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Toward Inflation Targeting in Sri Lanka

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Abstract

This paper develops a practical model-based forecasting and policy analysis system (FPAS) to support a transition to an inflation forecast targeting regime in Sri Lanka. The FPAS model provides a relatively good forecast for inflation and a framework to evaluate policy trade-offs. The model simulations suggest that an open-economy inflation targeting rule can reduce macroeconomic volatility and anchor inflationary expectations given the size and type of shocks faced by the economy. Sri Lanka could aim to target a broad inflation range initially due to its susceptibility supply-side shocks while enhancing exchange rate flexibility and strengthening the effectiveness of monetary policy in the transition to an inflation forecast targeting regime.

Contents   Page

I. INTRODUCTION

The trade-offs policymakers face in the conduct of monetary policy are determined by the structure of the shocks confronting the economy and the transmission mechanisms that link monetary policy instruments to inflation and other real variables. However, there has been limited analysis of the sources of shocks (Wimalasuriya 2007 and Duma 2008) and monetary transmission mechanism in Sri Lanka (Thenuwara 1998, Thenuwara and Jayamaha 2002), providing little guidance on the optimal implementation of monetary policy.

Monetary management in Sri Lanka is based on a monetary targeting framework. Commercial banks in Sri Lanka are at the center of a formal financial system, and, for most part, the conduct of monetary policy focuses primarily on the supply of, and demand for, reserve money (CBSL 2010). As a result, interest rates and open market operations represent an instrument to achieve a given monetary target, although the interest rate channel has become an important mechanism of transmitting monetary impulses as interbank money markets and secondary markets for government debt have developed, as in most other emerging markets. The CBSL has also, at times, tightly managed the exchange rate, further complicating monetary management. Finally, the dominance of commercial banks and information asymmetries are likely to mean that the credit channel is a prominent part of the monetary transmission mechanism (Bernanke and Gertler 1995).

It is now widely accepted that the primary role of monetary policy is to maintain price stability (IMF 2005). As such, many central banks have adopted a flexible inflation targeting strategy, using interest rates as their operational target, and with very little role for monetary aggregates in the conduct of policy (Berg and others, 2010). From a theoretical point of view, the science of monetary policy, based on a New Keynesian modeling approach, does not assign money a special role in controlling inflation (Clarida, Gali, Gertler 1999). Considering further that the relation between money and prices (and output) is often volatile and unstable, a policy message from those mainstream macro models suggests disregarding monetary aggregates altogether in the analysis of monetary policy. While the global financial crisis and "great" recession has led to a re-examination of the role of monetary policy, Cúrdia and Woodford (2009) find that in a simple new Keynesian model with time-varying credit (arising because of financial frictions) the optimal target criterion (i.e. the optimal monetary policy) remains exactly the same as in the basic New Keynesian model, that is the central bank should seek to stabilize a weighted average of inflation and output gap.[2]

In such an environment, many view the current monetary policy setting in Sri Lanka as an interim stage in a move toward wider adoption of formal inflation-targeting practices in which inflation (more precisely, expected inflation) is the intermediate target, instead of either some monetary aggregate or the exchange rate. In fact, the CBSL's medium-term strategy considers such a transition and the annual roadmap for monetary and financial sector

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[2] This does not preclude the possibility of a role for monetary policy in maintaining both price and financial stability or a wider role in macroprudential policies, which is beyond the scope of this paper (see BIS 2010)

policies for 2011 and beyond (CBSL 2011) takes a first step by looking beyond monetary aggregates alone and signaling a gradual shift toward targeting inflation more directly.

The purpose of this paper is to develop a practical model-based forecasting and policy analysis system (FPAS) to support inflation forecast targeting (Laxton and others, 2009). There are a plethora of studies on the preconditions of moving towards inflation targeting and appropriate sequencing (see Carare and others, 2002, and Laxton and others, 2009), therefore section II focuses on implementing a FPAS model for Sri Lanka by estimating a workhorse macroeconomic model used by many inflation targeting central banks taking into account Sri Lanka specific factors. In addition, in section III we assess CBSLs current monetary framework and degree of financial development with a view identifying ways to strengthen the effectiveness of monetary policy in the transition to a fully-fledged inflation forecast targeting (IFT) regime.

