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The contribution of the output gap to the conduct of inflation targeting in the Philippines

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This paper evaluates whether the inclusion of the output gap in the central bank's estimated reaction function would improve the conduct of inflation targeting in the Philippines. A reduced-form vector autoregression model was constructed using exchange rate, output gap, inflation, and interest rate as the relevant variables. The authors use two measures for the short-term interest rate: the reverse repurchase rate and the T-bill rate. Results from counterfactual simulations show that the adoption of a Taylor-type rule, which involves the use of the output gap, minimizes the deviations of inflation from its target.

Based on the empirical results of this study, the inclusion of the output gap is significant in terms of its contribution to maintaining inflation at a level that is nearer to the desired target. It is recommended that further studies consider the use of output gap estimates derived from other procedures, especially those that employ Markov-regime switching techniques, which could account for shocks in the economy. In addition, the use of alternative model-representations for the Philippine economy within which counterfactual simulations may be performed is recommended as an area for future research.

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1. Introduction

In 1993, the Philippines enacted a new Central Bank charter (RA 7653) that established the maintenance of "price stability conducive to the balanced and sustainable growth of the economy" as the primary objective of its monetary policy. In the light of new developments in the global economic climate as well as changes in the structure of the economy over the past two decades, the monetary aggregate targeting approach used by the Bangko Sentral ng Pilipinas (BSP) was no longer as effective in allowing authorities to control inflation at desired level. Financial deregulation and liberalization had weakened the traditional relationship that links money supply to income and prices.

In answer to the demands presented by these changes, the BSP formally shifted to an inflation-targeting regime in January 2002. This approach allowed for more economic variables to be taken into consideration in the formulation of monetary policy. Rather than strictly observe the targets set for monetary aggregates, the central bank now monitors variables such as key interest rates, exchange rates, prices, and indicators of demand and supply. In addition, inflation targeting promotes transparency and accountability on the part of the BSP. It facilitates communication between monetary authorities and the public as announcements of the central bank's policy actions and the rationale behind these measures must be made. In instances when inflation would deviate from the target, the central bank is compelled to explain how and why such an outcome came to be. This mechanism thus leads to a better public understanding of the policy objectives of the BSP and to the strengthening of its credibility.

One of the most popular concepts that have surfaced in recent literature regarding inflation targeting is the output gap. Within a monetary policy framework, the output gap has often played a vital role as an indicator of inflationary pressures and is thus among the main building blocks of inflation forecasting models. Alternatively, from a fiscal policy perspective, the output gap represents a measure of cyclical activity as it signals existing excesses in supply or demand in the economy [Proietti, Musso, and Westermann 2002]. Indeed, the output gap has merited much attention as it can direct monetary authorities in choosing the most appropriate stance in fiscal and monetary policies.

In contrast to the central banks of a number of developed countries, the BSP has yet to evaluate the significance of including the output gap as a component in its newly adopted framework for inflation targeting. To date, there has yet to be a variable that solely represents the gap in the formal model that the BSP uses. One can only surmise that perhaps the gap's exclusion can

be attributed to the lack of related literature and research that have been conducted in the context of the developing world. Very recently, however, several studies have estimated the output gap for the Philippines and its neighboring countries.[1]

There are reasons to believe that including the estimates of the Philippine output gap can significantly improve the BSP's practice of inflation targeting. There is much clear evidence demonstrating that inflationary pressures tend to increase (decline) as output rises (falls) relative to potential [*Journal of Monetary Economics* 1999]. As the output gap is influential in determining and forecasting inflation, it naturally plays an important role in the conduct of monetary policy. Following the simple interest-rate rule proposed by Taylor [1993], studies have demonstrated that the output gap is indeed significant in estimated reaction functions of central banks [Gerlach and Yiu 2002].

Theory aside, experience has shown that the output gap has been successfully applied in the practical conduct of monetary policy in many high-income countries that practice inflation targeting. These countries include Canada, Israel, New Zealand, Sweden, and the United Kingdom [Walsh 2001]. More important, empirical evidence shows that the output gap contains information on inflation even in emerging market economies. Coe and McDermott [1999] find that the output gap is a significant determinant of inflation for 11 out of the 13 Asian countries under study. Outstandingly, the gaps remain significant even when other variables, such as measures of monetary disequilibriums, are included in the equations.

This paper aims to determine whether the inclusion of the Philippine output gap as a component in inflation targeting would improve the performance of the inflation-targeting framework used by the BSP. It seeks to investigate whether the Philippine output gap should be included in the BSP's estimated reaction function.

2. Review of related literature

2.1. International literature

In a study conducted by Bolt and van Els [1998], output gaps for 11 European Union (EU) countries, the United States, and Japan are constructed based on measures of potential output derived from a constant elasticity of

[1] These include works of Dakila [2001], Gerlach and Yiu [2003], Bautista [2002a, 2002b], and Yap [2003].

substitution (CES) production function.[2] National output gaps for each individual country were estimated along with aggregate output gaps for the European Union and the euro area (which excludes Denmark, Sweden, and the United Kingdom). Using a modern version of the Phillips curve model, it is examined whether these output gaps really contain information on future inflation.

