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Modelling reality: A short history of selected Philippine macroeconometric models

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DISCUSSION PAPER SERIES NO. 2018-39

Modelling Reality: A Short History of Selected Philippine Macroeconometric Models

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Philippine Macroeconometric Models

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Abstract

This scoping paper aims to present a summary of the past and present macroeconomic models of the Philippine economy. This paper looks at the various approaches and methodology used in modelling the economy. The various approaches were compared and contrasted in order to find the best possible way to model the Philippine economy. The strengths and the criticism of each model is also highlighted. In particular, the Cowles Commission Approach, the LSE Approach, and the General Equilibrium method was discussed and evaluated. From the literature review, it appears that there is a need for a new model for the Philippines considering only one model is actively being used for policy simulations. The development of a new macroeconomic model is also consistent with the needs of the major macroeconomic policy making bodies of the State (NEDA, BSP, etc.) to conduct macroeconomic surveillance, analysis and policy simulations.

This scoping paper aims to trace the evolution of macroeconomic modelling approaches in literature. In particular, the Cowles Commission Approach, the LSE Approach, and the General Equilibrium method are discussed by focusing on the theoretical underpinnings and assumptions of and criticisms on each model. The paper also provides a summary of the past and present macroeconomic models of the Philippine economy and highlights the strengths and criticisms of each model. The stock-taking indicates that there is a need for a new macroeconomic model for the Philippines considering that the only active model lacks further details on the real sector and is intended to address policy questions in the monetary sector. The development of a new macroeconomic model is also consistent with the needs of the major macroeconomic policy making bodies of the State, such as National Economic and Development Authority (NEDA) and the Bangko Sentral ng Pilipinas(BSP), to conduct macroeconomic surveillance, analysis and policy simulations.

Keywords: Macroeconomic model, Philippines, Error-Correction Model, modelling, econometrics

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Modelling reality: A short history of selected Philippine macroeconometric models

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1. Introduction

The Philippine Development Plan for 2016-2022 (to be referred to as PDP 2016) identifies several strategies that need to be implemented in order to improve the ability of the fiscal sector to promote development and inclusive growth. One of the particular strategies identified involves improving the existing capacity of the major macroeconomic policy making bodies of the State (NEDA, BSP, etc.) to conduct macroeconomic surveillance, analysis, and policy simulations. In order to do so, the PDP 2016 highlights the importance of pursuing regional and international cooperation in order to achieve a fiscal sector that can craft responsible and supportive policies in the coming years.

With this in mind, this paper contributes to the discussion by jump-starting the development of a new macroeconomic model that takes into account the emerging needs of the policy planners. In order to do so, this paper will begin with a present inventory of the existing macroeconomic models in the Philippines. The initial study will serve as the first step in the construction of a macroeconomic model for the Philippines. The model will be done through a partnership between the Philippine Institute for Development Studies (PIDS) and the Bangko Sentral ng Pilipinas (BSP).

Section 2 of this paper will review different approaches in macroeconomic modelling as described in literature. The discussion will begin with the Cowles Commission Approach. The discussion will also touch upon the other existing approaches in model building like the London School of Economics approach. There will also be a discussion on the various types of General Equilibrium (GE) Models, from the Computable General Equilibrium (CGE) models to the Dynamic Stochastic General Equilibrium (DSGE) model.

Section 3 of this paper contains an inventory of the existing macroeconomic models in the Philippines. This part of the paper summarizes the previous reviews and inventories of macroeconomic models in the Philippines. In particular, this paper will briefly discuss the reviews done by Velasco (1980) and Bautista (1988) on the pioneer models of the Philippine economy. The discussion will then proceed to summarize the work of Yap (2002) in describing the models from the period 1990-2002.

Section 4 of this paper enumerates and describes the status of macroeconomic models of the Philippine economy still in use today. It covers models designed from 2003 to the present.

Section 5 of this paper plans the development of the PIDS-BSP Philippine macroeconomic model, its status and the future plans for the model.

¹ The first and second authors are senior research fellows; the third and fourth are research fellows; the fifth is a supervising research specialist; the last four are research analysts. All authors are from the Philippine Institute for Development Studies.

2. Evolution of macroeconomic models

A macroeconomic model is a specific subset of economic models that is used in quantitative analysis of economic policies. For ease of discussion, Yap (2002) differentiates between macroeconomic models (MEMs) and computable general equilibrium (CGE) models. It should be noted, however, that both models may have characteristics that are not exactly macroeconomic in nature. Most MEMs attempt to answer specific macroeconomic questions, with some models preferring to only concentrate on a few variables of interest (inflation models, etc.) On the other hand, CGE models take pride in their microeconomic foundations in establishing the decision rules of the household. The resulting aggregation of household decisions then determine the levels of the macroeconomic variables.

Economic modelling began in the 18th century. French scientist, F. Quesnay constructed the “tableau economique” (economic tables) with output, employment and other variables. At the end of the 19th century, economists attempted to national economic accounting. Three trends emerged from formalizing national economic accounting.

General equilibrium analysis was developed by Leon Walras. It answers Antoine Augustine Cournot’s question on whether an equilibrium should exist in all markets simultaneously. Cournot was able to show that although prices will be able to equate supply and demand in a single market, it is unclear if the same result can be expected to hold in all markets at the same time. Walras’s Law implies that the sum of excess demand in the market must equal to zero. Thus, in a n -good market, $n-1$ markets clearing will imply clearing of the last market (Friedman, 1955).

