Philippine Management Review 2019, Vol. 26, 17-30.

Tracking the Philippine Economy Using a Macroeconometric Model

Leila C. Rahnema* and Carlos C. Bautista**
University of the Philippines, Cesar E.A. Virata School of Business, Diliman, Quezon City 1101, Philippines

This paper presents a small macroeconometric model of the Philippine economy. The model consists of eleven equations, six of which are behavioral equations and five are identities. The six behavioral equations of the model are estimated using OLS on annual macroeconomic data from 1999 to 2015. In-sample forecast of the endogenous variables is conducted to determine the tracking ability of the model. The simulation results show satisfactory tracking ability as shown by the simulation statistics and reflected in the graphs of the simulated variables. This shows that the model has adequate forecasting capability and may be used to conduct sensitivity and policy analysis.

1 Introduction

A small macroeconometric model is developed for the purpose of simulating and tracking the path of the Philippine economy. In general, macroeconomic models examine the economic consequence that would have resulted from changes in the level of gross domestic product (GDP), government spending, consumption, tax policies, money supply and other macroeconomic variables (Pindyck and Rubinfeld, 1976). By simulating the model during the period for which historical data for all variables are available, a comparison of the original series with the simulated series for each endogenous variable can provide a useful test of validity of the model. The Philippine macroeconometric model can also be used for policy analysis and forecasting of key macroeconomic variables.

Ex post simulations can also be useful in policy analysis. By changing parameter values or letting exogenous policy variables follow different time paths, one can examine and compare what might have taken place as a result of an alternative policy. Likewise, at the microeconomic level, industry econometric models can also be used to simulate the effects of alternative regulatory policies or other factors affecting the industry. The model can be extended to forecast beyond the estimated period as a good benchmarking tool as well as for sensitivity analysis and policy analysis.

There are a few models of the Philippine economy which range from medium to large: for example, Bautista et al. (2004), Ducanes et al. (2005), Rodriguez and Briones (2002). Like these models, the model of this study belongs to the traditional Keynesian model that is based on the IS-LM framework. This model however differs from previous ones in its treatment of the monetary side. Instead of a money demand function, the study uses an interest rate equation representing the Taylor Rule adopted by Philippine monetary authorities as the monetary policy framework since 2002. The Taylor rule has been the focus of academic discussions as monetary targeting has fallen out of favor and has not been used by most Central Banks.

The second section provides a brief review of the literature on macroeconomic modelling. As a background for the modelling process, the third section describes the Philippine economy from 2000 to 2015 which is the coverage of this study. The fourth section discusses the model structure and the equations in the model. The fifth section shows the empirical estimates, model evaluation and historical simulation results. The last section concludes the study.

2 Review of Related Literature

The long history of macroeconomic model building can be split into several subperiods, depending on the changing goals, macroeconomic concepts, econometric and statistical methodologies and institutional conditions. Welfe's book on Macroeconomic Models (2013) serves as an extensive compilation of various types of model structures spanning nearly three decades of macroeconomic modelling. Model building dates back to the 1960s and 1970s in Western Europe and Japan and then

* Correspondence: Tel: +63 2 928 4571; Fax: +63 2 929 7991. Email: leila_rahnema@yahoo.com
** Correspondence: Tel: +63 2 928 4571; Fax: +63 2 929 7991. Email: bautista@up.edu.ph

in the other parts of the world. The book gives the history and milestones of macroeconomic modeling around the world.

The first models of the United States (US) economy were constructed by Tinbergen (1939), and after World War II, more models were built and inspired by Klein (1950). Annual data were used in these models and drew on the Klein-Goldberger model (1955), but quarterly forecasting models followed soon. Klein tried exploring the possibilities macroeconomic modelling offered by describing an economy whose development was well recognized and for which rich data sets were available. As a result, three small annual models were built.

Model I was comprised of 6 equations: 3 behavioral and 3 identities. Models II and III were more elaborate than model I. Model III contained 12 behavioral equations and is regarded as the precursor of the Klein-Goldberger model. Consumer demand was a function of wages, salaries and property incomes. Investments were determined by property incomes (current and lagged) and the initial stock of fixed capital only. The model contained an equation explaining employment that was derived from the inverted production function. This model, as well as its versions, defined the fundamental identity, i.e., Gross Domestic Income equals the sum of consumption, investment, government spending and net exports.

Another characteristic feature of Klein's early model was that it took advantage of the new econometric techniques that were developed after the Haavelmo critique (1943), namely, two-stage least squares (TSLS), full maximum likelihood (ML), and limited-information maximum likelihood (LIML). The last two methods and OLS were used for estimating the above models' parameters.

The Klein-Goldberger model (1955) paved the way for the builders of many other medium-term and annual models of the US economy. This model was generally utilized in the numerous studies on the pre and post-war properties of the US economy that extensively made use of multiplier analysis. Its applications to forecasting the annual time series were less frequent and attracted criticism. The critics maintained that the short-term forecasts and analyses would be of greater practical value for the administration and large corporations but the annual frequency of the models greatly reduced the range of reactions and interventions they could undertake. These demands obviously called for the construction of the quarterly, if not monthly, macroeconometric models (Bodkin et al. 1991).