Results show that except for Belgium, fluctuations in the levels of individual output gaps significantly precede changes in the course of inflation. Going further into the analysis, the inflation effects of the changes in the level of the output gaps were shown to differ to a large extent across countries. In Italy, Sweden, and the United Kingdom, the output gap is significant at the 5 percent level or less, indicating that movements in the gap estimates have strong effects on inflation. In Spain, the Netherlands, Finland, Japan, and Germany, the output gap is significant at the 10 percent level, demonstrating moderate effects on inflation. Thus empirical results from the study are consistent with the hypothesis that the national gaps may serve as information variables on inflation in monetary policy formulation.

Concerning the aggregate European output gap, this measure is significant in predicting inflation in individual EU countries except for Spain. The proof that an aggregate European output gap may be used as a signal for inflation in individual countries reinforces its acceptance as a policy indicator. Results also point toward the successful application of the gap's use as an inflation indicator for the European Union and the euro area as a whole. This is supported by the fact that the aggregate European output gap significantly precedes aggregate European inflation. The significance of an aggregate output gap thus holds promise for its use in regions where the level of development is quite similar across countries.

In the case of New Zealand, Claus [2000] considered whether the output gap would still be a useful indicator of pressures on inflation despite the persisting uncertainty regarding its estimates. The Hodrick-Prescott (HP) filter, the Reserve Bank of New Zealand's multivariate (MV) filter, a structural vector autoregression (SVAR),[3] and the unobserved components (UC) model were

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[2] The EU countries included in the study are Austria, Belgium, Germany, Denmark, Spain, Finland, France, Italy, the Netherlands, Sweden, and the United Kingdom. The United States and Japan are used in the study as comparator countries.

[3] Based on long-run restrictions on output, the SVAR exploits the statistical relationship between inflation and growth. It does not impose constraints on the short-run dynamics of the permanent component of output. An advantage is that it allows for estimated transitional dynamics following permanent shocks in the economy [Bolt and van Els 1998].

the procedures used for estimating the output gap. The gaps from these methods were then evaluated to determine the extent of their ability to explain inflationary pressures as measured by the consumer price index (CPI).

To test whether the output gap can forecast inflation, two models were constructed. The first model relates the *level* of the output gap to changes in inflation such that inflation tends to rise (fall) with a positive (negative) gap. The second model relates *changes* in the level of the gap to changes in inflation. In this case, the course of inflation will be stable as long as there are no changes in the level of the output gap over time.

In general, the plots of the change in actual inflation and the predictions from the HP, MV, SVAR, and UC gaps confirm the finding that the output gap is a good indicator of inflationary pressures because actual and predicted inflation tend to move in the same direction. For New Zealand, it could be concluded that when the output gap is positive (negative), two times out of three, inflation will increase (decrease) in the next quarter and three times out of five it will increase (decrease) the following year.

2.2. Philippine literature

Although studies regarding inflation targeting and the output gap made especially for the Philippines come few and far between, a dissertation by Dakila [2000] proved to be a pioneering breakthrough. In his paper, the author's primary objective was to provide a quantitative assessment of the gains from a shift in monetary policy stance by the BSP that is consistent with the new mandate given in 1993. Dakila analysed the effects of exercising discretion alongside with following a rule-based procedure and considered several types of monetary policy rules. Of particular relevance to this study would be the adoption of Taylor-type rules in which the interest-rate instrument targets a combination of price and output stability objectives.

Dakila examined the use of a Taylor rule for monetary policy, and observed that its adoption imposes a small cost in terms of an increased deviation in inflation from the target rate. This result is not surprising as the inclusion of the output gap variable in the equation would naturally cause a trade-off between deviations of output from potential and deviations of inflation from its target. However, it was shown that results in simulations conducted that employed an interest-rate rule, on the one hand, and the Taylor rule, on the other hand, are broadly similar. This suggests that the penalty for including the gap variable is not substantial in attaining the inflation target. Likewise, targeting a certain rate of inflation may not impose much cost in terms of output.

In conclusion, Dakila argues that it is feasible to use monetary policy rules with the reverse repurchase rate as the policy instrument. With the adoption of these rules, simulated inflation rates have lower deviations than actual inflation with respect to the targeted rate. Similarly, the use of the Taylor rule can also lead to a stable and reduced rate of inflation, although its contribution is slightly less relative to other interest-rate rules in his study.

The most recent study conducted in Philippine literature was that by Yap [2003] who measured the Philippine output gap using three atheoretical methods: (a) the linear time trend model, (b) the Hodrick-Prescott filter, and (c) the unobserved components model. To establish the relationship between the output gap and inflation, the author estimated an inflation model in error correction (ECM) format. First, the CPI was specified as a function of cost-push factors (which include the Dubai crude oil price and the exchange rate) and money supply. Subsequently, each alternative measure of the output gap was added to the inflation equation.

Results show that the output gaps derived from the three different methods were all significant in Yap's inflation model. The gaps from time trend method have the highest t-statistics, followed by those from the UC method and, last, from the HP filter. The author noted that the apparently superior performance of the time trend method is surprising since the method yields estimates that are nonstationary. It was argued that this outcome is simply a sample phenomenon rather than an intrinsic advantage of the method. Overall, the author concluded from this simple procedure that the output gap is useful in an inflation model that uses Philippine data. This study, however, did not show whether the gap can actually be used in the BSP's inflation-targeting framework.