From this stepping point, general equilibrium analysis describes the national economy as a system of equations that explains the behavior of economic agents, with the price being set by equating demand and supply. The economy is assumed to be purely competitive when in static equilibrium. The system is expected to contain several million equations, one for each type of good. This scope makes estimation challenging and impractical.

Business cycle model analysis was developed between 1933 and 1935 by Ragnar Frisch and Michal Kalecki. Both of their works give a major role to the investment function in describing the national economy. The initial level of fixed capital and the interest rate determines the level of investment in the system. This specification resulted in the model exhibiting oscillation and cyclical behavior. The next model builder to follow in this approach is Jan Tinbergen. He built models of the Dutch and US economy in 1935 and 1939, respectively. Cyclical fluctuations were explained using final demand. New business cycle theory has since been developed by Kydland and Prescott (1982). It explains business cycles as a function of stochastic shocks, instead of it being determined inside the model as an inherent property of the market.

The work of John Maynard Keynes, especially his “The General Theory of Employment, Interest, and Money” (1936) became the cornerstone of “mainstream” models based on the work of L.R. Klein. Keynes’ macroeconomic analysis is based on the analysis of aggregated variables, making model building much easier. Keynesian analysis focuses on the role of aggregate demand in driving the economy. Keynesian analysis allows the economy to be in a state of disequilibrium, with resources not being fully utilized. Therefore, it is possible that final demand is not enough for all the resources (i.e. labor) in the economy to be fully utilized.

This assumption makes long term unemployment possible. Investment is thought to be a function of interest rates. The liquidity preference of households and firms also take a primal role in determining money supply and interest rates.

The macromodels built under the spirit of Keynes assume that the observed data represents realized demand. Assuming labor is available in excess (long term unemployment), supply can be assumed to follow demand, with aggregate demand being the indirect determinant of demand for production factors.

The “mainstream” models constructed in the 1960s and the 1970s by the US, Western Europe and Japan follows the Cowles Commission approach, which is characterized by a Neo-Keynesian theoretical flavor and a demand-oriented approach (Klein, 1999). The main methodology of the Cowles Commission approach will be described below.

The Lucas critique (Lucas, 1976), which says that economic agents could anticipate economic policy, resulted in some adjustments on the model building process. In the US and the UK, researchers looked at rational expectations as a possible remedy. Other economic modelling agencies, however, chose an approach based on the concept of adaptive expectations, due to the assumption of limited rationality (Welfe, 2012).

The Sims Critique (Sims, 1980) on the perceived arbitrariness of structural models led to the development of the Vector Autoregressive (VAR) methodology. In the UK, the London School of Economics (LSE) approach uses a “general to specific” specification approach (Hendry, 1995). Johansen in 1988 proposed a new parameter estimation for non-stationary variables. Engle and Granger in 1987 proposed a two-step cointegration analysis procedure. This method is now commonly used since the late 1990s. In the Philippines, the BSP continues to use the Engle and Granger method.

In the 1990s, the World Bank tried building computable general equilibrium (CGE) models (Welfe, 2012). As stated earlier, a general equilibrium model is expected to contain several million equations, with each equation pair corresponding to one particular good. D. Jorgenson proposed a special aggregation of economic agents, and hence, equations. This aggregation resulted in the development of empirical computable general equilibrium models (Wallis, 1994). The static nature of CGE models resulted in the development of Dynamic, Stochastic General Equilibrium models now favored by research centers attached to central banks.

The PIDS-BSP project will focus on estimating and formulating a macroeconomic model. As such, the remaining sections will focus on discussing the fundamentals of macroeconomic model building. The remainder of this section will present a timeline and analysis of macroeconomic modelling in context of different economic schools of thought.

Next section contains an analysis on the Cowles Commission Approach, Cointegration Analysis, and the LSE approach. Other alternatives such as the Vector Autoregressive (VAR) models and the DSGE models are also discussed.

2.1 Cowles Commission approach and the Lucas Critique

The Cowles Commission is an economic research institute founded by the investment counsellor Alfred Cowles in 1932. Alfred Cowles together with Irving Fisher and Harold Davis started the Commission. Initially located in Colorado Springs, Colorado, the Commission

moved to the University of Chicago in 1939. James Tobin was appointed director of the Commission, but because of he refused to leave Yale University, the Commission made another move from Chicago to New Haven, Connecticut. The Commission was then renamed to be the Cowles Foundation for Research in Economics.

The Cowles Commission approach is based on the previous realizations on how the demand and supply curves can be modelled. It has long been understood that in situations where the supply curve alone is shifting, the resulting price-quantity data traces the demand curve, and vice versa. However, in most situations, both the demand and supply curve are shifting, which makes estimation more complicated.

To resolve this issue, the commission used systems of simultaneous equations in model building. This is based on the assumption that economic behavior is determined by agents acting simultaneously in the market place. This assumption is a strong one, and is a source of some criticisms that continues to the present day (Friedman, 1939). Nevertheless, most economists, along with existing literature, accept simultaneity to be a reasonably correct assumption.

It should also be noted that the Cowles Commission approach assumes that economic theory will provide the method in choosing which variables to be included in the model and the specification of the equations to be estimated. Since economic theory is used in specifying the equation, the choice of economic theory to adhere to becomes an issue as well. Most of the early models of the Cowles Commission has a definite Keynesian flair in its theoretical underpinnings, which reflect the status quo of their time.

