A Monetary Policy Model for the Philippines

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This article principally seeks to acquaint the readers with the features and basic structure of the Macroeconomic Model for the Philippines (MMPH), which is the latest addition to the suite of models that comprise the BSP’s forecasting and policy analysis system. The MMPH is a small-scale semi-structural policy model that aims to provide an organizing framework for producing coherent forecast scenarios and policy analysis. It is an organizing framework because it incorporates the forecast iterations that will come out from the process of consultations with sector specialists and between staff and management. The goal of the model is to generate the consensus view on how macroeconomic developments are evolving and how they can better inform the forecast.

I. The MMPH Framework

The basic principle of the MMPH’s modelling framework is to lay the building blocks that reflect key relationships for understanding the monetary transmission mechanism based on forward-looking agents and a central bank that reacts to the output gap as well as the deviation of inflation forecast from target (Berg et al., 2006; Benes, Hledík, and Vavra (2005); Coats, Laxton, and Rose (2003)). Instead of estimating large models that seek to mimic the detailed features of the economy to understand the various transmission mechanisms, the MMPH focuses only on key macroeconomic relationships that are most relevant to monetary policy. It does not, however, diminish the role of other models in helping inform policy decision-making in central banks because there are recognizably other policy concerns that cannot be addressed by a monetary policy model such as the MMPH.

Aside from a parsimonious set-up, the model imposes a theoretically-consistent structure that ensures correct signs for the parameters of the model and hence, a reasonable dynamic path of the response of the key macroeconomic variables to shocks (as measured through impulse response functions) over the BSP’s two-year policy horizon. The focus of the forecast is not on the precision of the point forecast but, more importantly, on the projection path over the policy horizon that is consistent with the consensus assessment of staff and management on the emerging outlook, given the available information set. The projection path can be extended to the medium term with reasonable assumptions or scenarios on key external variables.

The simplicity in design and theoretically-imposed parameter signs are preferred due to a number of uncertainties that complicate monetary policy, namely: (i) uncertainty about the transmission channels of monetary policy, which are not invariant over time; (ii) uncertainty about identifying the effects of the shocks because of multiple shocks that hit the economy at any time; and (iii) uncertainty about the measurement of unobservables in the transmission mechanism. The more elaborate the structure is, the less tractable the model becomes.

1 The views expressed herein are those of the authors and should not be construed to represent the views of the Bangko Sentral ng Pilipinas (BSP). This article is a synthesis of the model development work undertaken during the authors’ participation in the Advanced Applied Macroeconomic Modeling Program (AAMMP) of the Modeling Unit of the Economic Research Department of the IMF in Q42011 and Q22012. The authors are grateful to Deputy Governor Diwa C. Guinigundo, Assistant Governor Ma. Cyd N. Tuaño-Amador, Director Zeno R. Abenoja, and Director Francisco G. Dakila, Jr. for their full support for the authors’ participation in the AAMMP; to Douglas Laxton for spearheading the program; to Jaromír Benes, Michal Andrle, Patrick Blagrave and Peter Elliott for sharing their knowledge and expertise. All errors, misinterpretations, and omissions are the responsibility of the authors.

2 The technical details on parameterization and policy experiments will be discussed in a forthcoming working paper.

What do we get from MMPH? How is it different from econometric models?

The structure of the MMPH has the advantage of being able to flexibly implement informed judgment within a theoretically-consistent framework. Where applicable, it can incorporate forecasts generated either from econometric (structural) or time series (non-structural) models. The general equilibrium framework and forward-looking feature allow for the assessment of the dynamic path of key macroeconomic variables in a theoretically-consistent manner.

Model maintenance is relatively simple because of parsimonious data requirements and model structure. While parsimony is a key tenet in model development and forecasting, adherence to it is often lost in practice as modellers seek to address many policy issues through ad-hoc model extensions. In such attempts, theoretical grounding and stock-flow inconsistencies in the data are often overlooked as replicating the data generating process becomes the overriding concern. As the model becomes bigger and more complex, data updating becomes a tedious process and model tractability is compromised. With theoretical restrictions imposed, there is less need to re-estimate and re-specify the model with every new data update.

The emphasis on simplicity in design recognizes that model development is a time- and resource-intensive undertaking. An institution like a central bank is always confronted with three real constraints: institutional, individual, and resource constraints. Too many complexities can confound the learning process with the worst possible scenario of having a complex model relegated to the backburner despite efforts and resources expended on it.

What are the model-development challenges with MMPH?

The model does not purport to have the nowcasting or short-term forecasting power of time series models because all the current-quarter indicators of even the simple model are not available at the time monetary policy is determined. For example, one of its core variables – the output gap – depends on GDP series that has a one-to-two-quarter lag. Thus, for current quarter monetary policy setting, nowcasts from statistical models and expert judgment are needed to tune the current and the next-quarter output gap estimate.