3. Theoretical framework

3.1. The Taylor rule

Taylor [1993] suggests a very specific and simple rule for monetary policy. The policy instrument in the Taylor rule is the federal funds rate (FFR), the level of which is determined by the following components: (a) the level of the short-term interest rate that would be consistent with full employment (the equilibrium real interest rate), (b) the average inflation rate over the past four quarters,[4] (c) the deviation of actual inflation relative to the target, and (d) the

[4] Alternatively, this component can also be defined as the contemporaneous inflation rate specified as (ln Pt– ln Pt-1) • 400 where Pt is a measure of the price level or its lagged value [Razzak 2001].

output gap. Although there are a number of ways by which the Taylor rule can be specified, the form most typical and relevant to this study is as follows:

$$i_t = \pi_t + r^* + \lambda_\pi (\pi - \pi^T) + \lambda_{yt}(y_t) \quad (1)$$

where

i_t is the federal funds rate

π_t is the average inflation rate over the past four quarters

r^* is the equilibrium real federal funds rate

π^T is the target inflation rate

y_t is the percent output gap [100 • (real GDP – potential GDP) / potential GDP]

λ_π is the weight assigned for deviations from inflation

λ_{yt} is the weight assigned for deviations from the output gap

Walsh [1998] comments that since there are very few parameters involved in this rule, they can be varied in order for monetary authorities to gain insight into how systematic adjustments in policy responses change the dynamic characteristics of output, inflation, and interest rates. Moreover, targeting rules such as the Taylor rule are advantageous in the sense that they can be used feasibly and efficiently for different models of an economy. Especially in cases wherein data are lacking or problematic, it may be difficult to actually find one true model that would accurately capture the workings of the economy. Thus, it may be favorable to adopt a rule, such as the Taylor rule, that performs fairly in a wide range of models than a rule that would work best but only in one particular model [Dakila 2000].

4. Methodology

4.1. The vector autoregression model

In the absence of a full-blown macroeconomic model of the economy, a vector autoregression (VAR) model has been suggested as a more feasible approach in analysing policy effects. VARs have been well argued to provide for coherent and credible approaches to data description, forecasting, structural inference, and policy analysis [Stock and Watson 2001].

4.1.1. Selection of variables

In conducting simulations to test a policy rule that used the monetary base as its instrument, McCallum [1997] estimated an unconstrained (reduced

form) VAR model consisting of four variables. In his work, inflation, interest rate, change in nominal gross domestic product (GDP), and change in base money were used to track the behavior of the US economy.

This study will deviate from McCallum's model in four respects: (a) the policy rule in question will use the interest rate as its instrument, (b) the change in nominal GDP will be replaced by the output gap, (c) the change in base money variable will be excluded, and (d) an exchange rate variable will be included in the model. These modifications were made to answer the specific objectives of this paper.[5]

Substituting the change in nominal GDP variable with the output gap is made for obvious reasons. Since all the variables in the VAR model are endogenously determined, the output gap itself must be included. Otherwise, simulations cannot be performed when the interest-rate equation is replaced by the Taylor rule. Also, dissimilar to McCallum, the central bank's policy instrument in this case is the rate of interest. In effect, changes in the economy's behavior that are caused by changes in the monetary base, would be sufficiently captured by the interest rate.

While the inclusion of a variable for the monetary base may not be considered necessary, the inclusion of an exchange rate variable may prove to be vital. The inclusion of the exchange rate in this model is made for the reason that rich and dynamic relationships exist between the exchange rate, inflation, interest rate, and output—especially for the Philippines, which stands as an emerging market economy heavily influenced by external factors.

4.1.2. Model specification

Two sets of VAR models are constructed. The first set involves the use of the reverse repurchase (RRP) rate as the relevant policy instrument as suggested by Dakila [2000] in his study of monetary policy. The second set involves the use of the Treasury bill (T-bill) rate for comparison purposes. Each set will be composed of three VAR models that correspond to output gap estimates derived by Yap [2003] using the HP filter, the time trend method, and the UC method. The following equations are used to represent a simplified model of the Philippine economy.

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[5] The authors of this paper do not suggest that the VAR models involving these four variables in particular would accurately track the general behavior of the Philippine macroeconomy. Rather, it is argued that the chosen specification of this type of VAR model would better track a certain aspect of the general behavior of the macroeconomy that is pertinent to the study.

$$\begin{bmatrix} (Y_t) \\ exchrate \\ intrate \\ gap \\ cpinf \end{bmatrix} = A \bullet \begin{bmatrix} (Y_{t-i}) \\ exchrate_{t-i} \\ intrate_{t-i} \\ gap_{t-i} \\ cpinf_{t-i} \end{bmatrix} + u_t \quad (2)$$

where

exchrate is the nominal exchange rate in pesos per dollar (averaged quarterly)

intrate is the nominal interest rate (the RRP rate or T-bill rate)

gap is the output gap estimate derived from either the HP filter, the UC method, or the time trend method

cpinf is the inflation rate based on the consumer price index

A is the square matrix containing the coefficients of the estimated Y_{t-i}

Y_{t-i} is a vector of lagged values of each of the four macroeconomic variables

u_t is the error term to accommodate for shocks

4.2. Counterfactual simulation exercises

Counterfactual simulations will be conducted by replacing the estimated interest-rate equation from the VAR model with the Taylor rule, which is specified as follows:

$$intrate = \delta_\pi (\pi - \pi^T) + \delta_x (y - y_n) + a \quad (3)$$

where

$(\pi - \pi^T)$ is the deviation of inflation from the targeted rate

$(y - y_n)$ is the percent output gap [100 • (real GDP – potential GDP)/potential GDP][6]

a is a constant that consolidates the term for the equilibrium real interest rate and the average inflation rate from equation (1)[7]

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[6] Note that in Dakila's [2000] study, the output gap is defined differently. It is expressed as the difference between the log of a three-month moving average of GDP and a trend GDP series, as discussed in section 2.