Keynesian economics as espoused on *The General Theory of Employment, Interest, and Money* (Keynes, 1936) is generally based on three assumptions. The first assumption recognizes the primacy of aggregate demand, which is made up of private consumption, investment, government consumption and net exports (imports) as the primary driver of the economy. The second assumption involves the relative nominal rigidity of prices and wages. The third assumption, which flows from the second one, says that the primary variables that adjust on the short run in order to maintain equilibrium is real output, and by extension, employment. The third assumption also says that the market does not have an inherent self-balancing tendency for full employment. Thus, there is space for the government to influence aggregate demand either directly through government expenditures or indirectly through interest rates.

This Keynesian focus resulted in the models being used for policy evaluation. This reflects the Keynesian idea that the economy can be fine-tuned in the short term using government spending, tax rates and interest rates. The models were also used for conditional forecasting - forecasts of the endogenous variables based on specified values of the exogenous variables.

The general assumptions made by the Cowles Commission in building their models are listed below (Christ, 1994):

- a. Economic behavior is best described by simultaneous equations.
- b. The equations are linear in systematic variables and disturbances.
- c. The systematic variables are observable without error.
- d. Time is modelled as a discrete, rather than continuous, variable.
- e. Perfect knowledge on whether variables are exogenous or not.
- f. The reduced form must exist.

- g. The predetermined variables are linearly independent.
- h. The structural equations have pre-identified restrictions on their parameters which are correctly identified.
- i. The error terms are normally distributed and serially independent.
- j. Dynamic stability of the estimated models.

Assumption (a) is already discussed in passing in the beginning of this section. Although economic action is usually seen as reactive to the knowledge of some previous action, the short reaction time of the market (minutes to days) and the level of aggregation of most of the macroeconomic indicators that are measured (quarterly or annual) allows the recursive event to be modelled by a simultaneous equation. Alternatively, one can also use a perfect information assumption to assume away the lag of the independent variables, During modelling, the dynamic effects of the recursive information system can also be modelled into a simultaneous equation by including lags of the necessary variables, which is a common technique in modelling.

Assumption (b) at first glance seems like a strong assumption, as it imposes a restriction on the relationship between the variables of interest. However, transformation techniques like logarithmic transformation make the estimation of a linear model possible. Advances in nonlinear modelling and the development of non-linear estimators have made this assumption unnecessary in modelling. It can be argued that the Cowles Commission made linear models due to technological and technical issues, not theoretical ones.

Assumption (c) just assumes that the variables needed to explain the economy are observable and already available. It also assumes that there are no measurement errors. This assumption is a practical one that makes model building possible and easier. The same can be said about assumption (d), or the assumption that time is a discrete variable as opposed to a continuous variable. Treating time as a discrete variable allows the use of difference equations in modelling instead of differential equations. Difference equations are easier to work with compared to differential equations. This assumption is normally made not just in economics but in other fields as well.

Assumption (e) assumes knowledge about what variables are exogenous and what variables are endogenous. Assumption (e) basically assumes that the model being estimated is correctly specified.

Assumption (f) just assumes that the reduced form of the model that is being estimated exists and can be estimated. It assumes that the model can determine the values of jointly dependent variables. Assumption (g), in technical terms, is an assumption of the existence of the moment matrix that can be inverted. The existence of a moment matrix that can be inverted follows from linear independence of the predetermined variables. While it is true that this is not often the case, omission of the linearly dependent predetermined variable is always a possibility. Thus, assumption (g) is just a limitation of the amount of predetermined variables that can be evaluated given a particular sample size. As long as the sample size is bigger than the number of predetermined variables, assumption (g) can be met.

Assumption (h) is the assumption that is closely tied to the theoretical underpinnings of the model. Basically, assumption (h) says that the model should have the proper theoretical underpinning and the proper and complete variable list. Over-identifying the model results in

the generation of a model with inefficient parameters. Under-identifying, on the other hand, results in missing variable problems. Not surprisingly, this assumption is the basis of many criticisms of the Cowles approach.

Assumption (i) specifies the behavior of the error terms in the equation. While normality is a strong assumption, it is not a necessary one. In fact, the results of the estimate will still hold even if this assumption is relaxed. However, this assumption is useful in constructing test statistics. New techniques have already been developed to take care of possible non-zero mean, non-singular covariance matrix, and serially correlated error terms.

To summarize, assumptions (a), (g) and (h) are mathematical and theoretical assumptions that guarantee the existence of an optimal model. Assumptions (b), (e) and (i) are assumptions that are made to handle the technological and technical limitations of the previous periods. Assumptions (c), (d) and (f) are practical assumptions made for possibility/ease of estimation (Christ, 1994).

Disenchantment with the Cowles Commission approach first began on general dissatisfaction on Keynesian macroeconomics. Since the Cowles Commission advocates a structural approach, it rises and falls on the popularity of the theory used in establishing the structural relationships. The first criticism was largely theoretical, with the difficulty of establishing microfoundations on the Keynesian treatment of various components of the economy. The rigidities in wages and prices that lead to their “stickiness” is particularly problematic, although promising research is still being done in this particular area. Another theoretical criticism lies in the treatment of expectations in the model (Diebold, 1998).

The final nail against Keynesian theory is its inability to explain the possibility of stagflation. Keynesian theory predicts that changes in the aggregate demand affect output and employment and not prices. As such, it cannot explain the persistent high levels of both inflation and unemployment in the 1970s. This dissonance contributed to general dissatisfaction in Keynesian theory.