Several other models followed Klein's "Post-war Quarterly Model" such as the Wharton Models, DRI Model, Michigan Model, BEA Model, MPS Model, Hickman- Coen Model, Fair Model, St Louis Model, Liu-Hwa Model (Welfe, 2013, Chap. 3).

After several years from the construction of macroeconometric models in the US, Canada and other developed market economies started to follow in their footsteps. Important developments could be observed in the United Kingdom, France and the Netherlands, the cradle of macroeconometric modelling. Generally, macroeconometric modelling in European countries developed following the US pattern. Rational expectations were explicitly introduced and neoclassical concepts were applied to model the production sector as well as the household sector. New estimation techniques were used. Their block of equations did not contain formulations explaining the demand and supply sectors, but the activities of households, enterprises, public institutions, etc., as well as markets, for instance, a labor market. The equations were specified according to microeconomic theory. A tabular summary of Welfe's different types of models across different countries is presented below in Table 1.

Welfe's (2013) book devotes a section on system of models for Far East Asian countries that includes Philippine models – Yap (2002) and the Asian Development Bank (ADB) quarterly model of the Philippine economy (Cagas et al, 2005). The latter model used the 1990–2004 quarterly data and had 65 equations, 48 of which are stochastic.

Several Philippine macroeconometric models for forecasting and policy simulations have been constructed since the 1960s. One of the earliest models was built by Encarnacion et al. (1971) at the School of Economics of the University of the Philippines. This macroeconometric model was used in the preparation of the Philippines' 1972-76 development plan. However, this macroeconometric model has not been used for development planning. This was mainly due to doubts on the ability of the model to accurately describe relationships on the Philippine economy after 1972.

Table 1. Summary information on Country models

Country	Number of models	Average Number of Equations	Estimation Method/s
Canada	23	452	OLS, TSLS
United Kingdom	12	831	OLS, ECM[1], COINTEGRATION
France	26	403	OLS, ECM
Netherlands	6	95	FIRST DIFFERENTIAL, OLS, TSLS, RATES OF GROWTH
Japan	6	71	OLS
Philippines	1	65	ECM
South Korea	2	50	OLS
Indonesia	1	100	OLS
Taiwan	1	31	OLS
Thailand	1	85	OLS
New Zealand	1	105	OLS, ENGEL GRANGER
China	2	509	OLS, TSLS
India	4	70	OLS
Pakistan	1	88	OLS
Sri Lanka	1	60	OLS
Algeria	1	21	OLS
Egypt	2	14	OLS
Iraq	3	63	OLS
Libya	1	21	OLS
Kuwait	1	66	OLS
Ghana	1	29	OLS

Seeing the need to revamp the model, the National Economic Development Authority (NEDA), through the collaborative effort of the Philippine Institute for Development Studies (PIDS), funded a research project to develop a computer-based econometric model of the Philippines. The main objective of that model was to guide the formulation of the Medium-Term Development Plan of the government. In the NEDA 2000 edition, the model was divided into four blocks: the real sector (including output, expenditure, employment, prices, and wages), the fiscal sector, the financial sector, and the external sector.

Rodriguez and Briones (2002) constructed a quarterly macroeconometric model of the Philippine economy referred to as the "Ateneo Macroeconomic and Forecasting Model" (AMFM) designed for forecasting and policy analysis using key macroeconomic variables: GNP, GDP and its components, CPI, 91-day T-bill rate and unemployment rate. Similar to the NEDA 2000 model, the AMFM has 4 blocks namely, (1) the real sector which determines the national output and its components, prices, employment and wages, (2) the government sector which represents the spending and sources of national government finance, (3) the financial sector which depicts the interaction of agents in the financial market and (4) other external sectors that portray the transactions of the Philippines with the rest of the world.

Another Philippine macroeconometric model constructed by Ducanes, Cagas, Qin, Quising, and Magtibay-Ramos (2005) of the Economics and Research Department, Asian Development Bank describes a small quarterly macroeconometric model of the Philippine economy which consists of sectors of private consumption, investment, government, trade, production, prices, money, and labor. The authors used the equilibrium/error correction model (ECM) form to embed long-run economic theories into their equations. All the behavioral equations were estimated individually by recursive OLS. The use of dummy variables was kept to a minimum except for seasonal dummies. There were 48 behavioral equations, 17 identities, and 81 variables in all. The behavioral equations are specified and estimated using PcGive and PcGets software while the model simulations are performed in the software package Winsolve. Instead of the conventional four blocks, this model is composed of eight blocks (Ducanes et al., 2005, p. 4-7); namely,

[1] Error Correction Model: An error correction model belongs to a category of multiple time series models most commonly used for data where the underlying variables have a long-run stochastic trend.

- the private consumption block that has a consumption demand function of income and "wealth" which are, in turn, affected by the deposit rate and the unemployment rate.
- the investment block that has an investment demand function. Investment is also affected by changes in the real domestic lending rate and the total government debt to GDP ratio (proxy for risk).
- the government block, where the total revenue is mainly a function of tax revenues collected.
- the trade block, uses a world trade matrix comprising 30 countries that account for 85 percent of Philippine exports to calculate the imports of the world from the Philippines. Philippine exports are then assumed to be a function of this world trade variable.
- the production block, assumes that real output (GDP) can be represented by a Cobb-Douglas production function.
- the price block, where the price index is used to determine other prices such as the producer price index, price deflator of investments, export price index, price deflator of GDP, consumer price index, world oil price, and so on
- the monetary block, which contains equations for narrow money (M1), net foreign assets (NFA), domestic credit of money banks, and interest rate on overnight borrowing the employment block shows the shifts in employment level and movements in the labor force.

