A Note on the Problems Facing Macro-econometric Model Building in Developing Economies: The Case of Sudan

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Abstract

This paper sets out to address the problems facing macroeconomic model building in developing economies Intricacies and deficiencies of datasets for most macro-variables result from an amalgam of debilitating factors It reflects a variety of related problems. As a consequence, it is rather difficult to single out specific problem that has a single solution .The wide gap between econometric theory and econometric practice should be a cause for alarm in developing countries. Hence this paper underlines the urgency of a form of collaboration and coordination between the various bodies making up the National Statistical System (NSS). Both national and international credible support and effective assistance is urgently needed. In the absence of such support, one has a less sanguine view of the capacity of data producers, in particular, to rid the difficulties involved. While huge efforts are exerted to specify and estimate macroeconomic models for developing economies, their usefulness is quite limited attributable to data deficiencies - data that lack objectivity and comparability. For adequate modeling, the paper concludes that model builders should critically probe data sets in order to correct their deficiencies before their ultimate use.

Keywords: Modeling, Metadata, Methodology, Aggregation, National Statistical system, Comparability.

(1) Introduction

Over the past sixty years or so, a range of contributions endeavor to develop sound macro-econometric models to explain the apparently anomalously weak progress of the Sudan economy. These models have all multi-equations structure; their specifications involve large numbers of endogenous and predetermined variables. This paper purports to question the validity and reliability of data sets underlying these variables, rather than the models capabilities of capturing the various characteristics of developing economy or serving the intended purposes for which they are formulated. Consequently, this necessitates a shift in focus from the sheer technicalities of econometric model building to the deficiencies and methodological problems associated with datasets in a developing economy. Consequential upon that, the emphasis of the paper is entirely on the questions of quantifications, measurements and controversies arise in terms of sources, methods and institutional inadequacies. Data deficiency transcends from more collections of the required datasets to conceptualization and methods of aggregation.

Against this background, the paper addresses both producers and users of data. Producers of data need financial assistance at both national and international levels to enhance validity and reliability. On the other hand, users of data, specifically model builders, are advised to examine the metadata (definitions, sources, methods etc……), such information will enable them to evaluate the appropriateness of the data for their own designated purposes.

The importance of such evaluation stems from the fact that the quality of the empirical results and the policy implications based on them depends to a considerable extent on the quality of datasets as a crucial ingredient in model building. Hence, informative data is urgently needed to assess the strength of the model results and gauge their uncertainties. Overlooking data quality could precipitate devastating policy strategies, and distorted development plans and programs based on erroneous empirical findings.

(2) Methodologies and Approaches Used for Macro-econometric Building

The methodology of simultaneous equations model buildings as conceived and elaborated by the Cowles Commission since the forties underwent numerous developments. This methodology imposed the probability approach in the sense that a precise stochastic model capturing the basic feature of the investigated phenomena should be specified as well as the stochastic mechanism that generates the data set. A unified theory of estimation in the presence of prior information to increase the precision of the estimated parameters had also been introduced. The small sample properties of the simultaneous equations estimators had, also, been probed, in addition to the presence of non-linearties. New models had been specified to explore new emerging situations and new types of data. In spite of all these enormous developments initiated by Cowles Commission with respect to the econometric methodology, still the great bulk of recent research levels criticism against traditional macro-modeling based on the Cowles Commission approach. The basic arguments underlying this criticism are well documented in the literature in terms of six aspects, namely:

- Forecasting inadequacy.
- Theoretical contrasts with rational expectation theory.
- Structural stability (Lucas critique).
- Arbitrary assumptions of zero restrictions.
- Endo-exogenous division of the model variables in order to satisfy identification conditions
- The existence of the problem of unit root and ignoring of time series properties.