Similar to other model development efforts, the learning curve is steep – learning the subject and techniques could take a long time given the skill set that needs to be developed. While the model is not explicitly derived from choice-theoretic foundations, additional explanatory indicators cannot just be mechanically added to the equation. A battery of tests will have to be undertaken with each additional parameterization to ensure that the historical narrative that underpins the specification and parameterization is not compromised.

II. The MMPH in Close View

The MMPH is designed for a small open-economy like the Philippines. It shares the dynamic, stochastic, and general equilibrium features of a DSGE model. However, while its key behavioral equations are similar to those that arise from the underlying choice problems of firms and households, they are not presented in a form that is explicitly derived from choice theory as one would see in a DSGE model.

Overview of the MMPH Structure

Central to the inter-linkages of these behavioral equations are expectations about the future. As elucidated in the discussion of specific equations, the aggregate demand equation relates expected output to the real interest rate. The model articulates the role of the real interest rate as an inter-temporal price, i.e., an inflation targeting central bank must raise

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4 Nowcasting is a method that tracks real-time flow of high frequency datasets monitored by central banks and how such affect current-quarter forecasts (nowcasts). Each time new data are released, the nowcasts are updated on the basis of progressively larger data sets (Giannone, D., Reichlin, L., and Small, D. (2008)).

5 Policy tests, historical shock decomposition, and ex post recursive filtering and forecasting.
the nominal interest rate when potential output growth is expected to increase and lower it when potential output growth is expected to decline. This is because expectations of higher output in the future induce higher current aggregate demand – consumers spend more and firms invest more because of higher potential earnings from higher potential growth.

Figure 1 provides a simplified schematic diagram that depicts key relationships in the model. For simplicity, the diagram starts with the policy rate. The determination of the path of nominal policy rate is endogenous as it responds to the deviation of actual output from potential output (output gap) and the deviation of inflation forecast from target (inflation gap). This is shown by the feedback loops from output gap and inflation. Any policy rate adjustment rate affects inflation expectations and the real interest rate, with the latter feeding into the output gap and subsequently, inflation. Aside from output gap, inflation is also affected by international commodity prices, exchange rate, and world inflation through its impact on import prices. Output gap, on the other hand, is influenced by foreign output gap, remittance gap, real exchange rate gap, and unemployment gap.

Policy rate movement also affects expectations about the exchange rate. For a given level of nominal exchange rate, domestic inflation, and foreign inflation, the real exchange rate is determined. Real exchange rate, in turn, affects aggregate demand, and hence, output gap. Depending on the extent of the exchange rate pass-through, inflationary pressures arising from excess demand conditions can either be tempered or magnified.

The link to the rest of the world is provided through three key endogenous variables for the US economy: external demand captured by the foreign aggregate demand equation (foreign output gap), aggregate supply equation (US inflation), and US policy rule. The rationale for the use of US as a proxy for world demand is premised on the observed synchronicity in the Philippine and US business cycles as well as on the vertical production networks within the Asia-US region.6

Figure 1

Schematic Diagram of the MMPH

Model parameterization7

Model parameterization was undertaken by testing various combinations of parameter values that reflect the characteristics of the macro economy and theoretical consistency of monetary policy response to shocks. Preliminary parameterization was based on the results of partial equilibrium analyses using ordinary least squares method and generalized method of moments as well as simple ratios and proportions in the data. It is understood clearly that parameterization goes beyond the initial assignment of parameter values but entails several parameter adjustments. This approach recognizes that estimation is not a sine qua non in model development for the reason that not all important economic relationships can be reasonably estimated even with extensive data.

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6 This is known as the tripolar trade through China. In this structure, (i) East Asian economies produce sophisticated components and export them to China; (ii) China assembles them into final products; and exports them to the United States for consumption (page 78 of IDE-JETRO WTO Trade Patterns and Global Value Chains in East Asia, 2011).

7 See Appendix 1 for the current model parameterization.
Data transformation and filtering

Where appropriate, data series are deseasonalized and log-transformed. For ease of presentation, the time subscript in the variables is suppressed except for the forward-looking and backward-looking components. Variables that end in \( t \) refer to trends whereas those that end in \( g \) refer to gaps. Variables that begin with \( g \) refer to growth rates. For historical analysis, a multivariate filter\(^8\) is used to generate mean forecasts of the future target variables, conditional on the current information set.

The Core Behavioral Equations

The MMPH is a structural gap model considering that as an aggregate demand management tool, monetary policy can only influence the business cycle. The model is not about structural policies and growth reforms that the government must pursue.

Potential Output. Potential output growth (\( Y_t \)) corresponds to trend GDP growth that is compatible with the inflation target and is not strictly interpreted as the full employment output growth. This is a choice for simplicity because of the fact that much richer dynamics may be obtained from more complicated models, provided reliable data on employment and capital stock exist.