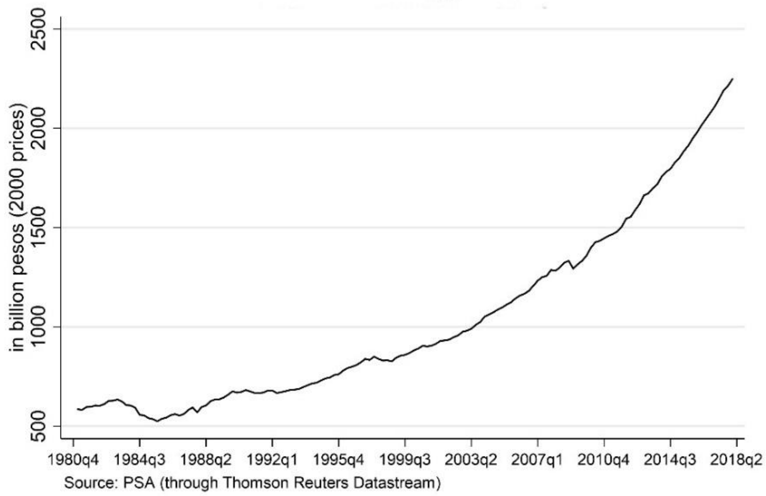
Two sets of simulation experiments were carried out. The first set was designed to evaluate the predictive accuracy of the model while the second set was mainly designed to evaluate the policy simulation capacity of the model. The paper then looked into the policy simulation potential of the model as illustrated by three types of simulations: interest rate shocks, fiscal policy shocks, and world oil price shocks. The first set of simulations showed the importance of maintaining a low interest rate regime in the country. The second set of simulations showed that addressing the deficit and debt problems was very important if the Philippine government hoped to achieve and maintain higher growth of its economy in the medium and longer term. The oil price simulations showed the vulnerability of the Philippine economy to external shocks. Overall, the results of their policy simulations showed that the country was highly vulnerable to external shocks.

A macroeconometric Philippine model developed by Bautista et al. (2004) is based on a general equilibrium macroeconomic model with monopolistic competition (Blanchard & Kiyotaki, 1987) that allows derivation of the domestic price level and aggregate output. Fifteen policy experiments were presented in this paper wherein an exogeneous variable was changed for each experiment to determine if indeed it had an effect on the model. The model consisted of 186 variables 104 of which were endogenous and 48 behavioral equations estimated with OLS. EVIEWS 4.1 was used as the software for the simulation and forecasting of the models. The results of the policy simulations show that increases in the minimum wage rate, tariff rate and oil prices have stagflation effects.

3 The Philippine Economy from 2000-2015

The Philippine growth in the years 2000 onwards is among the highest in Asia. For the years 1980s to 2000s, there was low economic growth in comparison with Southeast & East Asian neighbors. The Philippine economy has been on a higher growth trajectory since that of beginning of the current decade as shown in Figure 1. Growth drivers were reported to be from private consumption on the demand side, and services on the supply side. Private consumption has been partly fueled by OFW remittance which is over two-thirds of the country's GDP. The service sector contributed to over one-half of the country's GDP.

Figure 1. Real Gross Domestic Product



This paper primarily looks into the Philippine economy during the years 2000-2015. The first two years of the data reflect the turbulent times caused by the first ever impeached Philippine President. In 1998, Joseph Estrada was elected president. Even with a competent economic team, the Estrada administration failed to capitalize on the gains of the previous administration. Issues such as cronyism, incompetence and corruption plagued his administration. This caused the lessening of foreign investors. Turmoil such as numerous bombing threats and actual bombings, calamities, extreme weather conditions, kidnappings, and other criminal activities contributed to the weakening of the economy.

Toward the end of Estrada's administration, the fiscal deficit had doubled to more than P100 billion from a low of P49 billion in 1998, inching almost 3 percent of GDP (Yap, 2002). Estrada's poor fiscal management was a major economic concern (Yap, 2002). This fiscal deficit was not only caused by a growing demand for expenditure, it was a failure on the revenue side. The Estrada administration collapsed in January 2001 through a second "People Power Revolution" and was replaced by his vice-president, Gloria Macapagal-Arroyo.

Another distressful event that affected the Philippines was the 2008 global economic and financial crisis[2]. As a result, the Philippine economy began to slow down considerably in 2008. The global crisis spawned a recession among industrialized countries, leading to a contraction in world trade. GDP growth rate in 2008 fell to 3.8 percent, compared to 7.1 percent in 2007. The impact of the 2008 global meltdown was felt by developing economies through a drastic decline in their exports. In the case of the Philippines, this is reflected in a decline in GDP growth in the fourth quarter of 2008 and first half of 2009. Inflation rose to 9.3 percent in 2008, a steep rise from close to 3 percent on the average in 2007. Unemployment slightly increased, but the declining exports cut employment more in the manufacturing sector than in other sectors. However, overseas Filipino workers remittances continued to grow. Because of this, foreign exchange reserves continued to rise despite the fall in exports and incipient capital outflows. The growing fiscal deficit, largely due to the need to increase government expenditures to offset lower consumption, investment, and exports added to the problems encountered during this period (Yap et al., 2009).