II. A FPAS Model for Sri Lanka

The monetary policy analysis is conducted using a small "New Keynesian" macroeconomic model with rational expectations (Berg, Karam, and Laxton 2006b).[3] In recent years, the macroeconomic literature has used dynamic stochastic general equilibrium (DSGE) models and small New Keynesian models to analyze economic behavior and to forecast future developments. The DSGE models are based on theoretical underpinnings and have been found to be very useful in analyzing the effects of structural changes in the economy, as well as the effects of longer-term developments such as persistent fiscal deficits and current account deficits. On the other hand, by virtue of their relatively simple and readily understandable structure, small New Keynesian models have been used for forecasting and policy analysis purposes in central banks and by country desks in the IMF. A number of inflation-targeting central banks have used similar models as an integral part of their FPAS (see Laxton and others 2009).

The model features a small open economy including forward-looking aggregate supply and demand with microfoundations and with stylized (realistic) lags in the different monetary transmission channels. External shocks from the rest of the world are captured here by U.S. growth. Output developments in the rest of the world feed directly into the small economy as they influence foreign demand for Sri Lankan products. Changes in foreign inflation and/or interest rates affect the exchange rate and, subsequently, demand and inflation in the Sri Lanka economy.

The model has four behavioral equations: (1) an aggregate demand or IS curve that relates the level of real activity to expected and past real activity, the real interest rate, the real exchange rate, and foreign demand; (2) a price setting or Phillips curve that relates inflation

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[3] This contrast with the financial programming approach which emphasizes the role of monetary aggregates in analyzing the monetary sector (see Berg, Karam, and Laxton 2006a for a discussion of the different approaches).

to past and expected inflation, the output gap, fuel prices, and the exchange rate; (3) an uncovered interest parity condition for the exchange rate, with some allowance for backward looking expectations; and (4) a rule for setting the policy interest rate as a function of the output gap, expected inflation, and the exchange rate.

The output gap equation is as follows:

$$ygap_t = \beta_{ld} ygap_{t+1} + \beta_{lag} ygap_{t-1} - \beta_{RRgap} RRgap_{t-1} + \beta_{Zgap} zgap_{t-1} + \beta_{RWygap} ygap_t^{RW} + \varepsilon_t^{ygap}$$

where $ygap$ is the output gap, $RRgap$ the real interest rate gap, $zgap$ the real exchange rate gap, $ygap^{RW}$ the output gap in the U.S., β a series of parameters attached to those variable, and ε^{ygap} an error term, which captures other temporary exogenous effects. The gap terms are measured as deviations of actual values from trend. In other words, this equation means that the output gap in time t is a function of its expected value in the next period, its lagged value in the previous period, the real interest rate (lagged, negatively), the real depreciation (lagged, positively), the foreign country's output gap (external demand), and a disturbance term.

Aggregate supply is described by a "New Keynesian Phillips" curve:

$$\pi_t = \alpha_{\pi ld} \pi 4_{t+1} + (1 - \alpha_{\pi ld}) \pi 4_{t-1} + \alpha_{ygap} ygap_{t-1} + \alpha_{zgap}(z_t - z_{t-1}) + \alpha_o(\pi_t^o - \pi^o) + \alpha_{olag}(\pi_{t-1}^o - \pi^o) + \varepsilon_t^\pi$$

where $\pi 4_{t+1}$ is the four-quarter ahead y-o-y inflation rate, $\pi_t 4_{t-1}$ the four-quarter lagged y-o-y inflation rate, $ygap$ the output gap, $z_t - z_{t-1}$ the real depreciation, π_t^o the domestic fuel price inflation[4], α the parameters, and ε_t^π an error term. In words, this equation means that inflation is a function of expected inflation, lagged inflation, the lagged output gap, real depreciation, fuel price inflation (both current and the lagged) and a disturbance term. Expected inflation enters the equation due to the assumption of staggered price-setting (Calvo-style) while indexation schemes can rationalize the backward-looking inflation component. This somewhat stylized lag structure leads to a substantial degree of inertia in the inflation process which is observed empirically.