Introducing a new set of challenges pertaining to policy analysis, Lucas critique opens a new domain of research which is referred to as analysis of "Deep Structural Parameters". The complex and often contentious economies of market, led to criticism of Cowles Commission approach which is based on the structural multi-equations modeling. As a consequence, three methodological alternatives are suggested by Sims (1980, 1982), Leamer (1983) and Hendry (1991). In Sims theoretical Vector Autoregressive (VAR) model, there is no discernment between an endogenous and exogenous variable. Its' major flaws are the problems of "over-parameterization, interpretation of individual coefficients and the resultant multicollinearity. For a developing country, the choice for appropriate lag length is a central challenge due to the rather shortness of annual time series and the complete absence of monthly and quarterly data for most macro-variables. The interpretation of coefficients is sometimes overcome by estimating the impulse response function (IRF). This requires the tracing of shocks in the error term; it is rather difficult to identify the source of such shocks in a developing economy. For instance, the magnitude and extent of dominance, dependence and susceptibility to international relations is quite considerable for developing countries. The complexities of international relations are quite intractable.

The concept of exogeneity is redefined in Leamer's methodology to which Lucas critique does not apply. Leamer tries to convey specific message as Boldkin, Klein and Marwah (1986) are noticed, namely: judgment and economic intuition is needed for macro-econometric modeling. However, sound judgment requires stable economies characterized by smooth functioning systems. This might be true for developed economies. However, this is rather lacking and far-reaching aim for developing economies. Those economies are quite vulnerable; forces entirely outside their control can have decisive and dominating impacts on the stability of their economic systems. On the other hand, "the general to specific modeling approach" as suggested by Hendry requires extensive specification. Through the use of a battery of diagnostic tests based on forecasting performance and residuals, the most adequate specific model could be obtained. Despite these significant development in the different aspects of the methodology of macroeconomic modeling which, in particular, help in better understanding the complexity of the specification process and in providing valuable guidance to it, still one doubt their relevancy and suitability for a developing economy given the inherent distinctive features of these economies besides the uncertain and perilous data sets for most macro-variables. The applicability of such methodologies requires improved data quality in order to convert the uncertainty, originated mainly from huge discrepancies in data sources, measurement errors among others, into manageable risks that the model builder might be able to handle.

Hendry's general to specific approach needs extended time period to allow for dynamic structure. A general specification might include lags up to the fifth order. Such sort of data is not available in developing countries.
Klein (1965) claimed that macroeconomic modeling could be appropriate for a developing economy provided that specific modifications are produced. Be that as it may, still the availability of data and its frequent revisions are major restrictive factors. Critics of model building for developing economies fret incessantly over that aspect. Model builders should be more attentive to data quality. The challenge facing model builders is not only to comprehend the functioning of the economic system and to identify its basic features but rather how to manage the data deficiencies. The message here is very simple, but it is striking how often it is overlooked. One wonders why adequacy of model building, relevant to data requirement, does not provoke intense passion in developing countries either in their defense or opposition.

(3)Sudan National Statistical System (NSS)

Supposedly, the national statistical system (NSS) of any country should comprise, as constituent parts, the following entities, UNDP (2012):
- Producers of statistics.
- Users of statistics
- Suppliers / providers of data items.
- Statistical training institutions / centers and research institutions.
- The civil society and media.

All of those entities should collaborate as a team. For the purpose of this paper, emphasis will be laid on the Sudan Central Bureau of statistics (CBS) as the major body responsible for the production of macroeconomic data, besides Sudan Central Bank and the Ministry of Finance and National Economy. Most macroeconomic models for the Sudan were built around the national income identity. Datasets concerning national income and its various components are produced by the CBS. The question that should be posed: does the Sudan CBS is well equipped and qualified to deliver the required data for a proper modeling of the economy. We are skeptical due to a host of debilitating factors: firstly, despite the fact that the prevailing Statistics Act of 2003 assigns the CBS the function of establishing and promoting a national system of statistical information, the constituent components of this system and its subsystems are not yet shaped into a full-fledge, solid form. How one coordinates and integrates un-solidified entities and their interrelated functions. Secondly, the functions assigned to the CBS are the collection, processing, analysis and dissemination of integrated statistical information, in addition to act as a coordinating, monitoring and supervising agency for NSS as pointed out earlier. The question here, does the CBS has the required capabilities to perform such functions? The central observation of those who studied the prevailing conditions surrounding Sudan CBS is in nutshell: there is complete absence for formal coordinating bodies; its relation with other data producers and users is effected through transient channels, such as ad hoc committees, task forces, workshops and seminars. Coordination among producers of data is one of the ten principles advocated by the United Nations in 1994 so that National Statistical Systems achieve consistency and efficiency. Hence one fundamental limitation of the NSS in Sudan is the absence of cohesive statistical coordination. Collaboration and coordination among data producers and users is required to:

  - Pool resources to minimize cost.
  - Prevent repetitive tasks that reproduce the same data sets.
  - Avoid disparity between measures.
  -Generate better data for development.

The challenges facing the CBS in Sudan are subject of intense and on – going debate. Knowledge of these challenges is vital to fully understanding and solving the formidable hindrances for producing high quality datasets. Nevertheless, those are not esoteric challenges reserved only for the Sudan but face most developing countries. The challenges are multifarious and some of them require a flash insight to confront and solve. Others are attributable to different causes, but they can be massed together in one major cause: "Lack of resources", in form of staffing, infrastructure and funding .The rest pertains to the inadequacy of organizational structures and institutional arrangements and the ill coordination within the CBS and of the entire NSS. A number of coherent strategies are designed by experts to face these challenges in the National Strategy for the Development of Statistics (NSDS) in Sudan (2012 – 2016). The document of the strategy, justifiably, pointed out that these challenges should be addressed in a holistic and strategic manner. The strategy is now awaiting implementation. The experts are still in the process of setting action plans.

A more searching exploration and rigorous assessment is required in the future to judge the ultimate value of this strategy and to discern whether its set targets are fully realized or not. A realization of the strategy will lead to improvement in data quality, hence, might stimulate and encourage macroeconomic model buildings.

(4) Data Problems Confronting Model Building in Developing Economies:

Despite the fact that almost all macro-economic modeling for developing economies conform strictly to the steps of econometric methodology in their construction , their inherent inadequacies originate somewhere else , namely , the domain of data. In view of their use of annual time series data, all kinds of data problems reign in full force in the different stages of model building namely: specification, estimation, evaluation and forecasting. To be more specific, absence and paucity of data for certain key variables might have adverse effects on correct specification. Estimate of the parameters may be poor due to measurement errors particularly if they are not white noise. Future observations of some explanatory variables (endogenous or predetermined) used for forecasting may be inaccurate due to frequent revision of data. These data problems, in turn, undermine the explanatory and forecasting powers of these models. Model builders in developing countries are usually satisfied and content with the obtained empirical results in view of their conformity to the acceptable technical criteria of model evaluation. However, they soon discover that beneath its dubious technical veneer, model evaluation is not sufficient when it comes to the application of the model. That is to say, despite the statistical and econometric plausibility, the performance of the model is quite poor. Having pointed that, there is no intention to ridicule the econometric methodology. We just claim that the problem is entirely due to the fact that the quality of data does not fit the econometric techniques used, quality here could be defined as fitness for use. To substantiate this claim three models of the Sudan economy are selected. As a matter of fact, a number of models are built for the Sudan economy, sectoral and non- sectoral. The selected models are the only published ones, namely: Marzoug(1975) Model ,Mohamed-Ahmed and Fadlalla(1985) model, Mohamed-Ahmed et.al(2012) model. The estimation periods of these models range over the year 1955 to the year 2005 with different sample size for each. Three statistical and econometric criteria for evaluation, common for the three models, are reported in tables (1), (2) and (3).

Table (1): Coefficient of multiple determinations in different models

Models	Below 0.7	0.7 – 0.79	0.80 – 0.89	0.90 – 0.99	Total
Marzoug					
No of equations	5	7	4	4	20
Percentage	25	35	20	20	100
Mohamed – Ahmed & Fadlalla					
No of equations	1	1	2	6	10
Percentage	10	10	20	60	100
			s	Mohamed – Ahmed & other	
No of equations	5	–	4	5	14
Percentage	36	–	28	36	100

Source: Compiled by authors.