4 Structure of the Model

Older macroeconometric models use annual data and as such are better suited to forecast only medium to long-term analysis. This paper uses quarterly data to provide analysis for short-term forecasts and simulation. Like other macroeconometric models, this paper relies on econometric techniques to determine values of parameters of the equations.

---

[2] Read more about the 2008 economic and financial crisis in Yap's Discussion paper "Impact of the Global Financial and Economic Crisis on the Philippines: The 2008 Global Financial and Economic Crisis."

This study constructs a macroeconometric model of the Philippine economy that can be used for policy simulation and forecasting. This macroeconometric model consists of six equations and five identities, making it one of the smallest models. The model is a variation of the IS-LM model since the money supply equation is replaced by the Taylor rule (1993) and is known as the IS-MP model.[3] The six behavioral equations describe the aggregate demand and supply in levels, the IS function in levels, the Taylor rule, a real exchange rate depreciation equation, an imported inflation equation and a net exports equation.

5 Model equations

The model has 6 equations as shown in Table 2. Table 3 lists the definition of the variables. Dummies are used to account for the effects of the US recession in 2001-2002 and the global financial crisis in 2008-2009. Equation (1) in Table 2 describes the aggregate supply and shows the positive relation of q_t and p_t. Likewise, a positive relationship of p_t and p_t^z is assumed to exist. Output demand is modeled in Equation (2) as an IS function. This shows an inverse relation between output and the real interest rate. The third equation is the BSP reaction function that follows the "Taylor rule". Basically, the Taylor rule is an interest rate forecasting model which is designed to provide "recommendations" for how a central bank (Bangko Sentral ng Pilipinas) should set short-term interest rates as economic conditions validate its short-run goal of fostering growth and maintaining price stability. The fourth equation determines the real exchange rate depreciation. This equation incorporates factors such as net exports and OFW remittance found to be important in the Philippine's real exchange rate movements in the long run. Equation (5) serves to recognize the importance of crude oil price changes in determining import price inflation. Finally, net exports are determined by movements in Gross Domestic Product, the real exchange rate and their lagged values.

Table 2

$$\ln p_t = a_0 + a_1 \ln q_t + a_2 \ln p_t^z + a_3 \ln p_{t-1} + +a_4 d08 + \epsilon_{1t} \tag{1}$$

$$\begin{aligned} \ln q_t = b_0 + b_1 r_t + b_2 \ln rer_t + b_3 \ln rer_{t-1} + b_4 \ln q_t^* + b_5 defq_{t-1} \\ +b_6 \ln q_{t-1} + b_7 \ln q_{t-2} + b_8 d08 + \epsilon_{2t} \end{aligned} \tag{2}$$

$$i_t = c_1 \pi_t + c_2 \pi_{t-1} + c_3 g_t + c_4 i_{t-1} + \epsilon_{3t} \tag{3}$$

$$\begin{aligned} \widehat{rer}_t = d_0 + d_1 nx_t + d_2 nx_{t-1} + d_3 \Delta r_t + d_4 \Delta r_{t-1} + d_5 \widehat{rem}_{t-1} \\ +d_6 \widehat{rer}_{t-1} + d_7 d00 + d_8 d08 + d_9 i.qtr + \epsilon_{4t} \end{aligned} \tag{4}$$

$$\hat{p}_t^z = \alpha_0 + \alpha_1 \widehat{nx}_{t-1} + \alpha_2 \hat{p}_t^{oil} + \alpha_3 \hat{p}_{t-1}^{oil} + \alpha_4 \hat{p}_{t-1}^z + \epsilon_{5t} \tag{5}$$

$$\begin{aligned} nx_t = \beta_0 + \beta_1 \ln rer_t + \beta_2 \ln rer_{t-1} + \beta_3 \ln q_{t-1}^* + \beta_4 \ln q_{t-1} \\ +\beta_5 nx_{t-1} + \beta_6 nx_{t-2} + \epsilon_{6t} \end{aligned} \tag{6}$$

[3] See Romer (2013) for a detailed discussion of the IS-MP framework.

Table 3. Variable Definitions

^	p_t	general price level represented by the CPI;
^	p_t^z	import price index;
^	q_t	aggregate output represented by real GDP;
^	$r_t = i_t - \pi_t$	real policy interest rate;
^	$rer_t = e_t p_t^* / p_t$	real exchange rate;
^	i_t	BSP policy rate;
^	$\pi_t = \ln(p_t / p_{t-4})$	annual inflation rate;
^	$g_t = \ln(q_t / q_{t-4})$	annual GDP growth.
^	nx_t	net exports(exports less imports of goods & services);
^	$\widehat{rer}_t$	real depreciation = $\ln(rer_t / rer_{t-4})$;
^	$\hat{p}_t^z$	imported price inflation = $\ln(p_t^z / p_{t-4}^z)$;
	rem_t	OFW remittance;
	$d00$	crisis dummy = 1 for quarters 2000q1 to 2002q4, and 0 otherwise.
	$d08$	crisis dummy = 1 for quarters 2008q1 to 2009q4, and 0 otherwise.
	$defq_{t-1}$	deficit to GDP ratio
	$i.qtr$	categorical dummies for 3 quarterly periods.
	p_t^{oil}	crude oil price.
	q_t^*	US real GDP;
	p_t^*	US CPI;

^Endogenous variables: these are the left-hand side variables in equations in Tables 4A, 4B and the identities of the model (Table 5).