The real exchange rate (z) reflects the effect of imported goods' prices on inflation in an open economy.[5] The real exchange rate equation is:

$$z_t = \delta_z z_{t+1} + (1 - \delta_z) z_{t-1} - [RR_t - RR_t^{RW} - \rho^*]/4 + \varepsilon_t^z$$

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[4] We extend the standard Phillips curve by adding inflation of oil in the equation.

[5] An increase in the real exchange rate (z) corresponds here to a real depreciation.

where z_t is the real exchange rate (an increase represents a depreciation), RR_t the real interest rate, RR_t^{RW} the real interest rate in the U.S., $\rho*$ the equilibrium risk premium on the domestic currency, δ_z the smoothness parameter, and ε_t^z an error term. This equation, an uncovered interest rate parity condition, involves that the real exchange rate is a function of the expected real exchange rate (the first two terms), the real interest rate differential (corrected for the currency risk premium), and a disturbance term.

Finally, the monetary policy rule is given by:

$$RS_t = \gamma_{RSlag} RS_{t-1} + (1 - \gamma_{RSlag})\left(RR_t^* + \pi 4_t + \gamma_\pi (\pi 4_{t+4} - \pi_{t+4}^*) + \gamma_{ygap} ygap_t + \gamma_{zgap} zgap_t\right) + \varepsilon_t^{RS}$$

where RS_t is the nominal interest rate, $RR*$ the equilibrium real interest rate, $\pi*$ the inflation target, $zgap$ the real exchange rate gap, γ the parameters, and ε_t^{RS} an error term. This equation means that the nominal interest rate is set depending on its lagged value, the equilibrium real interest rate, current inflation, the deviation of four-quarter ahead y-o-y inflation from its four-quarter ahead target, the output gap, the real exchange gap and a disturbance term.

While this model is simple and abstracts from many important features of the economy, such specifications have long been the workhorse of monetary policy analysis. In addition to effectively capturing the key channels of monetary policy transmission, this framework has the virtues of clarity and tractability. Moreover, this workhorse model is extended to better capture the Sri Lanka specific factors:

- First, the large and persistent fiscal deficit in the Sri Lanka could be an important source of shock to the economy. Therefore, we include the fiscal balance in the output gap equation and a fiscal rule to simultaneously capture the possibility of countercyclical fiscal policy and ensure a stable public debt path as in as in Honjo and Hunt (2006).

    $$FBgap_t = \theta_{ygap} ygap_{t-1} - \theta_{Dgap} Dgap_{t+1} + \varepsilon_t^{FBgap}$$

    where FB is the fiscal balance, and $Dgap$ the deviation from the government's debt target. Debt is defined as the cumulative fiscal balance, and the debt target is set equal to zero, which implies the equilibrium fiscal balance is zero and there is no debt accumulation overtime. This can be thought of as normalization around a nonzero, but constant, ratio of public debt to GDP.

- Second, we extend the model to include macro-financial linkages as in Carabenciov and others (2008). The global financial crisis and the "great" recession have highlighted how financial developments can affect the real economy, particularly through "financial accelerator" effects (Bernanke and others, 1999). Given the dominance of banks in the Sri Lanka, we focus on bank lending conditions as in Carabenciov and others (2008), where bank lending (BL) is a function of $BL*$, the equilibrium level of BL, the real interest rate gap, and banks' expectation of the

economy four quarters ahead. The output gap is explained by the same variables as in equation above as well as by a distributed lag of ε_t^{BL}. The values of the coefficients imposed on the distributed lag of ε_t^{BL} are intended to react to a pattern in which an increase of ε_t^{BL} (a loosening of credit conditions) is expected to positively affect spending by firms and households in a hump-shaped fashion, with an initial buildup and then a gradual rundown of the effects as in Carabenciov and others (2008).

$$BL_t = BL^* - \chi_{RRgap} RRgap_{t-1} + \chi_{ygap} ygap_{t+4} + \varepsilon_t^{BLT}$$

The revised output gap function is given by:

$$ygap_t = \beta_{ld} ygap_{t+1} + \beta_{lag} ygap_{t-1} - \beta_{RRgap} RRgap_{t-1} + \beta_{Zgap} zgap_{t-1} + \beta_{RWygap} ygap_t^{RW}$$
$$- \beta_{FBgap} FBgap_{t-1} + \beta_{BL} \eta_t + \varepsilon_t^{ygap}$$

where
$$\eta_t = 0.04\varepsilon_{t-1}^{BLT} + 0.08\varepsilon_{t-2}^{BLT} + 0.12\varepsilon_{t-3}^{BLT} + 0.16\varepsilon_{t-4}^{BLT} + 0.20\varepsilon_{t-5}^{BLT} + 0.16\varepsilon_{t-6}^{BLT} + 0.12\varepsilon_{t-7}^{BLT}$$
$$+ 0.08\varepsilon_{t-8}^{BLT} + 0.04\varepsilon_{t-9}^{BLT}$$

is the distributed lag of ε_t^{BL}.