Only permanent shocks such as technological change and sustained inflow of foreign direct investment that affect the productivity of capital and labor can affect the long-run development of the supply side of the economy. They can also move the contemporaneous cyclical part of output as expectations of higher potential output in the future also brings about an impetus to current period aggregate demand.

Current growth of trend GDP is a weighted sum of its own lag, a constant steady state output growth (\( dyss \)) that characterizes the underlying economic growth momentum, given initial conditions, and a shock.

\[
gY_t = \rho_g Y_t \cdot dyss + (\rho_g Y_t) \cdot gY_{t-1} + RES_gY_t; \text{ where } RES_gY_t \sim N(0, \sigma_{RES_gY_t}) \quad (eq1)
\]

where:

- \( gY_t \) Growth rate of trend GDP
- \( dyss \) Steady-state GDP growth rate
- \( RES_gY_t \) Shock to trend GDP growth with zero mean and constant variance

The level of potential GDP equals previous period’s level and quarterly growth rate with some shocks:

\[
Y_t = Y_{t-1} + \frac{gY_t}{4} + RES_Yt; \quad RES_Yt \sim N(0, \sigma_{lGDP}) \quad (eq2)
\]

where:

- \( Y_t \) Trend GDP (level)
- \( gY_t \) Growth rate of trend GDP
- \( RES_Yt \) Shock to trend GDP with zero mean and constant variance

The steady-state GDP growth rate (\( dyss \)) is set at 5.0 percent,\(^10\) which also approximates the average trend growth of the economy during the inflation targeting period. It can be seen from the right graph in Figure 2 that annual GDP growth and potential output growth have moderated after the global financial crisis (GFC). This trend is consistent with weakening global demand that dented net export trend growth as well as with the softening trend growth in domestic demand components (Figure 3). Potential output growth has reverted to its pre-GFC average and has been slowly rising since then.

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\(^8\) See Appendix 2 for description of measurement (observables) variables used in the model.

\(^9\) The Multivariate (MV) filter uses additional information to inform the estimate of a state variable (unobservable). The MV methodology treats the filtering problem as a system, where estimates of potential output, NAIRU, inflation and other parameters of a dynamic model are determined simultaneously. The filtering device used is Kalman filter, which is a recursive data processing algorithm employed to generate an optimal estimate of the unobserved state given the set of measurements. It is optimal in the sense that all noise is Gaussian. The Kalman filter minimizes the mean square error for the estimated parameters. The process of finding the “best estimate” from noisy data leads to “filtering out” the noise (Harvey and Shephard, 1993; Kleeman, 1996).

\(^10\) Southeast Asian Economic Outlook 2011/12 puts 2012-2016 real GDP growth at 4.9 percent.
It is recognized, however, that there is still much scope for raising potential GDP growth if there will be major productivity gains in human and physical capital, particularly in the industrial sector in the next three years. The noteworthy growth performance in 2012 bodes well for better and more sustained growth prospects going forward provided the foundations for this growth are further reinforced at a much faster pace in the medium-term.

Usui [2011] noted that the Philippines’ slow process of industrialization has greatly impinged on its capacity for accelerated productivity gains. The lack of sustained improvement in physical and human capital infrastructure and a supportive regulatory environment over a long period undermined industrial deepening and diversification, notwithstanding initial success in electronics. The Southeast Asian Economic Outlook 2012/2013 identified three critical policy areas for the Philippines’ sustained growth in the post international financial crisis era, i.e., human capital development, infrastructure development, and tax collection and administration reforms. Significant strides in fiscal management and debt management have been achieved. It is therefore highly imperative to build on these gains to disengage from the boom-and-bust cycles that characterized the Philippine economic growth history.

Output Gap. Output gap \( Y_g \) is defined as the difference between actual GDP and potential output. It can be interpreted as a notional measure of excess demand or excess supply that affects the overall inflationary outlook vis-à-vis the inflation target.

Output gap is specified to be positively related to its own lead and lag, real exchange rate gap, foreign output gap, real remittance gap, and unemployment rate gap; and negatively with real interest rate gap.

\[
Y_g = \alpha_1 * Y_{g_{t+1}} + \alpha_2 * Y_{g_{t-1}} - \alpha_3 * (R_g + cc) + \alpha_4 * RMT_g + \alpha_5 * Z_g + \alpha_6 * YF_g + \alpha_7 * UR_g + RES_{YG}
\]  

(eq3)

where:

- \( Y_g \) Output gap
- \( Y_{g_{t+1}} \) Lead output gap
- \( Y_{g_{t-1}} \) Lagged output gap
- \( R_g \) Real policy rate gap (real reverse repurchase rate gap)
- \( cc \) Credit condition
- \( RMT_g \) Remittance gap (in domestic currency)
- \( Z_g \) Real exchange rate gap
- \( YF_g \) Foreign output gap
- \( UR_g \) Unemployment rate gap
- \( RES_{YG} \) Shock to output gap

\[1^1 \] GDP series is log transformed (i.e., \( \text{LOG}(\text{GDP}) \times 100 \)) and seasonally adjusted.
A negative coefficient for the real interest rate gap means that higher real interest rate relative to trend real interest rate translates into higher opportunity cost of money for households and investors. Higher opportunity cost of money induces households to consume less and investors to curtail or postpone new investment plans.