Table (2): The evidence of first order serial correlation of disturbance

Models	The hypothesis of zero auto correlation of disturbances is accepted at		The hypothesis rejected At Either level	The Test Is Inconclusive	Total
	50% Significant Level	1% Significant Level			
Marzoug					
No of equations	10	6	2	2	20
Percentage	50	30	10	10	100
Mohamed – Ahmed & Fadlalla					
No of equations	4	1	1	4	10
Percentage	40	10	10	40	100
Mohamed – Ahmed & others					
No of equations	7	4	3	–	14
Percentage	50	29	21	–	100

Source: Compiled by authors.

Table (3): T – value of the regression coefficient in different models.

Models	Class Intervals for the t – value				
	Below 1	1 – 1.99	2 – 2.99	3 and above	Total
Marzoug					
No of Coefficient	2	19	11	32	64
Percentage	3%	30%	17%	50%	100%
Mohamed – Ahmed & Fadlalla					
No of Coefficient	1	1	6	15	23
Percentage	4.5%	4.5%	26%	65%	100%
Mohamed – Ahmed & others					
No of Coefficient	–	–	4	42	46
Percentage	–	–	9%	91%	100%

Source: Compiled by authors.

Most of the results are statistically and econometrically plausible. However, when one examines whether their intended purposes are served or not, the weaknesses of the models become quite apparent given the time frame of their specification and use. For instance Mohamed-Ahmed and Fadlalla (1985) model fails to give rather precise forecasting for the endogenous variables. This failure can be attributed unequivocally to the poor quality of the data due to successive revisions and the instable character of the economy during both the estimation and prediction periods. The World Bank Group in collaboration between staff from ministry of Finance and Economic Planning, Sudan Bureau of Statistics and Central Bank of Sudan developed recently: "Sudan Macroeconomic and Fiscal Model ''. The model is a classical Klein type or Cowles commission type model, similar in structure and design to global models such OECD's interlink model, the IMF's MULTIMOD model, the UN's Project link model and the Federal Reserve's model. The model consists of 212 equations both behavioral and identies. Most equations are estimated by using one – step error correction approach of Wickens and Breusch (1988) over the period 1970 – 2015 depending on data availability. The front end of the model consists of an excel user interface to facilitate operationality and assessment of its properties. The model basic objectives are either to forecast or to implement policy shocks.

The model almost captures all salient features of the Sudan economy and quite operational in tracing the transmission mechanism of both endogenous and exogenous shocks. Hence, providing the potential for better understanding the intricacies of the feature performance of the economy. However the model builders claim that for a better forecast the model requires high frequency data used as portents or signals to give a sense of the direction of the economy. That is, high frequency data to be used as leading indicators. Unfortunately, such leading indicators involve certain problems: they are not always accurate; the extent of time between the change in such high frequency data and change in the forecast series neither is rarely consistent nor gives much information about the magnitude of the change. In addition to careful monitoring, another one way out, could be a construction of a cohesive index from such high frequency data to eliminate randomness and volatility and ensure accuracy. It might also be noted that the demographic aspects are introduced in the model in an implicit manner through definition of certain variables on per capita basis. Explicit introduction of certain demographic aspects is imperative for a country like the Sudan with high population growth and almost open borders for immigration. Not only does population growth and immigration produce continuous increase in the demand for consumer goods and investment expenditures [i.e., the demand block in the model], it also expands the labor force of the country.