- Third, we introduce a pass-through coefficient pt to capture the pass through of international oil price to local fuel prices.

$$\pi_t^o = pt(\pi_t^{RWo} + 4(z_t - z_{t-1}))$$

where π_t^{RWo} is the international oil price inflation.

A. Bayesian Estimation

The model is estimated using Bayesian techniques. Advancement in both computing power and software has made Bayesian estimation of structural rational expectations models' more feasible.[6] Bayesian estimation provides a middle ground between classical estimation and the calibration of macro models. The use of classical estimation in a situation of a relatively small sample size (which is almost always the case for macro time series data) often gives macro model results that are inconsistent and faced with simultaneity challenges. Models with calibrated parameters avoid this problem, but are often criticized as representing no more than the modelers' judgment, which may or may not be consistent with the data.

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[6] For a detailed description of the Bayesian estimation technique see Schorfheide (2000) and Geweke

(1998). Details on the software for estimation can be found in Juillard (2004).

We estimate the model using the Bayesian estimation module in DYNARE (Juillard, 2001). Bayesian inference has a number of benefits. First, it formalizes the use of prior empirical or theoretical knowledge about the parameters of interest. Use of prior distributions makes the highly nonlinear optimization algorithm considerably more stable, making it feasible to apply the technique when sample periods are short. This is a particularly important aspect for Sri Lanka where quarterly National Accounts data only start in 1996Q1. In addition, the estimation procedure also allows for measurement errors in the data. For Sri Lanka this is also extremely important because the data tend to be quite volatile. Some of the excess volatility in the data is thus allocated to measurement error which does not enter into the stochastic simulations. Second, Bayesian inference provides a natural framework for parameterizing and evaluating simple macroeconomic models that are likely to be fundamentally mis-specified. Thus, as pointed out by Schorfheide (2000), the inference problem is not to determine whether the model is "true" or the "true" value of a particular parameter, but rather to determine which set of parameter values maximize the ability of the model to summarize the regular features of the data. Finally, Bayesian inference provides a simple method for comparing and choosing between different mis-specified models that may not be nested on the basis of the marginal likelihood or the posterior probability of the model. In particular, Geweke (1998) shows that the marginal likelihood is directly related to the predictive performance of the model which provides a natural benchmark for assessing the usefulness of economic models for policy analysis and forecasting.

Bayesian estimation requires construction of the posterior density of the parameters of interest given the data. If we denote the set of parameters to be estimated as θ using observations on a set of variables X, the posterior density can be written as $p(\theta \mid X)$. The posterior density is thus the probability distribution of θ, conditional on having observed the data X. It forms the basis for inference in the Bayesian framework. Following Bayes law, the posterior density is proportional to the product of the prior density of the parameters $p(\theta)$ and the distribution of the data given the parameter set $f(X \mid \theta)$:

$$p(\theta \mid X) = \frac{p(\theta)f(X \mid \theta)}{f(X)}$$

where $f(X)$ is the marginal distribution of the data. The conditional distribution function of the data given the parameter set $f(X \mid \theta)$ is equivalent to the likelihood function of the set of parameters given the data $L(\theta \mid X)$. The likelihood function can be calculated from the state-space representation of the model using the Kalman filter (see Ljungqvist and Sargent (2004) for details). Bayesian inference therefore requires: (i) the choice of prior densities for the parameters of interest, and (ii) construction of the posterior from the prior densities and the likelihood function. The remainder of this section discusses briefly how to construct the posterior distribution. The choice of prior is discussed later, together with the estimation results.