6 Estimation Results

The estimated equations and the identities are used to simulate the path of the 11 endogenous variables. The model's six equations were estimated using OLS on quarterly data from 1991:1 to 2015:4. The data were obtained from the Bangko Sentral ng Pilipinas, IMF Financial Statistics and the Philippine Statistical Authority. Five identities shown in Table 6 are used to calculate the inflation rate, the GDP growth rate, the real BSP policy rate, the levels of the real exchange rate and the imported price level.

The results are presented in Tables 4A and 4B. Table 5 gives the variable definitions of the model. Because the objective of the paper is to produce forecast that can track the movement of the economy, the adjusted-R^2 and correctly signed OLS parameters are the primary basis in deciding to accept an estimate to be included in the simulation model (Bautista et al., 2004). The statistical significance of the parameter estimates has traditionally been given secondary importance in simulation and forecasting models of this type. All variables except the interest rates are in logarithms.

Equation (1) in Table 4A estimates the aggregate supply equation in levels. Lagged values of the variables are used to tease out the lag structure that describes the dynamics of the economy. As shown, there is a positive relation between the price level and lagged output. This is true for CPI and the lagged import price index which are significant at 1 percent and 10 percent respectively. An open economy IS equation is estimated in equation (2) of the Table. Output is assumed to be a function of the real policy rate, the real exchange rate, US GDP and the government deficit to GDP ratio. The latter is significant at 5 percent and the policy rate is negatively related to output which is what the IS relation shows. Equation (3) is the Taylor rule showing the reaction of BSP to inflation and output growth. Both are insignificant but correctly signed and appear to have lower values compared to those obtained for other countries. Only the lagged dependent variable is significant at 1 percent, which indicates persistence in the policy rate or the infrequent changes in the rate.

Table 4B shows the last 3 equations estimated by OLS. Equation (4) assumes that real depreciation is influenced by the current and lagged values of net exports and the change in real policy rate. Significant test results for these variables are mixed. For the real policy rate, the positive effect of the contemporaneous value is negated to some extent by its lagged value. The relationship is normally negative but can be positive, e.g., during crisis periods. Lagged growth rate of OFW remittance is significant at 5 percent. Imported inflation in Equation (5) is affected significantly by net exports. As expected, crude oil import price inflation has a positive and significant effect on imported inflation. Net exports in Equation (6) are assumed to be a function of output, the real exchange rate and US GDP all of which are statistically significant. In the case of the Philippines, an increase in output raises imports that leads to a decline in net exports. The first 3 equations have relatively high adjusted-R^2s compared to the last 3.

Table 4A. OLS estimates

	(1)	(2)	(3)
	$\ln(p_t)$	$\ln(q_t)$	i_t
$\ln(q_{t-1})$	0.042	0.846**	
	(1.59)	(8.00)	
$\ln(q_{t-2})$		0.109	
		(1.12)	
$\ln(p^z_{t-1})$	0.023+		
	(1.84)		
$\ln(p_{t-1})$	0.941**		
	(30.57)		
d08	0.007+	-0.01	
	(1.71)	(-1.47)	
r_t		-0.018	
		(-0.28)	
$\ln(rer_t)$		0.027	
		(0.70)	
$\ln(rer_{t-1})$		-0.048	
		(-1.10)	
$defq_{t-1}$		-0.121*	
		(-2.15)	
$\ln(q^{us}_{t-1})$		0.129	
		(1.55)	
π_t			0.206
			(1.64)
π_{t-1}			-0.165
			(-1.06)
g_{t-1}			0.066
			(1.21)
i_{t-1}			0.926**
			(14.68)
constant	-0.273	-0.82	
	(-1.53)	(-1.65)	
Adjusted R-squared	0.999	0.999	0.989
No. of Observations	68	68	67

t statistics in parentheses; + p<0.10, * p<0.05, ** p<0.01
Note: The equation numbers above correspond to the equation numbers in Table 2.
The variable descriptions are given in Table 3.

Table 4B. OLS estimates

	(4) $\widehat{rer}_t$	(5) $\hat{p}^z_t$	(6) nx_t
$\ln(q_{t-1})$			-0.235*
			(-2.14)
$d08$	0.025		
	(1.25)		
$\ln(rer_t)$			-0.352**
			(-3.21)
$\ln(rer_{t-1})$			0.237*
			(2.31)
$\ln(q^{us}_{t-1})$			0.499*
			(2.09)
nx_t	-0.038		
	(-0.23)		
nx_{t-1}	-0.322+		0.302**
	(-1.96)		(3.20)
$nx_{t-1} - nx_{t-5}$		-0.271*	
		(-2.43)	
nx_{t-2}			0.240+
			(1.91)
$r_t - r_{t-1}$	1.047+		
	(1.80)		
$r_{t-1} - r_{t-2}$	-0.156		
	(-0.28)		
$\ln(rem_{t-1}/rem_{t-5})$	-0.103*		
	(-2.18)		
$\widehat{rer}_{t-1}$	0.695**		
	(8.50)		
$d00$	0.02		
	(1.26)		
$\ln\left(p^{oil}_t/p^{oil}_{t-4}\right)$		0.077**	
		(3.45)	
$\ln\left(p^{oil}_{t-1}/p^{oil}_{t-5}\right)$		-0.023	
		(-0.94)	
$\hat{p}^z_{t-1}$		0.352*	
		(2.55)	
constant	-0.004	0.003	-2.686+
	(-0.42)	-0.68	(-2.00)
Adjusted R-squared	0.763	0.403	0.585
No. of Observations	66	67	68