For the specification of an adequate model and effective procedure to preserve operationality of the model, prior assumed values are assigned to certain parameters to cater for specific situations. For instance, the sum of parameters in Cobb-Douglas production function is assumed equal one, the emerge situation, as a consequence of such assumption, characterizes constant returns to scale production activity for certain sectors of the Sudan economy. However, no concrete evidence is readily available to substantiate such a claim; the emerged situation could only be justified as part of specification search process. The assumed values for such controllable situational parameters offer challenges to the model builder skills in relation to how knowledgeable and familiar with functioning of the economic system under consideration. At the same time it offers opportunities, as it adds flexibility to the specification search process that might augment model adequacy, and hence predictability to help suggesting the best economic policies that should be pursued.

The model was used by the ministry of Finance and Economic Planning to assist in the preparations of the prevailing government budget _ fiscal year2017 and to act as a reference and guidance framework for its implementation. It is rather earlier to assess the performance of the model and its value in this endeavor. The challenge for the model builder in a developing country is not only to understand the functioning of the economic system and to be familiar with econometric concepts and methods, but rather to identify the problems and controversies surrounding the data and their impact on its characterization through modeling. Those controversies arise mainly from:

- Lack of transparency in sources and methods. Data in certain cases are collected to propagandize specific claim e.g. reduced rate of inflation.
- Lack of information about metadata.
- Presence of the aggregation problem.
- Disagreements in conceptualizations and definitions of variables.
- Different sources of data for the same variable e.g. GDP, the so – called comparability problem. This led to difficulty in interpretation of the discrepancy among them in terms of the magnitude and direction of bias.
- Data based on surveys with wide coverage in a country like the Sudan with huge cultural divergence, introduce measurement errors mainly attributed to design, semantic and cultural influences, for example, the construction of the consumer price index based on urban and rural markets.
- Complete absence of data for certain variables e.g. output of the traditional sector, wage, labor and employment series in Sudan.
- Lack of staffing, funding and infrastructure for data producers.
- Data from different sources are sometimes combined into a single table; such a practice might lead to misleading results and conclusions, the so called Simpsons' Paradox. This Paradox might not be directly related to model building, but could be of relevance in the discussion and analysis of the model results if compared with table results compiled from combining several sources.

(5) Implication of Data Problems for the Specification and Estimation of a Model

Inadequacy and lack of statistics is one of the major problems for building a macroeconomic model for a developing economy. The inadequacy of data compels model builders to construct their own series. For instance, the economy of Sudan is dichotomous; a traditional sector coexists with a modern sector. Traditional output is constructed overtime by making arbitrary assumptions. How sensitive are the results to these assumptions is rather difficult to tell. Obviously, some bias will be introduced in the estimates. Moreover, absence of time series for some equations for answering specific questions of serious consequences. The most apparent consequence of such a situation is a serious misspecification of some of the structural equations through omission of important explanatory variables, leading to serious specification errors. In general, both the inadequacy of the data and the fact that the model builder could not go beyond its boundaries and overcome its shortcomings greatly circumscribed the range of alternatives approaches for model building e.g. Vector Autoregressive, Top – to – Bottom, the Orthodox approach etc. Consequential upon that, compromises, concessions or approximations are imposed. Thus limiting the capability of model builders in judging how deficient the emerged data and how this deficiency affect analysis and interpretations of the empirical results. There are, also, some problems relating to data comparability as pointed out earlier. Data in Sudan suffers from comparability overtime, because the coverage of statistical series tends to improve with economic development. Producers of data in Sudan and most developing countries are less capable of making the necessary adjustment in alignment with this improvement , see Jerven (2013), Deaton and Heston(2010). The capability of the CBS in Sudan, as major producers of data, is hindered by many factors, see section (3).

Furthermore, the comparability problem arises from the adoption of different definitions and concepts in compiling data by the various domestic statistical units comprising the NSS in Sudan and other foreign agencies. For instance, there are different sources for the GDP either nationally or internationally. If one looks at the Sudan GDP compiled by the domestic sources: CBS, Bank of Sudan and Ministry of Finance and National Economy, on one hand, and the international database for other developing countries e.g. World Development Indicators, the Penn World Tables and database of Angus Maddison, on the other hand; the discrepancies among the figures are quite noticeable. Such incomparability is more serious in time series analysis owing to the fact that it is likely to change over time both in terms of its nature and magnitude. The controversies surrounding model building for a developing economy arise partially from the aggregation problem.