Given the likelihood function and a set of prior distributions, an approximation to the posterior mode of the parameters of interest can be calculated using a Laplace approximation. The posterior mode obtained in this way is used as the starting value for the Metropolis-

Hastings algorithm (see Bauwens, Lubrano, and Richard (1999) for details). This algorithm allows us to generate draws from the posterior density $p(\theta \mid X)$. At each iteration, a proposal density (a normal distribution with mean equal to the previously accepted draw) is used to generate a new draw which is accepted as a draw from the posterior density $p(\theta \mid X)$ with probability *p*. The probability *p* depends on the value of the posterior and the proposal density at the candidate draw, relative to the previously accepted draw. We generate 100000 draws in 4 chains in this manner, discarding the first 50000 draws to reduce the importance of the starting values.

Data

To estimate the model we use information on eight key macroeconomic variables for Sri Lanka running from 1996Q1 to 2010Q3: GDP, CPI, oil price inflation, interest rate, real effective exchange rate, fiscal balance, public debt and credit to the private sector.

The 3-month Treasury bill rate is used as a proxy of the nominal interest rate and the real exchange rate against the U.S. dollar is used as proxy for the real exchange rate. All variables are seasonally adjusted using the X12 filter, and expressed as deviations from a Hodrick-Prescott time trend and, with the exception of inflation and the exchange rate.

Steady State Values

The long-term steady-state values for key parameters—the inflation target, potential output growth, and the real interest rate—have an impact on the direction and speed of convergence of the model, particularly in the outer years. However, these values are not essential for the short- and medium-term forecasting exercise. We use the sample mean as the long-term target for inflation and the exchange rate.

Prior Distribution of Estimated Parameters

Our choice of prior distributions for the estimated parameters is guided both by theoretical considerations and empirical evidence. Given the lack of significant empirical evidence, however, we choose relatively diffuse priors that cover a wide range of parameter values. For the structural parameters, we choose either *gamma* distributions or *beta* distributions in the case when a parameter - such as the autoregressive shock processes - is restricted by theoretical considerations to lie between zero and one. Finally, as in much of the literature the inverted *gamma* distribution is used for the standard errors of the shock processes. This distribution guarantees a positive variance but with a large domain.

Parameter Values for Sri Lanka

The parameter values for Sri Lanka are chosen based on the modeling experience for other emerging markets, but adapted to our priors about the characteristics of the Sri Lankan economy and policy-making. The choice of priors for the parameters to be estimated is summarized in Appendix Table 1.

The β parameters in the output gap equation depend to a large extent on the degree of inertia in the economy, the effectiveness of monetary policy transmission, and the openness of the economy:

- Drawing on the experience of several applied country modeling efforts, Berg, Karam, and Laxton (2006b) suggest that the value of β_{lag} will lie between 0.5 and 0.9, with a lower value for less mature economies more susceptible to volatility. For Sri Lanka, we choose a value of 0.4 to take account of the emerging and volatile nature of the Sri Lankan economy.

- The lead of the output gap (β_{ld}) is typically small, between 0.05 and 0.15, and we choose a value at the mid-point of that range for Sri Lanka.

- The parameter β_{RRgap} depends on the effectiveness of the monetary transmission mechanism, while β_{zgap} and β_{RWygap} depend on the importance of the exchange rate channel and the degree of openness. We choose a low value β_{RRgap} and β_{zgap} to reflect the relatively weak interest rate channel and tightly managed exchange rate regime, respectively (Peiris and Saxegaard, 2008). The third parameter β_{RWygap} is chosen at 0.15 to reflect Sri Lanka's non-diversified export dependence.

- The fiscal balance gap β_{FBgap} is set at 0.2 given the large fiscal deficits in the past while the bank lending conditions variable prior is 0.1 in line with other studies on emerging markets.

The α parameters in the inflation equations depend on the role of expectations and aggregate demand on inflation dynamics, and the degree of exchange rate pass-through to prices:

- The $\alpha_{\pi ld}$ parameter in the headline inflation equation determines the forward component of inflation (while its inverse $1 - \alpha_{\pi ld}$ determines the backward component). This can be interpreted as depending in part on the credibility of the central bank, and in part on institutional arrangements regarding wage indexation and other price-setting mechanisms. A higher value of $\alpha_{\pi ld}$ close to 1 involves a "speedboat" economy where small changes in monetary policy cause large changes in price expectations; while a low value involves an "aircraft carrier" economy where inertia and backward-looking expectations cause prices to respond with greater delays to changes in monetary policy. We choose a mid-value of 0.6 for Sri Lanka, similar to studies on other emerging markets.