In addition to theoretical criticisms, the Cowles Commission approach also came under fire on the statistical side. Liu (1960) questioned whether the estimates of the parameters are accurate given the pervasive interactions of economic variables. Liu said that it may be impossible to get accurate parameters due to the nature of economic relationships and variables. The same question on the accuracy of the estimated parameters was echoed by Sims (1980). However, Liu and Sims arrived at different conclusions. While Liu concluded that the amount of relationships in the economy made modelling impossible and pointless, Simson the other hand concluded that there is a better approach to modelling than resorting to structural limitations. Sims pushed for the use of VAR models instead.

Another famous criticism of macroeconomic modelling came from Lucas (1976). Lucas summarized his critique by saying: "Given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of series relevant to the decision maker, it follows that any change in policy will systematically alter the structure of econometric models." As such, a change in the policy variables might change the decision rules that underlie estimated parameters, which makes the estimation of these particular parameters useless.

The best way to illustrate the Lucas Critique can be found on the estimation of the velocity of money in the classic monetarist equation:

$$mv = py$$

(Equation 1)

In this equation, m stands for the relevant measure of money supply, p stands for the price level, y stands for output and v denotes the velocity of money. Monetarist theory assumed that v is a parameter, which led to their conclusion that only money matters in determining inflation. However, it turned out that v captures the response of individuals to policy variables, which led to the effect of the money supply having a smaller explanatory role than expected. Today, the classic monetarist equation is often discussed as an identity instead of a structural form.

In addition to criticisms on both statistical and economic theoretical foundations, the Cowles Commission approach also suffered from more practical weaknesses, including the potentially small value added of using large macroeconomic models to forecasting. In the 1970s, studies have shown that simple statistical extrapolations often forecasted macroeconomic activity just as well as large-scale Keynesian macroeconomic models (Nelson, 1972). In other words, the additional complexity and data intensiveness needed to construct a large-scale Keynesian macroeconomic model did not translate to better forecasting accuracy (Diebold, 1998).

2.2 Improvements on MEMs born from criticisms on the Cowles Commission approach

Criticisms on the Cowles Commission approach led to the development of alternative approaches in macroeconomic building that promises improvements on the perceived weakness of the previous model building projects. In general, the improvements are modifications in several of the general assumptions made in model building. Usual improvements include (1) improvements in the use of economic theory, both in the choice of theory and in the structural components of the model, (2) greater focus on the long-run relationships of the variables in question by using the development of new econometric techniques, and (3) the inclusion of rational expectations and other ideas in the microeconomic foundation of macroeconomic theory (Diebold, 1998).

Due to these developments, the new generation large-scale models now share a number of important features. These features are (1) greater focus on the equilibrium conditions, (2) the incorporation of rational expectations, and (3) greater focus on the dynamic adjustments of the suitable variables in the short run that preserves the long run dynamics while remaining agnostic on the short run dynamics (Garrat, 2000).

Feature (1) is interpreted as a response to the criticism on the economic theory used in framing the model, as the use of Walrasian general equilibrium ideas improve the characterization of the long run relationships. Feature (1) results in the focus on the supply side of the model in determining the long run relationships. Feature (2) is a direct response to the Lucas Critique. Feature (3) is a workaround of the Sims Critique on the short run dynamics by not specifying a short run mechanism, allowing instead the variables to affect each other without restriction.

The focus on the long-run dynamics results in a greater interest in the supply side of the model. This is due to the long-run dynamics of the model being heavily influenced by the supply side

(Wallis, 2000). As such, the increase in the specification of the supply side requires a similar increase in theoretical sophistication to accommodate the relationship of the supply side and the demand side in a more reasonable way (Hall, 1995).

2.3 Cointegration Analysis and the LSE approach

Another approach to model building that evolved in response to the perceived failure of the Cowles Commission approach is the LSE approach. As its name implies, the LSE approach is associated with the London School of Economics and Political Science. The LSE approach is founded by Denis Sargan.

The Cowles Commission approach, uses economic theory to assume a structural form. In other words, it assumes that the structural form is already pre-determined and known, and the data is then fitted to this structure. Thus, the validity of the reduced form equation is not tested because it is assumed to be in the right form without the use of statistical tests to establish it. The LSE approach sees this as a crucial deficiency in the Cowles Commission approach.

The LSE approach recognizes the guidance of economic theory in determining the general specification of the model. However, the LSE approach argues that there is insufficient knowledge regarding the data generating process at the beginning of the model building exercise. Theory cannot specify all the relationships between the variables in question and whether their effects are substantial or not. Thus, there is a need to verify the structural form, thereby improving the credibility of the model.

The LSE approach begins its modelling by laying down the reduced form and then identifying the structural form of models. This is an inversion of the Cowles Commission approach, which begins in the use of the previously determined structural form (from theory) in order to come up with the reduced form. The reduced form is identified by first identifying the set of variables that will be included in the model. After this, the identified variables are labelled as either endogenous (modelled variable) or exogenous (non-modelled variable). The suitable lags for each variable is also identified.

Each step in the model building process (choosing variables, identifying the nature of the variable, and choosing the appropriate lag) is validated by statistical testing. The null hypothesis of the testing process is the absence of model mis-specification. The possible model mis-specifications include but are not limited to residual non-normality, autocorrelation, heteroscedasticity and lack of parameter constancy (Favero, 2001).

It has been established by Nelson and Plosser (1982) that most of the macroeconomic time series data available suffer from the presence of a unit root. This presents the problem of spurious regression. The LSE approach deals with it by drawing upon the procedures developed by Engle and Granger (1987), Johansen (1991) and Phillips (1991), among others.