t statistics in parentheses; + p<0.10, * p<0.05, ** p<0.01

Table 5

Identities of the Model
$\pi_t = \ln(p_t/p_{t-4})$
$g_t = \ln(q_t/q_{t-4})$
$r_t = i_t - \pi_t$
$\ln(rer_t) = \widehat{rer}_t + \ln(rer_{t-4})$
$\ln(p_t^z) = \hat{p}_t^z + \ln(p_{t-4}^z)$

7 Model Evaluation

The evaluation of the model is mainly via conventional statistics such as the mean error (ME), root mean square percentage errors (RMSPE) and the mean percentage errors (MPE). These measures take the average of forecast errors over the simulated period. The RMSPE and MPE of both solutions are compared to the actual values for key macroeconometric variables. As these measures indicate the errors associated with the model's forecasts, values closer to zero suggest good tracking ability. Below are the formulas for ME, RMSPE, MPE and RMS.

$$ME = \frac{1}{T}\sum_{t=1}^{T}(y_t^f - y_t)$$

$$RMSPE = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(\frac{y_t^f - y_t}{y_t}\right)^2}$$

$$MPE = \frac{1}{T}\sum_{t=1}^{T}\left(\frac{y_t^f - y_t}{y_t}\right)$$

$$RMS = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(y_t^f - y_t)^2}$$

As a rule of thumb, the higher the RMSPE, the worse the forecast is and should not go higher than 10%. Hence, as can be seen in Table 6 below, the in-sample forecast of imported inflation is the worst with an RMSPE of 53 percent. Overall, the model has satisfactory tracking abilities.

Table 6

	ME	MPE	RMSE	RMSPE
π_t	0.001	0.242	0.015	0.839
i_t	-0.004	-0.001	0.016	0.167
$\widehat{rer}_t$	-0.001	-0.588	0.054	1.061
$\hat{p}_t^z$	-0.001	6.022	0.039	53.182
nx_t	0.002	-0.470	0.030	5.215
g_t	0.002	0.193	0.014	0.619

Figures 2 to 7 show the simulation results of the model. The graphs following also show the crisis periods. Figure 2 presents the actual quarterly GDP growth rate for the years 2000-2015 and the simulated values from the model. It shows an increasing GDP growth trend from 2000 up to the last quarter of 2007 which is tracked fairly well by the model. The sudden drop of GDP growth at the beginning of 2008 as a result of the global financial crisis is also captured by the model. The recovery period that began in the last quarter of 2009 shows that the path of GDP growth is also close to the simulation result. In Figure 3, the spike in inflation during the 2007-2009 global financial crisis was captured adequately by the model. However, the volatility of inflation was not captured by the model. Figure 4 shows the actual quarterly depreciation data for the years 2000-2015. The model also shows the forecasted depreciation data for the same years given the model simulation. The model clearly follows the downward trend until the global crisis and predicts a more stable path during the post crisis period. Figure 5 shows the actual quarterly imported inflation data for the years 2000-2015 and the fitted values generated by the model. It can be seen from the graph that a fair number of turning points are accounted for by the model, indicating satisfactory tracking ability for the imported inflation. Figures 6 and 7 show the simulation results for net exports and the policy rate respectively.