[7] The decision not to adopt an estimate for the equilibrium interest rate is premised on the argument that this variable may change in response to shifts in fiscal policy, to the behavior of the private sector, and to changes in the levels of foreign interest rates [Walsh 2002]. Thus, the writers of this paper are hesitant to assume some long-term or "natural" value for the interest rate.

Equation (3) is the policy rule placed under consideration, which will serve as the central bank's reaction function. The values for the optimal coefficients, δ_{π} and $\delta_{x,}$ are derived from a separate ordinary least squares (OLS) procedure performed on this single equation.[8]

Since there are three VAR models for the different sets of output gap measures, there will also be three estimated Taylor-rule equations for each corresponding VAR model. The Taylor-rule equation would replace the interest-rate equation from the model in order to yield simulated rates of inflation. This procedure implies that if the BSP had followed this type of rule, which includes the output gap rather than the incumbent policy rule during the period covered, which excludes it, the simulated results would have been such in history.

The target inflation rate in this study is set at 5 percent. The rationale for setting this target level is based on the BSP's annual inflation target range of 4.5-5.5 percent for 2003. This is also the target rate of inflation adopted by Dakila [2000] in his study. According to him, this rate can be seen as a "transitional target," and if it is successful in maintaining inflation at this level, it would give way for the adoption of more ambitious inflation targets in the future.

4.2.1. Determining whether the inclusion of the output gap improves inflation targeting

In the case of a policy that behaves according to a Taylor rule, the optimal values for both deviations from the inflation target and the output gap are those that would yield the lowest root mean square error (RMSE). To determine whether the inclusion of the output gap in the estimated reaction function would actually minimize the deviations of inflation from the targeted rate, the RMSE will serve as the decision criterion. Redefining the formula in Danao [2002], the RMSE equation is given by

$$RMSE = \sqrt{\frac{\Sigma\left(\pi - \pi^{T}\right)^{2}}{n}} \qquad (4)$$

[8] Since the coefficients that were suggested by Taylor were used to describe the Federal Reserve's reaction to inflation and the output gap, it would be more appropriate to generate values from historical data in order to better customize the Taylor rule for the Philippine setting. This is supported by the argument made by Walsh [2002] that the values of these response coefficients would depend on the monetary transmission mechanism of the economy.

where

$(\pi - \pi^T)$ is the difference between the simulated values from the inflation target

n is the number of observations of either simulated or actual rates of inflation

The RMSE of simulated inflation rates from the model, which includes the output gap, will be contrasted against the RMSE of historical values of inflation. The course of actual inflation over the years is presumed to be the result of some type of monetary policy that the BSP has been using in practice. Although the preferences of the central bank in terms of trade-offs between macroeconomic variables are withheld from the public, it is known that the reaction function it employs does *not* include the output gap.

If the simulated inflation rates would yield lower RMSE values, this would imply that the inclusion of the output gap would lead to smaller deviations from the target rate. It can thus be inferred that the output gap can indeed improve the conduct of inflation targeting in the country. Furthermore, since the study uses three different sets of output gap estimates, the RMSE values of simulated inflation from each gap model can be compared to determine the type of gap estimate most suitable for inflation targeting in the Philippines.

5. Presentation of results and analysis

5.1. The Taylor-rule equations

The following are general features of the results from the OLS estimation procedure for the Taylor-rule equations (results from the OLS estimations are presented in Table 1). The six R^2 values for these equations are unsurprisingly low due to the fact that there are only two explanatory variables in the specification for the Taylor-rule equation. The Durbin-Watson (DW) statistics give the impression of the absence of first-order serial correlation. Before moving further into the analysis, one must keep in mind that the primary objectives of running an OLS procedure on the Taylor-rule equations are (a) to generate coefficients for deviations of inflation and the output gap, and (b) to generate values for the constant term that captures the equilibrium real interest rate and average inflation over the past four quarters as well.

For the first set of Taylor-rule equations involving the RRP rate, one would initially be alarmed in observing that the estimated output gap coefficients register the wrong sign. Since these coefficients were simply generated from

data, it is not to say that the interest rate reacts negatively rather than positively to deviations of output from potential. Rather, this result implies that data on the RRP rate, inflation, and output gap estimates exhibit such kind of behavior.[9]

