denominations in both current and capital accounts. Merchandise trade flows, both imports and exports, are disaggregated into four components namely, edible products, materials, POL products and manufactures. Invisibles which include services are treated as a single aggregate. The model also determines export and import unit values for each category of merchandise, net foreign exchange assets with the RBI, exchange rate of the rupee vis-à-vis the US dollar and external debt.

The last block of equations builds up a large number of macro economic aggregates whose components are determined in different block of the model. This includes real GDP, overall wholesale price index, implicit GDP deflator, consumer price index, private disposable income, total capital formation among others. In conclusion it is important to note that the model is simultaneously driven by both aggregate demand as

well as capacity creation in addition to natural factors and international economic developments.

Earlier versions of the model have been extensively used for both forecasting as well as policy analysis. The model has on the one hand stood on its own and on the other served as a component of the World Project LINK system. Forecasts and other policy analysis results based on the model have regularly been presented to the spring meetings of the Project LINK at the United Nation (in March) and the fall meetings at other venues (in September) every year for over a decade. We are happy to report that forecasts with respect to the rates of real GDP growth as well as inflation have been quite accurate. Those relating to trade and current account balance have been less satisfactory but better than any alternative forecasts. The model has more specifically been used to analyse the emerging trade scenario and price behaviour. These have taken shape as published work some of which is cited in this paper.

The completely exogenous variables in the model are an index of rainfall reflecting its quantum and distribution over time and space, international prices, world exports and the level of activity in the middle east, population growth, domestic production of crude and the Libor rate. Monetary policy variables include bank rate, cash reserve ratio an statutory liquidity ratio. Fiscal variables of importance are the level and intersectoral distribution of public investment. Those that are related to the external sector as well as to public finance are tariffs on imports, subsidy on exports. Other important policy variables include administered industrial prices including those of petroleum, agricultural support and procurement prices. Exchange rate can be treated either as endogenous or exogenous. Equations may be used link some of the variables to other economic indicators in case of forecasting but for policy analysis they can be taken as exogenously determined.

10. SOME CONCLUDING OBSERVATIONS

Though construction and maintenance of comprehensive economy-wide econometric models is no longer high on the academic agenda in the developed world it does attract much attention from the government and the corporate world. It would not be an exaggeration to say that this activity is of considerable interest even to professional/academic economists in the developing countries where the macroeconomic structure of the economy is yet to be charted and understood. In these countries the demand and relevance of policy modelling is certainly on the increase under their new policy regimes. Needless to add that such models have to attain a level of credibility by keeping pace with changing policy perceptions, macrotheoretic paradigms, better data availability and more refined econometric methodology. Improvements in computer hardware and software do render the job less daunting.

Given the existig state of the art and the need for its continuation, further work on econometric modelling must move in the following directions. *First*, this should be an ongoing activity. Models need to be frequently revised and updated in order to remain useful. To identify gaps and limitations of any models they should also be used frequently for policy analysis and forecasting . This has seldom been the case so far. *Second*, for an indepth understanding of the functioning of the economy and meaningful policy modelling effort must go into developing submodels for specific sectors in a way that these can be used on their own as also be able to serve as components of a larger system. Apart from agriculture, industry and some other sectors which have received attention so far, the harder job of modelling labour and capital markets needs to be taken up as far as data permit. How to deal with the informal components in each sector of the economy is a harder problem but one that must figure in the future agenda.

Third, it is time that an attempt is made to utilise the higher frequency data base. A beginning must be made with quarterly models. For specific segments of the economy monthly data too can be usefully utilised. This work can proceed on a parallel basis along with that on annual models. *Fourth*, modelling work must now make use of the

recent developments in econometrics to make the methodology more rigorous. Time series analysis would be the highest priority in this context because it will considerably enrich these models in terms of both methodology as well as the final outcome. A greater effort must be made in refining modelling work in the light of the available theory. One item that needs to be taken up seriously is the way expectations are handled and built into models, wherever relevant and feasible. Clearly, price and exchange rate formation and financial submodels can be taken up right away in this context.

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