Figure 2. Actual vs. Forecast

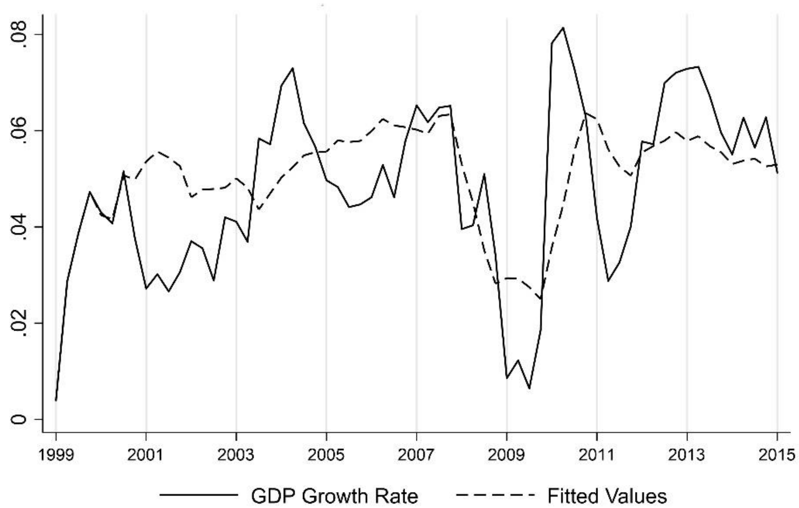


Figure 3. Actual vs. Forecast

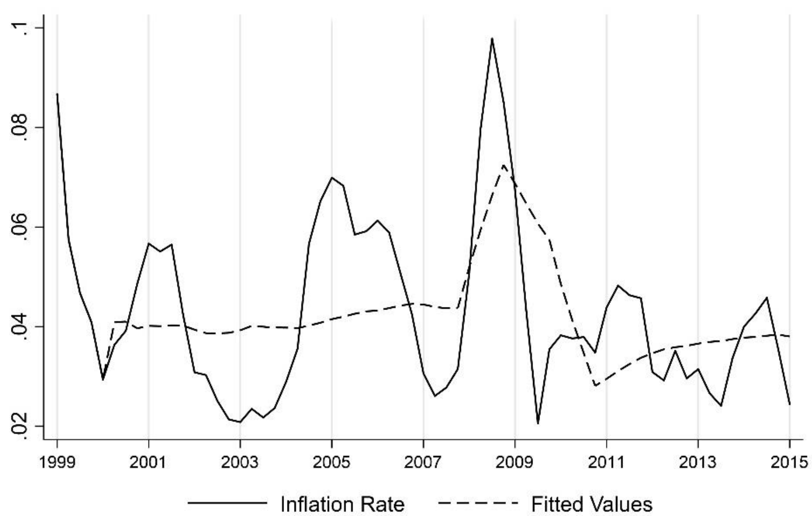


Figure 4. Actual vs. Forecast

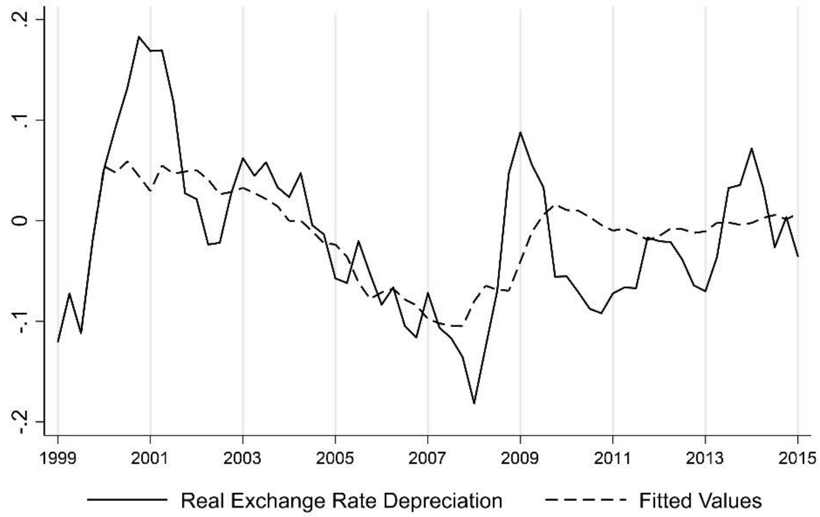


Figure 5. Actual vs. Forecast

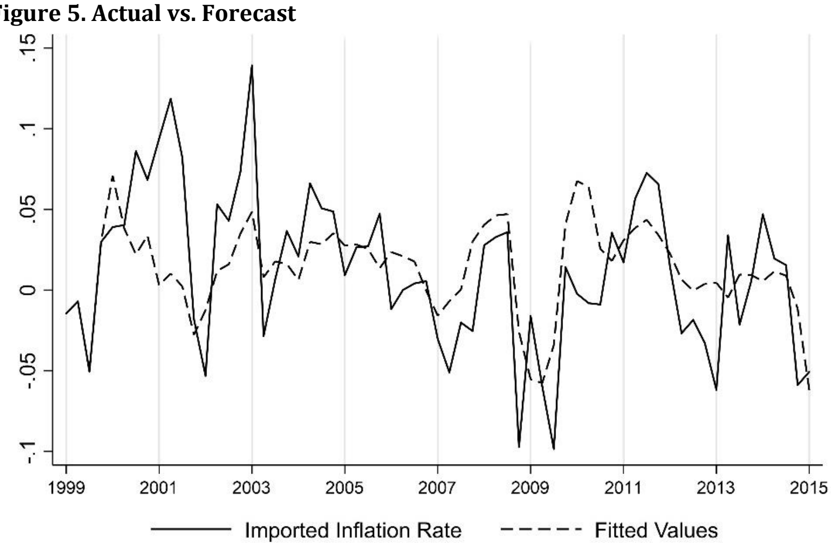


Figure 6. Actual vs. Forecast

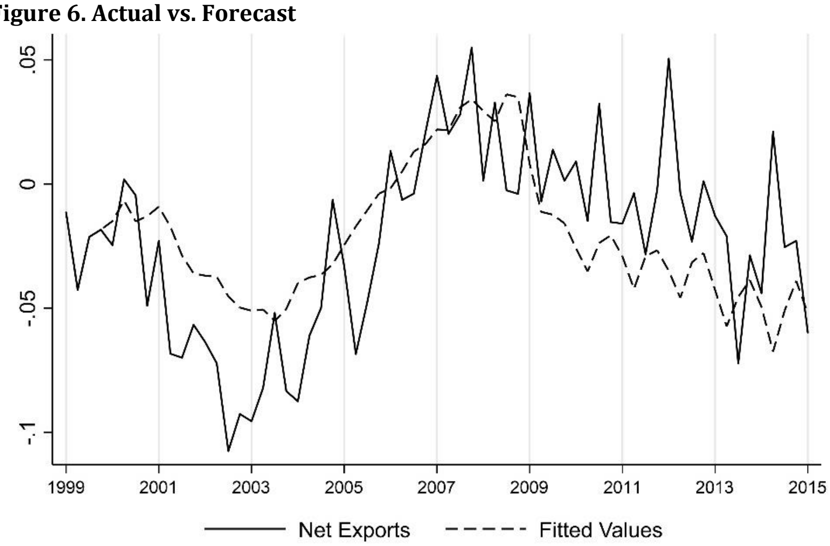
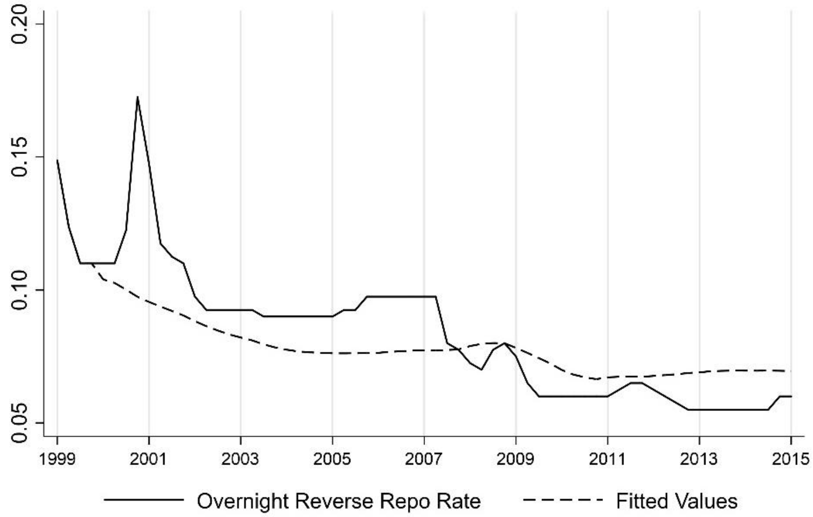


Figure 7. Actual vs. Forecast



8 Conclusion

This paper presents a small macroeconometric model of the Philippine economy. The model contains eleven equations, six of which are behavioral equations and five are identities. The six behavioral equations of the model are estimated using OLS on annual macroeconometric data from 1999 to 2015. In-sample forecast of the endogenous variables is conducted to determine the tracking ability of the model. The simulation results show satisfactory tracking ability as shown by the simulation statistics and reflected in the graphs of the simulated variables. The paper stops short of conducting ex-ante forecast. However, this and the policy simulations of the effects of changes in exogenous variables are areas for future study.

Future research can use this study's model as a core of a larger model. One extension can include sub-models of industries or sectors to link them to macroeconometric variables. Another extension is to enlarge the core model by introducing aggregate demand components. In this case, the IS equation is replaced by behavioral equations for consumption, investment, and government expenditures along with the existing net exports equation.

References

Bautista, C. C., Mariano, R. S. & Bawagan, B. V. (2004). *The NEDA quarterly macroeconomic model: Theoretical structure and some empirical results.* Paper presented during the 9th National Convention in Statistics, October, Manila, Philippines.