Table 1. Taylor-rule estimation results

RRP rate-based Taylor-rule OLS estimation results						
Variable	*GAPHP equation*		*GAPUC1 equation*		*GAPTREND equation*	
	Coefficient	*T-stat*	*Coefficient*	*T-stat*	*Coefficient*	*T-stat*
Constant	19.56630*	9.9851	19.17459*	10.3565	19.27522*	9.6530
$(\pi - \pi^T)$	1.97848*	3.3598	1.95270*	3.5030	1.86419*	3.0993
$(y - y_n)$	-0.47129	-1.3489	-1.30393**	-1.7223	-0.20332	-0.8299
R-squared	0.145		0.151		0.124	
Adjusted R-squared	0.117		0.1316		0.102	
DW statistic	1.97		2.02		1.77	
F-statistic	5.6534		6.3049		5.0112	
T-bill rate-based Taylor-rule OLS estimation results						
Variable	*GAPHP equation*		*GAPUC1 equation*		*GAPTREND equation*	
	Coefficient	*T-stat*	*Coefficient*	*T-stat*	*Coefficient*	*T-stat*
Constant	0.86775*	2.0884	0.97713*	2.3219	0.81190	1.5292
$(\pi - \pi^T)$	0.36910*	3.3437	0.38113*	3.5328	0.39113*	2.8971
$(y - y_n)$	0.17482	1.5570	0.40039	1.6162	0.10227	1.0326
R-squared	0.182		0.190		0.190	
Adjusted R-squared	0.162		0.164		0.158	
DW statistic	1.8		1.85		1.85	
F-statistic	9.2428		9.3472		6.0070	

* Significant at the 5 percent level
** Significant at the 10 percent level

The important point to consider is that this regression was performed on a single equation only, and that the results do not pertain to an entire econometric model as in the usual regression analysis using OLS estimation. Thus, analysis and inferences can only be drawn when the Taylor rule replaces the interest-rate equation in the VAR models that have been estimated. Conclusions and judgments are reserved until the VAR model is solved after the Taylor-rule equations replace the interest-rate equation. The same argument

[9] The writers reiterate that the interest-rate equation in the initial VAR model does not define the central bank's reaction function. It simply describes the dynamics of relationships among variables based on actual data.

holds true concerning the t-statistics of the gap coefficients, which appear to be insignificant. Again, assessments regarding the rule must be made based on its interaction with the entire four-variable model representation of the economy, rather than on the OLS estimation results themselves.

For the second set of Taylor-rule equations involving the T-bill rate, all the output gap estimates have the correct sign. The coefficients for the gaps are all positive, consistent with Taylor's specification. Again, the t-statistics do not show the gaps to be significant as in the models involving the RRP rate.

Concerning the values for the constants from Table 1 in the RRP models, the t-statistics show that they are highly significant. This is to be expected as the contemporaneous rate of inflation is largely a function of its lagged rates, among others. Moreover, the estimated values, which are roughly at 19, are quite reasonable as the equilibrium real interest rate for the Philippines, as estimated by Dakila [2000] in his study, was 9 percent.

In the set of VAR models corresponding to the T-bill rate, the estimated values for the constants all approximate 1, which is unreasonably low. This is especially true when considering the fact that the constant is supposed to capture both the equilibrium real interest rate and the average inflation. However, the constants remain significant at the 5 percent level, although the t-statistics are relatively lower than those in the first set.

Across the two sets of Taylor-rule equations, it can be observed that all the estimated coefficients for deviations of inflation from the target are larger relative to the estimated coefficients for percentage deviations of output from potential. This may indicate that historical values for the interest rate, be it the RRP rate or the T-bill rate, are relatively influenced to a larger extent by deviations from inflation rather than by the output gap. In terms of relative performance across the two sets of models, the writers of this paper are, at this point, not in any position to make any judgment. This is again due to the fact that the OLS procedure was conducted for the purpose of obtaining coefficients for the two variables in the Taylor rule and the values for the constant term.

The resulting differences between the two sets of models may be attributed to three factors. First, it may suggest that the rule may be suffering from some specification error. In particular, the aggregation of the equilibrium rate of interest and average inflation for the past four quarters into a single variable may have caused the discrepancies between the two models with regard to the estimated values for the constant term and their respective t-statistics. Second, it may be attributed to the fact that the data used to derive the coefficients for

the rule do not cover the same periods. Models involving the RRP rate cover data on all relevant variables from 1985.1 to 2002.4, while models involving the T-bill rate cover the period 1981.1 to 2002.4, depending on data availability. Third, although movements in the RRP rate and the T-bill rate are broadly correlated, time-series data on the RRP rate are highly variable.[10]

5.2. The contribution of the output gap

To test if the inclusion of the GAPHP variable in the central bank's reaction function lessens the deviations of inflation from the target, the interest-rate equation from the VAR model is replaced by the Taylor-rule equation. Using the RRP rate, Figure 1a shows that the variability of inflation has dramatically decreased with the adoption of the employed form of the Taylor rule. Sharp increases in historical inflation of 15.07 percent and 17.07 percent in the years 1983.4 and 1984.2, respectively, were noticeably avoided. The model yields lower simulated rates of 4.27 percent and 4.07 percent, respectively, which follow a much smoother path. Note, however, that, in general, movements in actual and simulated values for inflation are not correlated.

Just as in the first model, using the T-bill rate as the relevant rate of interest also reduced the variability of inflation. From Figure 1b, a generally lower and smoother inflation path can be observed. In this model, there seems to be an improvement with regard to correlations in the movement of actual and simulated inflation, implying that the VAR results involving the T-bill rate, in this case, are more realistic and thus more credible relative to the VAR results involving the RRP rate. More important, simulated rates of inflation from the T-bill model are much closer to the target level of 5 percent relative to simulated rates from the RRP model.