- The α_{ygap} parameter depends on the extent to which output responds to price changes and, conversely, how much inflation is influenced by real demand pressures, and is typically between 0.25–0.50. This parameter ultimately depends on the "sacrifice ratio," i.e., the loss of output necessary to bring down inflation. We set it at 0.4, near the mid-point of the range.

- The α_z parameter represents the short-term pass-through of (real) exchange rate movements into prices, and depends on trade openness, price competition, and monetary policy credibility. In the case of Sri Lanka, considering the tightly managed exchange rate regime, we set this parameter to 0.05.

The δ parameter in the real exchange rate equation determines the relative importance of forward- and backward-looking real exchange rate expectations. If δ is equal to 1, the equation behaves as in the Dornbusch overshooting model, i.e., the real exchange rate is a function of the future sum of all real interest rate differentials. This makes monetary policy a very effective tool. Berg, Karam, and Laxton (2006b), however, note that it may be imprudent to rely on such effective forward-looking linkages in the face of considerable uncertainty, and recommend choosing a parameter value lower than 0.5. Finally, note that the coefficient relating the real exchange rate and the real interest rate differential (adjusted for the risk premium) is unity, which assumes that arbitrage makes the uncovered interest parity condition hold.

The γ parameters in the monetary policy rule equation depend on the speed and aggressiveness with which the monetary authorities adjust the nominal interest rate, and the relative importance of the inflation target versus the real activity target and the exchange rate. It is common for central banks to pay some attention to real activity even in a "pure" inflation targeting framework and, thus, for the γ_{ygap} coefficient to be greater than zero. We choose a value of 0.5 as a prior, in line with other emerging markets. We choose a value of 1.5 for γ_{π}. However, we also assume that the central bank will try to smooth interest rates changes, and choose a γ_{RSlag} parameter value of 0.75 which is in line with the estimates of this parameter for emerging markets by Mohanty and Klau (2005). γ_{zgap} reflects the weight on the real exchange rate, which is quite common and significant in emerging markets (see Stone and others, 2009).

B. Estimation and Results

The model is estimated as an open economy, where the United States is treated as the relevant foreign sector for Sri Lanka. The posterior estimates of the parameters are summarized in Appendix Table 1.

The parameter estimates shed new insight into the monetary transmission mechanism as well as role of global and domestic shocks.[7] The posterior coefficients in the output gap equation put more weight on both the lagged output gap and the output gap of the rest of the world, but less weight on the real interest rate and real exchange rate than the prior coefficients. On the other hand, the posterior coefficients on the bank lending conditions variable and fiscal balance are greater than expected, highlighting the importance of macro-financial linkages and the potential role for counter-cyclical fiscal policy in Sri Lanka. In the inflation equation,

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[7] Details on the prior distributions and the resulting posterior distributions can be found in Appendix II

the posterior coefficients put less weight on the backward-looking elements and more weight on the forward-looking components than the prior coefficients, suggesting a large role for monetary policy in influencing inflationary expectations. There is also a somewhat large sacrifice ratio than expected while the pass-through of global oil prices to domestic prices is low given the infrequent adjustment of fuel prices in Sri Lanka. As far as the Taylor-rule is concerned, the estimated weight on the inflation gap is somewhat lower and on the output gap is slightly higher than in the priors, and the estimated smoothing coefficient is stronger than expected.

As far as the impulse response functions are concerned (Appendix Figures 1-3), the model shows reasonable and expected patterns. A shock to the disturbance term in the equation for the short-term interest rate (contractionary monetary policy shocks) has the expected effect of reducing output and putting downward pressure on the rate of inflation. A positive shock to the disturbance term in the BLT equation leads to an increase in the output gap and an increase in inflation. A shock to the disturbance in the fiscal balance equation (contractionary fiscal policy) leads to a decrease in the output gap, and to a decrease in inflation and in the policy interest rate.