After the identification of the short run responses, the long run properties of the system is then established by using cointegration analysis. Cointegration analysis is done on the reduced form equation. It should be noted that the identification of the short run simultaneous relationships is a different and separate problem from the identification of the structural long run relationship.

The LSE approach is best known for its preference of reparametrizing the model into an error correction mechanism (ECM). The reparametrization is theoretically justified by using a quadratic cost of adjustment framework. It also captures the idea that agents alter their behavior based on indication of disequilibrium.

For representation, consider the following data generating process for Y_t .

$$Y_t = \alpha_t + \sum_{i=1}^n \alpha_i Y_{t-1} + \sum_{k=1}^m \sum_{i=0}^n \beta_{ki} X_{kt-1} + \mu_t$$

(Equation 2)

Here, μ_t is the white noise error. Equation 2 is a reasonable model for any of the equations that are a part of the model.

The simplest form of Equation 2 happens when $m=n=1$. Given this, Equation 2 becomes:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \beta_0 X_t + \beta_1 X_{t-1} + \mu_t$$

(Equation 3)

Now, we reparametrize Equation 3 to an error correction mechanism as is typical of the LSE approach.

$$\Delta Y_t = \alpha_0 + \beta_0 \Delta X_t - (1 - \alpha_1)(Y_{t-1} - X_{t-1}) + (\alpha_1 + \beta_0 + \beta_1 - 1)X_{t-1} + \mu_t$$

(Equation 4)

Equation 4 is now the ECM specification of the process described by Equation 3. It describes the changes in Y as a function of changes in X as well as previous values of Y and X .

Logically, the next step after the reparametrization of the model is cointegration analysis. The Granger representation theorem guarantees the existence of a valid ECM if a set of variables is cointegrated of order 1,1. In other words, an ECM model does not suffer from the spurious regression problem if there is a set of level terms which cointegrate to a stationary error term (Cuthbertson, 1992).

Following this discussion, the reparametrization of Equation 1 (to a version similar to Equation 3) requires the estimation of a cointegrating relationship. This can be done by using various methodologies, including the use of ordinary least-squares (OLS). This relationship represents the long-run relationship among the variables. In addition, the estimation procedure will naturally produce residuals, which can be used in estimating the ECM. The process described above is essentially the Engle-Granger two-step procedure. All the component equations of the model can then be estimated this way.

A variant of the LSE approach deals directly with systems of behavioral equations and accounts for the possibility of there being more than one cointegrating relationship among a set of three or more variables. This is done through specifying an unrestricted VAR system and with the

use of the Johansen procedure to estimate all the possible cointegrating relationships. This procedure ends with a simplified VAR system called a vector error correction model (VECM).

2.4 Alternatives to traditional MEMs

It should be noted that there are other alternatives to the construction of large MEMs. The Sims critique on the over restriction of the short-run interactions led him to propose the use of Vector Autoregressive (VAR) models. VAR models are simply the vector extensions of the autoregressive (AR) models. As such, VAR models can be seen as the generalization of the AR approach.

VAR methodology resolves identification problems that was asserted by Christopher Sims as problems of macroeconomic models during his time. A VAR model is essentially a large scale macroeconomic model with unrestricted reduced forms, with all the present variables being treated as endogenous. This approach reflects the fact that it is impossible to accurately recognize which variables are endogenous and which variables are exogenous before the estimation procedure. Although economic theory may be able to say that a variable *should* be exogenous, the wealth of competing schools of economic thought makes choosing the exogenous variables an arbitrary exercise. In addition, rational expectations and the importance of the expected future values of the variables in modelling both supply and demand (particularly when one is dealing with prices) make the process of choosing variables as either exogenous or endogenous (restricting the model) difficult.

It should be noted that the identification of simultaneous equations in models with lagged dependent variables and serially correlated residuals (ie most econometric models) can be estimated in the same manner as those with serially uncorrelated residuals only if the exact lag length and order of serial correlation are exactly known prior to the estimation procedure. Due to this, the VAR approach now adds another dimension in the model building process due to the need to identify the necessary lag length in the model. Thus, the estimation of a VAR model (at least initially) removes the restriction not just on the type of variables (endogenous versus exogenous) but also on the lag of the variables (Sims, 1980).

It should be noted that a convergence between VAR models, cointegration analysis, and the LSE approach can be found in terms of their estimation methodology. For instance, when the problem of non-stationarity arises, the appropriate response is to transform the VAR into a VECM representation using underlying cointegrating relations among the variables, assuming it exists (Yap, 2002). Otherwise, ARIMAX or ARDL can be used.

Another modelling approach that flourished after the disillusionment from large scale “mainstream” macroeconomic models that follow the structuralist Keynesian approach is the computation of Computable General Equilibrium Models (CGE). A particular variant of CGE models that gained popular usage are Dynamic Stochastic General Equilibrium Models (DSGE). DSGE models employ the calibration approach in estimating its parameters. The general underlying framework of the DSGE model is the optimization of the intertemporal utility function of representative households and representative firms through the decision rule. The first order conditions (the Euler equation) along with the necessary transversality conditions yield equations that contain the parameters which enter the functions for preferences, production technology and the probability distribution of tastes and technology shocks.

The identification and estimation strategy of a DSGE model is first to estimate the aggregate demand and supply functions. The Euler equations are then used to elucidate the parameters of interest. Then numerical estimation of the remaining parameters is done, after which calibration is implemented. The simulated model is then evaluated by comparing the actual data with the simulated data, with the parameters being adjusted, when needed. While the DSGE model outlined above used neoclassical theory, some DSGE models use New-Keynesian theory to guide their specification (Gunning and Keyzer, 1995; Robinson, 1989).