In general, an ocular inspection of the two graphs that correspond to gap estimates from the HP filter suggests a marked improvement in inflation performance in terms of yielding lower and more stable rates of inflation. The simulation exercise suggests that the practice of inflation targeting involving the output gap greatly improves the course of inflation. The actual values that are used as the bases for comparison are taken to be the result of central bank preferences, objectives, monetary policy stance, and the incumbent policy rule/s used during the relevant period covered.

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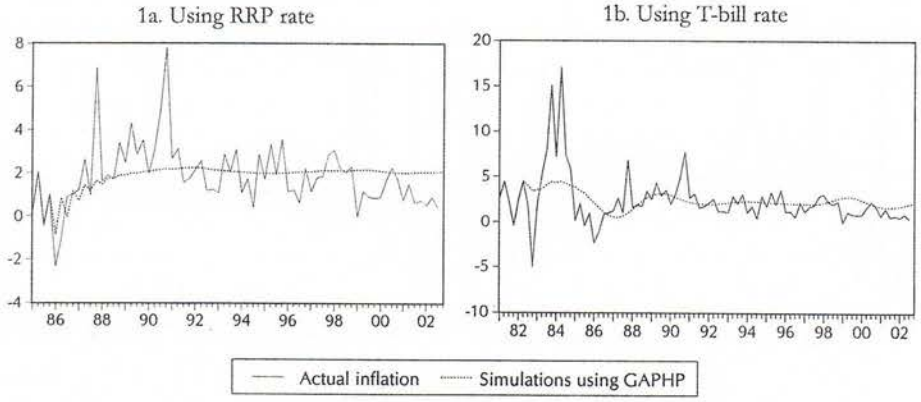
[10] Dakila [2000] states that "greater variability in the RRP rate is due to the exercise by the Central Bank of its discretion, with, however, market forces imposing some constraint upon the actions of the Central Bank in the long run."

Figure 1. Simulated inflation using GAPHP vs. actual inflation (RRP values are from 1985; T-bill values from 1981)

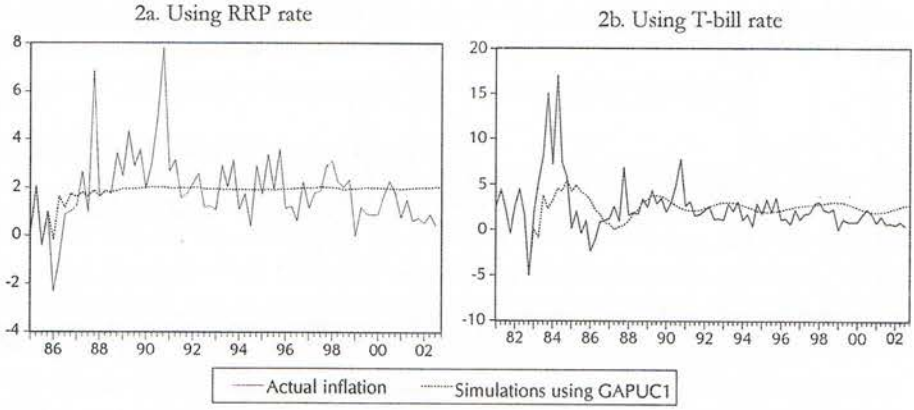


Thus, the writers infer that if the BSP had opted to conduct policy consistent with what the model suggests, the desirable outcome of price stability may have taken the place of variable inflation as in history. It is not to say that the BSP should adopt a rule that would take the exact form of the Taylor rule.[11] Rather, it seems that adjusting key policy interest rates in response to deviations of inflation from the target as well as in response to output gap estimates is highly favorable in terms of inflation performance. This argument, however, remains to be confirmed with the computed root mean square errors of simulated inflation, which are presented in the latter part of this section.

Regarding the VAR models that involve gap estimates from the unobserved components method, Figures 2a and 2b also suggest lower and more stable simulated rates of inflation. Again, the T-bill model seems superior to the RRP model in terms of yielding rates of inflation that are nearer to the target rate of 5 percent. In addition, movements in simulated rates of inflation correspond more to movements in actual inflation in the T-bill model. It seems that results involving the GAPUC1 are much similar to results involving the GAPHP. However, this observation can only be confirmed by their respective RMSEs.

[11] Svensson [2001] has several objections on the Taylor rule. First, he notes that no inflation-targeting central bank has formally committed to a Taylor rule. Second, he argues that the rule misses a sizable fraction of policy behavior as it can only account for around two-thirds of the behavior of the contemporaneous rate of inflation. Third, he contends that inflation-targeting central banks employ a much larger information set than is captured in the simple rule. Fourth, he remarks that a simple rule such as what Taylor recommends is inherently suboptimal.