Credit condition (cc) is a broad measure of an exogenous factor that can affect the cost of fund for borrowers such as the reserve requirement. Reserve requirement represents an opportunity cost for the money that could have been lent out by the banks. Given unchanged credit demand, a higher reserve requirement can reduce available credit through higher intermediation cost.

A positive real exchange rate gap means real exchange depreciation pressures, which provide a boost to aggregate demand. The use of the real exchange rate gap instead of real exchange rate level is intended to account only for the cyclical component of the real exchange rate that moves with the business cycle. This is because the trend component of the real exchange rate is defined by structural factors such as productivity growth and persistent global imbalances that cannot affect the short-run business cycle and are beyond the purview of monetary policy as a short-run aggregate management tool.

Other factors affecting the output gap are the foreign output gap, remittance gap, and unemployment rate gap. $Y_{FG}$ captures the effect of foreign demand on domestic output gap. $RMT_{G}$ enters the output gap equation with a positive sign because of its generally procyclical nature, except during periods of economic slowdown such as the aftermath of the technology bubble collapse in 2001 and the 2008 global financial crisis. The $URg$ in the model also has a positive sign because it is defined in the model as $URg = URt - UR$, where $URt$ is the trend unemployment rate and $UR$ is the actual unemployment rate. In this case, higher-than-actual trend unemployment rate means more employed workers and hence, higher aggregate demand.

**Phillips curve.** The determination of inflation in the model takes after the assumption of monopolistic competition and sticky prices. The inflation expectations formation is introduced as the weighted average of forward-looking inflation expectations ($d_{Pt+1}$) and adaptive expectations ($d_{Pt-1}$), in which the latter captures the rule-of-thumb price setting behavior (there are costs to changing prices) that imparts some intrinsic persistence to inflation.

$$dP_e = \delta \times dP_{t+1} + (1 - \delta) \times dP_{t-1}$$

(eq4)

The specification of typical Phillips curve only considers long-lived (permanent) cost-push shock. Thus, to capture the short-lived nature of most of the cost-push shocks that hit the economy during the inflation targeting period (e.g., weather-related disturbances, global commodity price shocks), a measurement equation for the short-run shock is introduced in the Phillips curve (PC). This is defined by

$$dP = beta1 \times (dPM - dZt) + (1 - beta1) \times [beta2 \times dP_{t+1} + (1 - beta2) \times dPc] + beta3 \times Yg + beta4 \times Zg + beta5 \times LRPCOMGAP + RES_{DP} + PP_{DP2} - beta6 \times PP_{DP2_{t-1}}$$

(eq5)

12 Reserve requirements refer to the percentage of bank deposits and deposit substitute liabilities that banks must keep on hand or in deposits with the BSP, which may not be lent out. Currently, it is 18% of the bank deposit liabilities. Another candidate variable for cc is a measure of the degree of financial stress in the Philippine financial system, similar to the St. Louis Financial Stress Index of the Federal Reserve Bank of St. Louis. A higher index means weakening of financial condition that raises the external finance premium of all funds. Given the inherent endogeneity of the index, it is essential to extract only the component that does not move with the business cycle and can thus, be interpreted as the pure cost of fund effect. Alternatively, the impact of the financial stress index can be a separate explanatory variable in the output gap equation, similar to the way the bank lending tightening index was included in the Global Projection Model for the US, EU, and Japan.

13 The effective real exchange rate variable in the equation is defined as $Z = S + PF - P$, where $S$ is the nominal exchange rate; $PF$ is All-Urban US consumer price index from the US Bureau of Labor Statistics; and $P$ is the domestic CPI headline inflation.