3. An inventory of macroeconometric models in the Philippines (1990-2002)

Before the publication of Yap (2002), the pioneering works of Velasco (1980) and Bautista (1988) catalogued the earlier models estimated before 1990. The survey of Velasco (1980) was part of the preliminary study done for the macroeconometric modelling project between (replace with: by) the Philippine Institute for Development Studies (PIDS) and the National Economic and Development Authority (NEDA). The conclusion of the survey identified possible avenues for the improvement of contemporary macroeconomic models.

One aspect of his model that Velasco wants to improve on is the nature of the specification of the trade deficit and the investment-savings gap, as well as the determination of the required capital flows that arise from it. In particular, Velasco wants the trade deficit and the investment-savings gap to be explicitly considered. Since modelling of the trade deficit will affect the current account deficit, he recommends improving the specification and estimation of the exports and imports, as well as the disaggregation of the trade sector. He also advocates a tighter interlinkage between the trade sector and the production sector, particularly on fuel imports.

In addition to his criticisms on modelling the trade sector and its insufficient linkage to the production sector, Velasco also touches on the degree and mechanism of interlinkages between the financial and the real sector. Most of the earlier models, including those done by the Central Bank, were designed to simulate the transmission channels of monetary policy into the real sector. However, the extent of the description of the real sector in these models leave much to be desired upon. The linkage of the financial and the real sector mostly runs from the investment decisions of the firms in aggregate. One of the models examined, the Encarnacion model, links the monetary and the real sector only through the determination of the price level by the money supply. This is in spite of the existence of a monetary sub-model in the system.

Another area that Velasco finds interesting involves the estimation of a fiscal planning model. The fiscal planning model can be used as basis for revenue forecasting. It can also be used as a handy guide for budget allocation, as well as in the management of the national debt.

Meanwhile, Bautista's (1988) analysis of the structure of different MEMs in the Philippines and his emphasis on the various shortcomings in MEMs led him to the conclusion that CGE models offer a better alternative to MEMs as far as evaluation and forecasting is concerned. Since this project is on the building of a macroeconometric model, further discussions on Bautista's analyses will no longer be pursued. Instead, it is enough to note that a more robust specification of the dynamic behavior of MEMs and a more realistic treatment of expectations are among Bautista's recommendations.

3.1 The PIDS-NEDA Annual Model

The PIDS-NEDA Annual Macroeconomic Model has several versions, the latest of which is the 2000 update of the Reyes and Yap (1993) version. Another publication that presents a model incorporating the important features of the previous versions is Mariano and Constantino (1994). The model has also been extended by the addition of the social sector (Reyes and Buenafe, 2001).

The main objective of the PIDS-NEDA model is to provide a coordinated framework for the formulation of medium-term development plans for the Philippines. It has been extensively used during the negotiations involving the country's external debt in the early years of the Aquino administration in the late 1980s. Moreover, it was also used to evaluate the impact of stabilization policies on the Philippine economy.

The latter versions of the PIDS-NEDA Annual Macroeconometric Model is essentially structuralist in nature. The expenditure sector of the model is specified along the lines of a Keynesian income-expenditure model. The model is said to be structuralist due to its recognition of the fact that supply bottlenecks affect certain sectors of the economy which may lead to a less than full employment equilibrium.

The model is specified that way in recognition of the then prevailing economic realities in the Philippines. The Philippines was modelled as an agriculture-based country. In this scenario, the role of aggregate supply in the determination of output is highlighted. In addition, the existence of various institutional constraints is also present in the specification of the model. Foremost among these constraints is the persistent unemployment and underemployment in the labour force.

The use of a Keynesian income-expenditure model is justified by the way chronic budget deficits and other macroeconomic imbalances are corrected. The use of fiscal and monetary policy in the management of these imbalances is well documented, along with the effect of policy in aggregate demand.

It should be noted that under the conditions raised above, the interaction of the usual aggregate supply and expenditure functions may not necessarily result in macroeconomic balance achieved by automatic price adjustments (the Walrasian solution). These factors rule out the classical approach of flexible prices and quantities. Instead, there is a need for the model to be specified on whether a particular sector is "fix-price" or "flexi-price" in the tradition of Taylor (1983). In a flexi-price sector, prices are assumed to adjust to clear the market through the demand and supply equilibrium while in a fix-price sector, prices do not change for a certain period of time but the disequilibrium in either demand or supply will put pressure on the price to correct production (Saari and Zakariah, 2007) Usually, agriculture is modelled as a flexi-price sector while industry is assumed to be a fix-price sector.

The PIDS-NEDA model is made up of four major sectors. The real sector is made up of production, expenditures, employment, wages and price equations. The other sectors are (2) the fiscal sector, (3) the financial sector, and (4) the external sector (trade).

At its core, the PIDS-NEDA model focuses on the real sector. The real sector of the model determines domestic output from both the production and expenditure components, along with the various price indices, the employment level and the wage rate. The GDP is determined by

the interaction of the production side and the expenditure side. In the production side, the production sub-components are modelled either as flexiprice goods, fixprice goods or as normal classical goods. The fixprice sub-component is assumed to practice mark-up pricing with an adjustable output level. The expenditure side is disaggregated following the usual accounting procedure of the national income account.

After estimating the GDP from the interaction of the production side and the expenditure side, the GNP is calculated by the addition of the net factor income from abroad.