Figure 2. Simulated inflation using GAPUC1 vs. actual inflation (RRP values are from 1985; T-bill values from 1981)

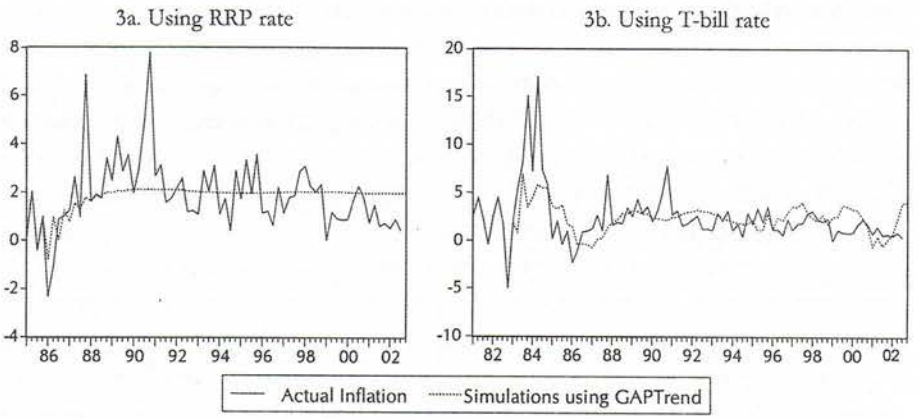


Simulation results that correspond to the GAPTREND variable are presented in Figures 3a and 3b. Now including the GAPTREND models in the analysis, several observations across the models for the three gap estimates may be noted. Apparently, all models that involve the RRP rate yield very similar results. In the RRP models, simulated inflation is exaggeratingly stable, nearly flat-lining at the 2 percent level. On the other hand, all three models involving the T-bill rate yield rates of inflation that are much closer to the target.

However, there lies a distinction between the T-bill models as reflected by simulation results from the GAPTREND model. From Figure 3b, it can be observed that movements in simulated inflation involving the GAPTREND more accurately match the movements in actual inflation relative to the preceding models that have been presented. Consequently, the path of inflation from this model is less smooth relative to those involving the GAPHP and the GAPUC1. It is also worth noting that while the GAPHP model yields the lowest simulated inflation rate for the year 1984.2, the GAPTREND model yields the lowest simulated inflation rate of 2.33 percent among all the models during the year 1983.4, which registered an actual inflation rate of 15.07 percent. Note that these were the two years when actual inflation peaked in the sample period.

From the graphs, it can be observed that simulated rates of inflation involving the T-bill rate are closer to the target and better correspond to movements in actual inflation. For these two reasons, the writers of this paper are led to believe that in terms of relative performance, the models involving the use of the T-bill rate are superior to the models involving the RRP rate.

Figure 3. Simulated inflation using GAPTREND vs. actual inflation (RRP values are from 1985; T-bill values from 1981)



Again, this argument remains to be confirmed by computations on the RMSE values.

5.2.1. Root mean square error

Following McCallum [1989], the RMSE values of simulated inflation from the different models using the three types of gap estimates are computed. Based on the formula as previously given in the methodology, the RMSE values that correspond to each of the six models are summarized below:

Table 2. Root mean square errors

Gap measure	$\Sigma(\pi - \pi^*)^2$ *(Summation of squared deviations from target rate of 5%s)*	*Number of observations*	*MSE*	*RMSE*
RRP rate:				
GAPHP	720.417133	71	10.259857	3.203101
GAPUC1	733.631185	71	10.457342	3.233781
GAPTREND	750.985480	71	10.706059	3.272015
Actual values	860.1728	70	12.28818	3.50545
T-Bill rate:				
GAPHP	665.3763	87	7.648003	2.765502
GAPUC1	770.3042	87	8.854071	2.975579
GAPTREND	806.4572	87	9.269623	3.044606
Actual values	1297.685	86	15.08936	3.884502

In general, one can conclude that the adoption of a Taylor-type rule, which allows the central bank to react to deviations from inflation and the output gap, can better achieve price stability that is nearer to the target value. This can be inferred from the fact that the root mean square errors from models involving all three types of output gap measures are lower than the RMSE values of historical inflation.[12] If the BSP had set interest rates in response to inflation deviations and the output gap, it would have achieved rates of inflation that are lower, less variable, and, more important, closer to its target rate. Results suggest that if the BSP had adjusted monetary policy according to fluctuations in inflation and to the output gap, high inflationary episodes would have been avoided. Moreover, costs that accrue to variability in inflation would have been minimized. With a lower rate of inflation, the purchasing power of economic agents would not be eroded as much, thus profiting a larger proportion of the Philippine population with low and fixed incomes. Benefits from having a low rate of inflation also include incentives for saving and investment, and increased competitiveness of domestic products as discussed in the introduction.

The RMSE values as presented in Table 2 suggest that the best gap measure that can be applied to an inflation-targeting framework in this case is the one derived from the Hodrick-Prescott filter, with the second being estimates from the UC method, and lastly, from the time trend method.[13] The models corresponding to GAPHP for both the RRP rate and the T-bill rate yield simulated rates of inflation with the lowest RMSE values of 3.2031 and 2.7762, respectively. From the RRP model, deviations from the target in the GAPHP model are lower relative to deviations of historical inflation by 8.6251 percent. As for the T-bill model, deviations from the inflation target are significantly lower by 28.8068 percent.

In assessing the relative performance of the RRP model versus the T-bill model, results seem biased for the latter. However, it cannot be concluded with absolute certainty that the T-bill model yields better results relative to the RRP model. This is due to the fact that given the difference in their sample sizes, the two models are, in effect, not directly comparable.

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[12] The RMSE values for actual inflation are not the same for the RRP models and the T-bill models due to the fact that the sample periods covered are different.

[13] This result is in stark contrast with Yap's [2003] finding that gap estimates from the HP filter are least significant in an inflation model. In addition, the result that Yap found bothersome—that the time trend method was apparently superior in terms of significance in the inflation model—is corrected and reversed in this paper.