14 The countercyclical behavior during economic downturns confirms Yang and Choi’s finding [2007] of the role of remittances in mitigating the negative shocks in the Philippines. Yang [2008] also shows that positive shocks affecting the exchange rate in countries with concentration of Filipino workers can result in higher remittances to assist liquidity constrained recipient households.
where:

\[ dP \] Quarter-on-quarter inflation
\[ dPM \] Quarter-on-quarter import price inflation
\[ dZt \] Rate of change in the real exchange rate trend
\[ dP_{t-1} \] Lagged inflation
\[ dPe \] Inflation expectations
\[ Yg \] Output gap
\[ Zg \] Real exchange rate gap
\[ LRPCOMGAP \] Real international commodity price gap
\[ PP\_DP2 \] Short-lived supply shock
\[ RES\_DP \] Cost-push shock

The adjustment of the import price inflation for the trend real exchange rate appreciation or depreciation removes the effects of changing productivity levels or imbalances that are structural in nature, and hence, cannot be influenced by monetary policy. Real marginal costs \((rmc)\) are not explicitly modelled due to data constraints in estimating unit labor cost and user cost of capital. Instead, the home part of the \(rmc\) in the Phillips curve is proxied by the output gap. This is based on the premise that wage pressures are embodied in the estimate of output gap such that for a given trend output, the prices of final goods already reflects any excess or deficiency in demand. On the other hand, for the imported component, \(rmc\) is represented by the real exchange rate gap, real international commodity price gap, and foreign output gap.

An essential feature of the Phillips curve is that backward and forward-looking components must sum up to one or what is known as the homogeneity restrictions on the parameters. The implications are two-fold: One is the super-neutrality feature, i.e., there is no long-run trade-off between output and inflation (i.e., Phillips curve is vertical in the long-run). The other important implication is that while the equation defines the dynamic path of inflation, it does not say anything about what the equilibrium inflation should be. In equilibrium when all gaps are zero, inflation simply reverts to target. This specification points to the fact that it is the prerogative of monetary policy to determine the inflation target and anchor expectations towards it, underscoring the instrument independence of an inflation-targeting central bank.16

International real commodity price gap also enters the Phillips curve to account for the impact of imported commodity prices (such as oil and food) on domestic inflation. It is simply modelled as a function of its own lag and foreign output gap.

\[ LRPCOMGAP = \psi_1 \times LRPCOMGAP_{t-1} + (1 - \psi_1) \times \psi_2 \times YF_{gt-1} + RES\_LRPCOMGAP \] \hspace{1cm} (eq6)

**Monetary policy reaction function.** The reaction function embodies the trade-offs that the BSP needs to balance such that it does not become an unintended source of volatility in the economy. The rule also cannot sidestep stabilization issues by putting large weight on the near-term inflation forecast. Output gap plays a central role in the model notwithstanding the uncertainty about its precise level. However, it is also equally costly to put too large weight on it or other measures of excess demand.

The monetary policy rule is a forward-looking reaction function. In this rule, the policy rate is a function of inflation gap (measured in year-on-year terms),\(^{17}\) output gap, as well as lagged policy rate that reflects inertia in actual policy setting due to uncertainty. It states that excess demand conditions and higher-than-target inflation expectations would require an upward adjustment in the policy rate.

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17 Inflation target is expressed on a year-on-year basis.
\[ RS = \gamma_1 \times RS_{t-1} + (1 - \gamma_1) \times (RR_t + PIETARGET_{t+1}) + \gamma_2 \times (dP_{t+3} - PIETARGET_{t+3}) + \gamma_3 \times Y_g + RES_RS \]  
\text{(eq7)}^{18}

In real terms, \( RR = RS - dP_{t+1} \)

where:
- \( RS \): Nominal reverse repurchase rate (policy rate)
- \( RR \): Real policy rate
- \( RR_t \): Trend real policy rate
- \( PIETARGET \): Inflation target
- \( dP \): Quarter-on-quarter inflation
- \( Y_g \): Output gap
- \( RES_RS \): Monetary policy shock

The equation also implies that even if inflation forecast may be below target, conditions of strong excess demand condition could also prompt the central bank to adjust the short-term rate as a pre-emptive measure to temper inflationary pressures going forward. The monetary policy rule is characterized by inertia, reflecting inherent uncertainty in the economic environment when the policy rate is determined. Given that there is inertia in the way output gap affects inflation, the short-term rate can only be, at best, set in a way that would project inflation to go back to target within a reasonable period, without new shocks.

Exchange rate gap (\( Z_g \)) is deliberately not included in the monetary policy rule because of the role it plays in the determination of the BSP’s monetary policy stance.\(^{19}\) The BSP resorts to occasional intervention in the foreign exchange market when the exchange rate movement is deemed too volatile and inconsistent with the country’s fundamentals. This occasional intervention motive is instead embedded in the UIRP equation, as discussed in the following section. Furthermore, there may be no significant information value from its inclusion in the monetary reaction function. This is because the exchange rate in the UIRP is already a function of expected future interest rates, which, in turn, are also determined by other macroeconomic variables.