On the fiscal side, government spending is assumed to be exogenous. The financial sector determines the money supply and the interest rates, which are then used in the real sector to determine output. The trade sector is disaggregated into various components as well. Government income is assumed to be endogenous.

The PIDS-NEDA model was considered to be a vast improvement over earlier MEMs (Yap, 2002). The major upgrades are on the explicit treatment of certain features of the Philippine economy and on strong linkages among various sectors. Nonetheless, it still falls prey to criticisms lobbed on models specified under the Cowles Commission approach.

Between 1985 and 1991, a sharp decline in public infrastructure spending for maintenance resulted in the economy slowing down. The Reyes-Yap version of the PIDS-NEDA model was used to evaluate the different ways in which public spending can be financed. The list below shows the ranking (from best to worst) of the options considered. The ranking was based on the projected behavior of output, on the assumption that the existing macroeconomic imbalances are sustainable.

The sharp decline of public infrastructure spending between 1985 and 1991 resulted in the economy to slow down and the Reyes-Yap version of the PIDS NEDA model was used to evaluate the different ways in which public spending can be financed. The list below shows the ranking (from best to worst) of the options considered. The ranking was based on the projected behavior of output, on the assumption that the existing macroeconomic imbalances are sustainable.

1. Improvement in tax administration
2. Increase in tax rate
3. External borrowing
4. Reallocation of budget
5. Monetization of public debt
6. Domestic borrowing

Another use of the PIDS-NEDA model was in the analysis of the impact of the economic policies in the Philippines from 1980-1986 (Constantino and Yap, 1988).

Constantino and Yap (1998) analyzed four policy scenarios using the PIDS-NEDA model. The first scenario calls for an increase in the exports of manufactured goods. The money supply was allowed to either expand or contract depending on the net impact of a higher balance of payment surplus and a lower budget deficit. Under this scenario, simulation exercises show that higher exports have the highest impact on GDP when the money supply and exchange rate is allowed to respond while imports are restricted. It has the lowest impact when imports and exchange rates are restricted while the money supply is allowed to respond.

The second scenario analyses the impact of changes in the world economic environment on the domestic economy. Simulations are done for cases assuming scenarios of growth in the world economy and increases in prices of traded primary commodities. Such increases are found to increase the price level that results in the reduction in the real value of government expenditures, and consequently, in GDP.

The third scenario assumes a 10% devaluation of the ER. Simulations were then done for case where there is a money supply response and case where there is no money supply response. The simulation results show an improvement in the budget deficit. However, the net decline in money supply has a simultaneous negative effect on the price level.

Finally, the fourth scenario assumes that the government provides a subsidy to exporters. Simulations are done assuming an increase in tariff rates, a reduction in the volume of manufactured imports, and a reduction in manufactured imports. The simulation results indicate an increase in GDP and a deterioration in the budget deficit.

Another variation of the PIDS-NEDA macroeconomic model that is worth mentioning is the NEDA Annual Macro-Social Model (Reyes and Buenafe, 2001). The NEDA Annual macro-Social Model was developed using the ECM approach. As such, two stage estimation was employed in the model. The first stage determines the long run relationships between the dependent variables while the second stage incorporates the short run dynamics into the model.

The NEDA Annual Macro-Social Model is organized in the same vein as the PIDS-NEDA model, but with the addition of a social sector component. The model features an endogenous agricultural sector, more thoroughly disaggregated industry and service sectors, and stronger linkages between the various components. The fiscal sector is linked with the financial sector via the monetary based and the interest rate of government securities through the method of deficit financing. The fiscal sector also influences the real sector through government expenditures.

3.2 The NEDA Quarterly Macroeconometric Model (NEDA-QMM)

Under the guidance of Peter Pauly of the University of Toronto, the NEDA-QMM gave a fresh perspective to modelling approaches in the Philippine economy. It was born from the interagency efforts of different government agencies with each one responsible for a particular block. For instance, the BSP specified and estimated the monetary block of the QMM.

The NEDA-QMM's key feature lies in the use of the Engle-Granger two-step procedure similar to that of the LSE approach. By applying this methodology, the NEDA-QMM was able to distinguish between the short- and long-run behavior of the model. The long-run values should converge to the levels dictated by the cointegrating relationship. However, Yap (2002) cautions that this relationship is derived from empirical data and is not necessarily consistent with relationships obtained from optimizing models.

Another technical feature of the NEDA-QMM lies in its extensive use of empirical tests to assure the validity of the structural form, following the LSE approach.

Despite the NEDA-QMM being a quarterly model, it remains similar to the PIDS-NEDA model in that the real sector is at its core; and thus, prone to the similar criticism to the PIDS-NEDA model. For instance, Yap (2002) notices that private consumption is disaggregated into food and non-food. However, there is no meaningful link provided in the model between food consumption and agricultural production. Also, the production sector is not disaggregated into the different components of agriculture and industry, and the value added of industry and services are affected by GDP instead of specific expenditure components. Yap adds that using such a model specification greatly weakens the feedback from the expenditure side to the production side since GDP is built up from the production sector.

The NEDA-QMM is also unique in its incorporation of a capacity utilization variable. The capacity utilization variable is calculated as the ratio between actual GDP and a measure of potential GDP. The capacity utilization ratio is a component of the model for expected inflation, standing as a proxy for the natural level of output. The other explanatory variables in modelling inflation are import prices, money supply and the price of agricultural products.

The value of expected inflation is used as a determinant of the 91-day Treasury bill rate. It is also used in the calculation of the various real interest rates.