In conclusion, based on both the graphical analysis and the RMSE criterion, one can safely conclude that the inclusion of the output gap variable in the central bank's reaction function, together with a variable for deviations from inflation, can indeed improve the conduct of inflation targeting by the BSP. The contribution of the output gap in achieving the target rate of inflation is further supported by the following argument.

Although the exact motivations, preferences and, more important, rules adopted by the central bank in the past are unknown, it is certain that the output gap component is not among the variables that formally enter into its reaction function. Thus, as mentioned earlier, the historical performance of inflation is attributed to policy actions that do not place the output gap under consideration, while the simulated performance of inflation is attributed to policy actions that do take the output gap variable under consideration.

6. Summary and conclusion

This paper is an attempt to test whether the inclusion of the output gap as a variable in the central bank's reaction function would improve the conduct of inflation targeting in the Philippines. A four-variable vector autoregression system was constructed using data on the exchange rate, interest rate, inflation, and estimates of the output gap derived from three atheoretical methods. Coefficients for the relevant variables in a Taylor-type rule, which are taken to represent the BSP's reaction function, were derived from a separate OLS procedure. Counterfactual simulations were performed by replacing the interest-rate equation in the VAR model with the Taylor rule. To determine whether the inclusion of the output gap minimized deviations of inflation from the target, the root mean square errors of simulated rates of inflation were contrasted against those of historical inflation.

In comparing the historical performance of inflation, which represents a policy rule that does not involve the output gap variable, to the performance of simulated inflation from a Taylor-type rule, it is clear that the inclusion of the output gap better leads to the achievement of an inflation target set by the central bank. Simulation results show a lower and more stable inflation path, suggesting that central bank responses to deviations of inflation and to the output gap improve the conduct of inflation targeting.

In particular, findings show that gap estimates derived from the HP filter yield the lowest RMSE values across all VAR models. This implies that the benefits to be gained from applying the HP-filtered output gaps to the BSP's

inflation-targeting framework would be largest in terms of maintaining a rate of inflation that is nearest to the target.

Although the study suggests that the inclusion of the output gap contributes to price stability, it cannot be determined whether the same would happen in real economy settings. In theory, the output gap can indeed improve inflation targeting, but whether or not it would yield the same result in reality largely depends on the BSP's ability and willingness to commit to the target. The outcome is dependent on the central bank's true preferences and on the goals that it wishes to pursue through the formulation and implementation of monetary policy.

Based on the results of this paper, the writers argue that if inflation targeting is practiced not just in theory but also in reality, formal considerations of the output gap in setting the central bank's monetary policy stance can contribute to the achievement of its mandate—that is, to maintain price stability. There are benefits to be gained from such considerations as the resulting reduction in both inflation and output volatility may lead to balanced and sustainable growth in the economy. Obviously, a low and stable rate of inflation alone cannot prevent the country from being continuously trapped in the boom-bust cycles that are characteristic of its historical economic performance. However, it cannot be denied that an improved inflation-targeting framework, which can be made possible by the inclusion of an output gap variable, can reduce uncertainty in the economy and aid monetary authorities in choosing the proper monetary policy stance under different circumstances. This contribution alone is already a significant step forward in the long road to stability and sustainability.

In line with this, the central bank may wish to pursue serious efforts in output gap estimation for the Philippine setting. The atheoretical methods used in this study are admittedly insufficient to erase the lingering doubts regarding the precise level of the gap estimates. It would be best to employ a good cross-section of the three different approaches in output gap estimation and, more important, for them to be customized in such a way that the methods adopted and the assumptions made are consistent with how the Philippine economy works in reality. Apart from the conventional estimation methods, it may also be advantageous to consider the use of procedures that employ Markov-regime switching techniques in order to account for shocks in the economy and breaks from the trend. With the use of various traditional and atypical methods of estimation, the central bank may be able to come up with output gap estimates that are robust and accurate. Credible estimates can then

provide the central bank with the assurance that the inclusion of the output gap variable would not lead to policy errors as experienced by other countries in the past.

Since the output gap is a measure of how far the level of real output is relative to potential, monetary authorities may also use this variable, as in other studies, as an indicator of inflationary pressures. The tightness or looseness of monetary policy can thus be adjusted accordingly in the light of changes in output gap levels. As in Claus [2000], if the output gap is positive, there are demand pressures that exist, signaling that inflationary pressures are increasing. This implies that the BSP may need to tighten monetary policy to achieve the targeted rate. If the gap is negative, inflation would likely decrease, indicating that the BSP may need to loosen its policies to improve prices and avoid disinvestment.

In addition, the study conducted by Bolt and van Els [1998] mentioned that output gap estimates can play a role for the proper understanding of developments in national budget deficits. It may be worthwhile to investigate this issue and to identify the qualitative and quantitative nature of the relationship that exists between the output gap and the budget deficit of an economy. These recommendations are not explored in the study and are thus reserved as areas for future research.

Concerning the model-representation of the economy, this paper simply relied on a vector autoregression model that consists of four variables, to serve as the foundation on which counterfactual simulation exercises are performed. It is suggested that the inclusion of other macroeconomic variables, such as measures of the money supply, monetary reserves, and/or nominal GDP, may provide more stable and efficient results. More important, if alternative macroeconomic models can be constructed and estimated in such a way that would better and more accurately track the behavior of the economy, the results of simulation exercises from these models may cross-check the validity of the writers' conclusions.

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