Aggregation is quite serious for model estimation whether temporal or spatial or over individuals or commodities. Statistically, it is difficult to assume that the errors in each variable have zero mean and independent of the variables incorporated in the same or even different equation. Consequently, a situation might be created in which some of the repressors are correlated, thus casting doubt on the advisability of assuming measurement errors in aggregate time series to be independently distributed [Denton, F, T and Kuiper , J (1965)]. Further, the presence of the aggregation problem makes it rather difficult to capture the impact policies on relative prices. Furthermore, in a multi-sectoral model flows among sectors might be enfeebled by high level of aggregation. There might seem nothing terribly impressive in establishing whether a data is characterized by a trend due mainly to persistent movement in prices in most developing countries. However, it is worthwhile to find out whether the series are characterized by a trend or not in order to trace the source of multicollinearity which might arise and to investigate its destabilizing effects on the model. Apart from that, a trend might render a time series non-stationary which exacerbates the situation even more.

(6) Concluding Remarks and Recommendations

The paucity and poorness of data in developing countries compel model builders to construct their models under severe conditions precipitating the following technical problems:

- Models are constructed under severe constraints of limited availability of data, mostly compiled annually, hence, leading to serious reduction in degrees of freedom and diagnostic testing.
- Misspecification of some of the structural equations might occur through omission of pertinent repressors causing serial correlation among the successive values of the disturbance term , thus , vitiating one of the basic assumptions upon which the optimum properties of least squares techniques rests.
- Severe multicollinearity problem might arise due to measurement errors and other sources of data deficiency which means that the information contained in the data sets are not rich enough to allow solving the problem, leading to destabilizing effects.
- Aggregative time series have a strong trend component and therefore are highly collinear; the use of such variables as independent regressors might raise interpretation problems. On the other hand, the trend component might render the variables non-stationary as pointed out.
- The formidable obstacles presented by data requirement compel specification search for the most adequate model, this might eventually lead to the reprehensible problem of data mining.

The above set of problems cast doubt on the applicability of sophisticated econometric technique with their highly developed computer packages to the kind of data available for a developing economy. Nevertheless, understanding of the economic process of these developing countries might improve through time with the improvement in the quality of data. The alternative, of course, is to abandon all hopes of quantifying the economic relationships of these developing countries. The exercise is worthwhile for it highlights the particular areas in which the data collection efforts for model building need to be strengthened. Hence, the intent of the paper is not to disparage the econometric methodology but rather to draw attentions to specific problems surrounding econometric model building for developing economies. In contrast to Angrist and Pischke (2009), we believe that sophisticated econometric techniques are quite valuable, but their implementations require improved data quality.

Based on the above observations we made about data sets in developing countries, we recommend that these datasets should not be taken at face value by model builders. To a considerable extent, the compiled data is the result of preliminary estimates or projections that lack rigid theoretical basis, sometimes, even guesswork and a product of less transparent methods of measurement and aggregation. Diligent investigation of this data by model builders is of utmost significance and it should be part and parcel of the pre-specification stage of model building, hence understanding the nature of the data problems for developing adequate macroeconomic model is fundamental. With such understanding comes the ability for using the model to predict and control. In addition, we recommend that credible support, both nationally and internationally, is urgently needed, in particular, for the producers of data in terms of staffing, funding and state – of – the – art infrastructure, for instance, Local Area Network (LAN) and Wide Area Network (WAN), GIS maps , Tablets , among others, to boost statistical capacity building. Use of modern tools and techniques of management is required to augment efficiency and effectiveness of the NSS.

In general, validity, reliability and availability of data are not only essential for technical sound model building for a developing economy, they have, also, substantial impact on the well – beings of inhabitants through inclusive, dynamic economic policies aiming at equitable shares of growth and improved development plans and programs based on refined, elegant macro-econometric model building.

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