**Uncovered Interest Rate Parity (UIRP).** The uncovered interest rate parity is an arbitrage condition that reflects how international investors seek to equalize the effective rates of return on different currencies, allowing for some country-specific risk premium. Interest rate differential is estimated vis-à-vis the US since Philippine foreign assets and liabilities are predominantly denominated in US dollars.

\[ RS - RS_{US} = 4 \times (S_e - S) + PREM - \omega_4 \times RMTF_g + \omega_5 \times dFXRES + RES_{UIP} \]  
\text{(eq8)}^{20}

where:
- \( RS \): Nominal reverse repurchase rate
- \( RS_{US} \): Nominal US Federal Funds rate
- \( S_e \): Expected nominal exchange rate (see eq 9)
- \( S \): Nominal exchange rate
- \( PREM \): Risk premium
- \( RMTF_g \): Remittance gap in US$
- \( dFXRES \): Quarter-on-quarter change in foreign exchange reserves
- \( RES_{UIP} \): Shock on exchange rate

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\(^{18}\) Policy rate is in annual terms, hence, the deviation of inflation forecast from target is also expressed in annual terms.

\(^{19}\) Peiris’ (2011) specification includes real exchange rate in the monetary reaction function, citing finding of Stone et al, 2009) that real exchange rate is “observed to be quite significant in emerging markets. Peiris noted that the coefficient of real rate gap was less than many other emerging markets.

\(^{20}\) The term \( 4 \times (S_e - S) \) is just the annualized rate of change in nominal exchange rate to make it compatible with policy rate expressed in annual terms.
Expected exchange rate is the weighted sum of forward-looking and backward-looking components. The drift corresponds to the adjustment for trend nominal exchange rate as defined by $2 \times (dZ_t + \text{PIETARGET} - \text{PIETARGET}_\text{US})/4$ in equation 9.21

$$S_t = x_i \cdot S_{t+1} + (1 - x_i) \cdot S_{t-1} + 2 \times (dZ_t + \text{PIETARGET} - \text{PIETARGET}_\text{US})/4$$  \hspace{1cm} \text{(eq9)}$$

where:

- $S_{t+1}$: Lead nominal exchange rate
- $S_{t-1}$: Lagged nominal exchange rate
- $dZ_t$: Annual trend real exchange rate depreciation/appreciation
- PIETARGET: Annual Philippine inflation target
- PIETARGET_US: Annual US inflation target

The premium ($\text{PREM}$) in the $\text{UIP}$ (eq 8) is derived from the trend-consistent $\text{UIRP}$, i.e., $\text{PREM} = \text{RR}_t - \text{RRF}_t - dZ_t$, where $\text{RR}_t$ is the domestic trend real policy rate, $\text{RRF}_t$ is the trend US real Federal Funds rate and $dZ_t$ is the trend real exchange rate. This should not be interpreted as the measure of premium used in many reports such as the Credit Default Swaps (CDS) or EMBI-Philippine indices, which do not lend themselves easily to replication, given different methodologies for constructing the indices. Instead, $\text{PREM}$ in the model simply represents the excess over the trend exchange rate depreciation/appreciation rate implied by the arbitrage condition. It captures the adjustment in returns demanded by foreign investors for country-specific risk.

The inclusion of change in foreign exchange reserves ($d\text{FXRES}$) and remittance gap in foreign currency ($\text{RMTFg}$) is meant to capture the impact on exchange rate of higher foreign exchange inflows, proxied by remittances, and the BSP’s foreign exchange intervention during times of excessive volatility.

**Okun’s Law.** Wage pressures are embodied in the measure of output gap, which feeds into unemployment and inflation.

$$UR_g = \chi_1 \ast UR_{g,t-1} + \chi_2 \ast Y_{g,t} + \text{RES}_\text{URG}$$  \hspace{1cm} \text{(eq10)}$$

$$UR_t = \chi_3 \ast urss + (1 - \chi_3) \ast UR_{t,t-1} + gUR_t + \text{RES}_\text{URT}$$  \hspace{1cm} \text{(eq11)}$$

$$gUR_t = \chi_4 \ast gUR_{t,t-1} + gUR_t + \text{RES}_g\text{UR}$$  \hspace{1cm} \text{(eq12)}$$

$$UR = UR_t - UR_g$$  \hspace{1cm} \text{(eq13)}$$

where:

- $UR$: Unemployment rate
- $UR_g$: Unemployment rate gap
- $UR_t$: Trend unemployment rate
- $gUR_t$: Growth rate of trend unemployment
- $urss$: Steady-state unemployment rate
- $\text{RES}_\text{URG}$: Shock to unemployment gap
- $\text{RES}_\text{URT}$: Shock to trend unemployment rate
- $\text{RES}_g\text{UR}$: Shock to growth rate of trend unemployment rate

The condition of surplus labor together with the institutional feature of minimum wage setting would imply that wage pressures do not make a significant dent on output gap or on inflation. Only about 3 million workers are covered by the minimum wage law, representing roughly 8 percent of the total labor force. There is a cap on the frequency of minimum wage adjustment per year, relatively small magnitude of wage adjustments when implemented, and reported under reporting of compliance with minimum wage law. Real wage growth (mean

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21 $\text{PIETARGET}$, $\text{PIETARGET}_\text{US}$ and $dZ_t$ are all expressed in annual terms. Thus, the factor 4 converts these variables into quarter-on-quarter terms. The factor 2 corresponds to 2 adjacent quarters, i.e., t-1 and t+1 quarters to make the exchange rate less erratic.