3.3 The Ateneo Macroeconomic Forecasting Model (AMFM)

The AMFM, developed by Rodriguez and Briones (2002), is a multi-equation macroeconometric model that utilizes quarterly data. It is comprised by 13 stochastic equations and 53 identities. Its basis is largely attributed to the Murphy model of Australia.

Similar to the PIDS-NEDA and NEDA-QMM, the AMFM has the real sector at its core with distinctions on production and expenditure. Unlike the NEDA models, output in the AMFM is determined from the expenditure side instead. Interestingly, the production sector follows a two-stage process wherein price levels adjust to equate total expenditure with total production.

The first stage attempts to represent the optimizing behavior observed on firms following profit maximization. The values derived therein are considered as equilibrium. In the second stage, a series of equations are used to depict the adjustment of economic variables to equilibrium. Yap (2002) notices that this largely resembles an ECM albeit the authors of the AMFM did not explicitly mention this. Moreover, Yap cautions as well that the authors of the AMFM did not test whether the differences between the actual and equilibrium values are stationary. This poses a problem as a nonstationary series would imply that either the theoretical model, or the assumed functional forms, or both are inappropriate descriptions of the Philippine economy.

Another criticism by Yap is that the AMFM specifies forward-looking inflationary expectations; thus, it could potentially make it difficult to achieve convergence in the process of obtaining model consistent inflationary expectations – a problem shared with the NEDA-QMM. Also, the absence of a link among the fiscal deficit, the BOP account, and the real sector limits the feedback mechanisms in the AMFM. This deficiency would lead to impaired ability to have adequate policy evaluation results.

4. Current status and inventory update of macroeconometric models in the Philippines (2003-2017)

Considering that the comprehensive review of Yap (2002) is more than a decade old, it would be interesting to know the current landscape of MEMs in the Philippines. Aside from the aforementioned MEMs, this section will discuss current MEMs in the Philippines and provide information on its current status.

Beginning with the earliest MEM identified in Section 3, the PIDS-NEDA model is currently no longer in use (PIDS-BSP, 2017). The latest version can be found in the study by Reyes and Yap in 1993 (as cited in Yap, 2002). The reason of its cessation is attributed to the transfer of personnel that handled it in PIDS. As such, this is a point of concern that should be addressed in order to ensure the continuity of succeeding models.

The status of the NEDA-QMM is currently unknown although it is also likely that it has ceased given that the latest study identifying the use of the NEDA-QMM can be found in Bautista, Mariano, and Bawagan's study in 2009. The AMFM is also not used anymore.

While none of the models discussed above are still functional, there are other MEMs that have been developed recently. These would include the Asian Development Bank's (ADB) quarterly macroeconometric model of the Philippines (Ducanes et al, 2005), and the BSP's DSGE model (McNelis et al, 2010).

In the ADB model, the MEM is designed to provide economic forecasts and policy simulations for various member economies. In the Philippine version, it is composed of eight blocks namely private consumption, government, trade, production, prices, monetary, and labor sectors. The government block was specifically designed to allow simulating the impact of various policies on government debt. Moreover, it contains 48 behavioral and technical equations, 17 identities, and 81 variables. The behavioral equations here are framed as ECMs and were estimated using ordinary least squares (OLS). The status of the use of the ADB model is currently unknown with just the Ducanes study in 2005 being its sole citation.

On the other hand, the BSP's DSGE model acts as a complement to existing models used by the BSP for policy simulation. It should be clarified though that not all models used by the BSP are MEMs as some of these are used to address specific needs concerning monetary policies. The BSP's DSGE model is a small open economy model with habit persistence, staggered pricing in home goods production, flexible wage adjustment cost to investment, and financial frictions. While the BSP's DSGE model is a sound MEM, it lacks further detail on the real sector even with the comprehensive representation of the monetary sector. Several BSP models including the DSGE model cited are currently in use (PIDS-BSP, 2017).

Based on the above discussion, there is currently one MEMs in active use, namely the BSP's DSGE model. There are two MEMs of unknown status, particularly the NEDA-QMM and the ADB model of the Philippine economy. Table 4.1 below shows a summary of the models cited in this study together with the years it was first and last used, the most recent version citing it, its status as of December 2017, and the institution responsible for maintaining the model. It should be said, however, that this scoping paper is by no means a comprehensive study but is rather a more purposive review of Philippine MEMs. There are notably other MEMs that exists in the Philippines with more limited uses (see Yap, 2002 for other MEMs not included in this study). Consequently, Table 4.1 no longer includes earlier MEMs surveyed by Velasco (1980).

Table 4.2 Summary of Philippine macroeconometric models

Model	Version Cited in Literature		Most Recent Citation	Status (as of Dec 2017)	Responsible Institution
	Earliest	Latest			
PIDS-NEDA Model	1986 ^a	1993 ^b	Ducanes et al, 2005	Inactive	PIDS, NEDA
NEDA-QMM	1996 ^c	2009 ^d	Bautista, Mariano, & Bawagan, 2009	Unknown	NEDA
AMFM	2002 ^e	2002	Ducanes et al, 2005	Inactive	ADMU
ADB Model	2005 ^f	2005		Unknown	ADB
BSP's DSGE Model	2010 ^g	2010	McNelis et al, 2010	Active	BSP

^a Constantino et al, 1989

^b Reyes & Yap, 1993 (as cited in Yap, 2002)

^c Yap, 2002

^d Bautista, Mariano, & Bawagan, 2009

^e Rodriguez & Briones, 2002

^f Ducanes et al, 2005

^g McNelis et al, 2010

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