Blanchard, O. J. & Kiyotaki, N. (1987). Monopolistic competition and the effects of aggregate demand. *American Economic Review*, 77(4), 647-666.

Bodkin, R. G., Klein, L., & Marwah, K. (1991). *A history of macroeconometric model-building*. Brookfield, VT: Edward Elgar.

Ducanes, G., Cagas, M.A., Qin, D., Quising, P., & Magtibay-Ramos, N. (2005). *A small macroeconometric model of the Philippine economy*. (ERD Working Paper Series No. 62).

Haavelmo, T. (1943). The statistical implications of a system of simultaneous equations. *Econometrica*, 11, 1–12.

Klein, L. (1950). *Economic fluctuations in the United States 1921-1941*. New Jersey: Wiley.

Rodriquez, U-P. & Briones, R. (2002). The Ateneo macroeconomic and forecasting model. *The Philippine Review of Economics,* 39(1).

Tinbergen, J. (1939). *Business cycles in the United States of America 1919–1932, Part II of Statistical testing of business-cycle theories*. Geneva: Economic Intelligence Service of the League of Nations.

Velasco, V.T. (1979). *A review and synthesis of macroeconomic models of the Philippines*. (PIDS Working Paper series, 7902). Manila: Philippine Institute for Development Studies.

Romer, P. (2013). *Short-run fluctuations*. Unpublished manuscript.

Rubinfeld, D. & Pindyck, R. (1976). *Econometric models and economic forecasts*. New York: McGraw-Hill.

Welfe, W. (2013). *Macro econometric models, advanced studies in theoretical and applied econometrics* (2013 edition). Heidelberg: Springer.

Yap, J., Reyes, C., & Cuenca, J. (2009). Impact of the global financial and economic crisis on the Philippines, impact of the global financial and economic crisis on the Philippines. (Discussion paper Series No. 2009-30).

Yap, J. T. (2002). *A perspective on macroeconomic and economy-wide quantitative models of the Philippines: 1990–2002*. (Perspective Paper, Symposium Series). Manila: Philippine Institute for Development Studies.