22 Remittances account for a substantial portion of foreign exchange inflows into the Philippines, outpacing inflows arising from foreign direct investments and portfolio inflows.

23 No petition for regional wage adjustment is allowed 12 months after the effectivity of a wage order, unless there are supervening conditions.
differential between annual nominal wage growth and annual inflation rate) for the period 1998-2012 is just about 0.9 ppt. Thus, in real terms, it can be inferred that variability in real wages accounts for a very small portion of the variability in real marginal cost, at least, historically. This is also supported by the fact that the number of underemployed (hence, lower wages) are much greater than the unemployed.

**Foreign Block.** The foreign block, represented by the US economy, consists of three major equations, namely, output gap, Phillips curve, and monetary policy rule. The equations of the foreign block are patterned after the 2008 Small Quarterly Projection Model for the US economy. The foreign block in the MMPH should not be taken as a forecasting model for the US but merely a tool for conditioning some other forecasts from satellite trade models or even the IMF Global Projection Model (GPM) forecast.

\[
YF_g = \alpha_{f1} \cdot YF_{g_{t-1}} + \alpha_{f2} \cdot YF_{g_{t+1}} - \alpha_{f3} \cdot RRF_{g_{t-1}} + RES_{YFG} \quad \text{(eq14)}
\]

\[
dPF = \beta_{f1} \cdot dPF_{t-1} + (1 - \beta_{f1}) \cdot dPF_{t+1} + \beta_{f2} \cdot YF_{g_{t-1}} + RES_{DPF} \quad \text{(eq15)}
\]

\[
RS_{US} = \gamma_{f1} \cdot RS_{US_{t-1}} + (1 - 0.65) \cdot [(RRF_t + PIETARGET_{US_{t+1}}) + \gamma_{f2} \cdot (d4PF_{t+3} - PIETARGET_{US_{t+3}}) + \gamma_{f3} \cdot YF_g] + RES_{RS_US} \quad \text{(eq16)}
\]

\[
RRF = RS_{US} - dPF_{t+1} \quad \text{(eq17)}
\]

where:

- \(YF_g\): US output gap
- \(dPF\): US inflation rate
- \(PIETARGET_{US}\): US inflation target
- \(RS_{US}\): US Federal Funds rate
- \(RRF\): US real Federal Funds rate
- \(RRF_t\): US real trend Federal Funds rate
- \(RRF_g\): US real interest rate gap
- \(RES_{YFG}\): Shock to US output gap
- \(RES_{DPF}\): Shock to US inflation
- \(RES_{RS_US}\): US monetary policy shock

There are several reasons for using the US economy as the proxy for the world economy. First, the use of US parameter values is deemed justifiable since the Philippine business cycle closely tracks the US business cycle. Hence, the magnitude of the parameters is expectedly within the same range of values. Second, the use of US as a proxy for foreign demand is also premised on the vertical production networks within the Asia-US region, with China as the center of the network. In this set-up, China is the core market for intermediate products, from which final consumption goods were produced for exports predominantly to the US. While Emerging Asian economies account for the largest share in trade balance with the Philippines, the US remains the final destination market for final goods (WTO and IDE-JETRO, 2011). Lastly, from a cost-efficiency perspective, a simple foreign bloc that captures key dynamics would suffice in the initial phase of model-building. Building a detailed regional foreign bloc for a small open economy like the Philippines is a very resource-intensive and time-consuming endeavor. It would be akin to having a full-scale Global Projection Model (GPM) of the IMF. Eventually, either the MMPH will link to the GPM or a smaller-scale external satellite model will be developed.

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24 The foreign block should not be interpreted as the model for the US economy. External assumptions over the forecast horizon are taken from the US block of the IMF Global Projection Model (GPM) and plugged into MMPH forecast path as given. Thus, the foreign block is a means to incorporate the impact of external demand on the Philippine economy but does not do real forecasting for the US economy.


26 This is known as the tripolar trade through China. In this structure, (i) East Asian economies produce sophisticated components and export them to China; (ii) China assembles them into final products; and exports them to the United States for consumption (page 78 of IDE-JETRO WTO Trade Patterns and Global Value Chains in East Asia, 2011).
III. Policy Tests

To illustrate the transmission of aggregate demand and aggregate supply shocks in the model, four policy tests were undertaken with the current version of the model.27

(a) Positive aggregate demand shock (Figure 4)

When a demand shock occurs (e.g., via fiscal stimulus, across-the-board wage pressures), inflation goes up. Monetary policy reacts to temper the build-up of domestic inflationary pressures. On impact, this action of the central bank brings about nominal exchange rate appreciation. With nominal exchange rate appreciation and rise in domestic inflation, real exchange rate appreciates, dampening the rate of growth of the domestic price of imports (i.e., imported inflation).

Notwithstanding the immediate monetary policy response to the shock, inflation still goes up and peaks in the 3rd – 4th quarter due to inertia in demand. Inflation goes back to target approximately twelve quarters after the initial shock. The challenge for monetary policy, therefore, is to bring inflation back to target over the two-year policy horizon set by the central bank. This feature of the monetary policy horizon acknowledges that optimal monetary policy is one that does not try to bring inflation back to target every period, otherwise such policy behavior will be inducing undue volatility in the market.

(b) Positive aggregate demand shock with unchanged monetary policy stance for four quarters (Figure 5)

This exercise is intended to demonstrate the cost of delay in monetary policy response in the face of demand shock. Without the exchange rate appreciation, the impact on inflation is immediate. Because the unchanged monetary policy stance is anticipated by the market, the inaction will feed into higher inflation expectations, thus, inducing greater inflation volatility that would require a stronger policy response the longer the duration of unchanged policy stance is.

(c) Aggregate Supply Shock (Figure 6)

A positive supply shock leads to an immediate, sharp rise in inflation. Monetary policy counteracts the inflation hike with higher policy rate. The higher interest rate initially triggers an exchange rate appreciation, which reverses itself afterwards. This pulls down the output gap in subsequent periods that leads to a gradual decline in domestic inflation.

As can be seen in the chart, inflation peaks earlier with a cost-push shock compared to an aggregate demand shock. The cost-push shock raises domestic inflation by a bigger magnitude than the aggregate demand shock because of its direct impact on real marginal cost.

(d) Short-lived aggregate supply shock (Figure 7)

A temporary supply shock results in much subdued inflation and moderate output loss. With unchanged US inflation, the higher inflation ensuing from the temporary cost-push shock triggers a nominal exchange rate depreciation that immediately reverses itself in the succeeding quarter. A shock that is expected to be temporary (e.g., supply disruptions due to typhoons, short-term geo-political turbulence) will expectedly affect investment and consumption plans by a lesser magnitude than a persistent shock.

27 Additional policy tests will be included in the working paper version of this article.
Concluding Remarks

This article provides only a snapshot of the core behavioral equations and the basic simulation results of the MMP. As in any economic modelling work, the MMP is a work-in-progress. Nonetheless, the preliminary results are theory-consistent with impulse response functions that reasonably reflect the dynamic path of key variables in response to shocks.

Figure 3
Actual Growth Rates vis-à-vis Trend Growth Rates of GDP Components

Figure 4
Positive Aggregate Demand Shock

Output Gap (Yg)
Quarterly Inflation (dP)
Annual Inflation (d4P)
Policy Rate (RS)
Rate of Change in the Nominal Exchange Rate (dS)
Rate of Change in the Real Exchange Rate (dZ)
Figure 5
Positive Aggregate Demand Shock with Unchanged Monetary Policy Stance for Four Quarters

Policy Rate (RS)
Quarterly Inflation (dP)
Annual Inflation (d4P)
Output Gap (Yg)

Figure 6
Aggregate Supply Shock
Quarterly Inflation Rate (dP)
Annual Inflation Rate (d4P)
Policy Rate (RS)
Rate of Change in Nominal Exchange Rate (dS)
Rate of Change in Real Exchange Rate (dZ)
Output Gap (Yg)
Appendix 1

Summary of Parameter Values

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<th>Parameter</th>
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Appendix 2

Measurement Variables Used in the Model

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<td>Unemployment Rate</td>
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<td>RS</td>
<td>BSP’s Reverse Repurchase Policy (RRP) Rate</td>
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<td>LRPCOM</td>
<td>IMF International Commodity Prices, weighted sum of fuel (POILDUB) and non-fuel commodities (PNFUEL)</td>
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<td>Inflation Target</td>
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<td>Overseas Filipino Workers’ Remittances (in US dollars)</td>
</tr>
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<td>Nominal Exchange Rate</td>
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<td>RS_US</td>
<td>US Federal Funds Rate</td>
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</table>

All variables are in logs and seasonally-adjusted where applicable.

References


Southeast Asian Economic Outlook 2012/13: With Perspectives on China and India. OECD Development Centre’s Southeast Asia Unit.