C. Forecasting

The FPAS model provides a relatively good forecast and can be used for implementing a flexible IFT regime. Appendix Figure 4 shows the conditional forecast (thick line) for Sri Lanka's GDP gap and inflation for the next 10 quarters (2010Q4- 2013Q1) based on the WEO forecast for the U.S. GDP and inflation, and the international oil price, as well as the unconstrained forecast (dotted line). The model forecast performs better than a Bayesian Vector Autoregression with the same set of data beyond the first two or three quarters.

The conditional forecast of the FPAS model suggest targeting a headline inflation rate in the range of about 4-7 percent over a medium-term horizon could be feasible in Sri Lanka, though the degree of uncertainty around the central forecast is relatively large. Thus, the use of FPAS models and open-economy monetary policy rules could help guide monetary policy and reduce the volatility of inflation and other real economy factors (see below). However, the susceptibility to supply-side shocks particularly food prices and large weight of commodities in the CPI basket in Sri Lanka make targeting a narrow range for headline inflation difficult. Thus, consideration could be given to defining a headline inflation target with a relatively wide tolerance level, or a measure of core or underlying inflation excluding volatile food and fuel components as in a number of other IFT central banks'. The absence of a consistent and long time series of the core measure of inflation used by the CBSL precluded an analysis of its usefulness in the FPAS model estimation but an extension of the FPAS to include alternative measures of core inflation in Sri Lanka could be considered for future research (see Saxegaard and Gupta 2009). In any event, the CBSL could always explain the reasons for any breach of an announced inflation target due to temporary or exogenous factors out of its control possibly through a quarterly inflation report as done by many inflation targeting central banks to minimize loss of credibility.

D. Optimal Rules

Using the estimates of the models' parameters and the estimated distributions for the stochastic shocks, solutions are derived for the variability in inflation and the output gap under alternative monetary policy reaction functions. First, we search the "optimal" values for the coefficients of the Taylor rule in the baseline model in section II by minimizing a loss function of inflation and output variability. The loss function takes the form of a standard quadratic form given by:

$$L = \sum_{t=0}^{\infty} \lambda_\pi (\pi_t - \pi^T)^2 + \lambda_y ygap_t^2$$

where λ_π and λ_y are the relative weight on inflation versus output-gap variability. For simplicity, we assume equal weights. Second, we compare the standard deviation of inflation and the output gap of the baseline model with "optimal" coefficients of the Taylor rule with those estimated from the model above given the same size and types of shocks faced by the economy. Appendix Table 2 compares the estimated weights with the optimal ones. The simulations suggest that a greater weight on inflation and a smaller weight on the output gap and exchange rate would help to reduce macroeconomic volatility. The results also confirm the well-known result that because of higher interest rate volatility targeting the exchange rate is significantly less successful than inflation targeting at stabilizing the real economy (see Anand and others 2009, and Calvo and others 1995). Given the increasing openness of the capital account in Sri Lanka, this suggests that tightly managing the exchange rate through foreign exchange interventions under full sterilization would be equivalent to having a large weight on the exchange rate in the open-economy Taylor-rule and thus lead to greater macroeconomic volatility than the "optimal" Taylor-rule estimated here.

III. TRANSITION TO INFLATION TARGETING

Monetary management in Sri Lanka is currently based on a monetary targeting framework (CBSL 2011). In this framework, the final target, price stability, is to be achieved by influencing changes in broad money supply which is linked to reserve money through a multiplier. Based on expected developments in the macroeconomy, the CBSL designs the monetary program which sets out the desired path for monetary growth and determines the path of quarterly reserve money targets necessary to achieve this monetary growth. The CBSL would then conduct its Open Market Operations (OMO) within a corridor of interest rates formed by its policy rates i.e. the repurchase rate and the reverse repurchase rate, to achieve the reserve money target. Policy rates are periodically reviewed, usually once a month, and adjusted appropriately, if necessary, to bring the reserve money to the targeted path.

A gradual transition to a flexible IFT regime from the current monetary targeting framework appears to be best option for Sri Lanka. In recent years, inflation targeting has come to be viewed as an appropriate regime for emerging market and developing economies and much experience has been gained on how to transition to full-fledged inflation targeting (IMF, 2005, Carare and others, 2002). A cursory analysis as to whether CBSL's monetary-targeting

framework should continue to play a major role in Sri Lanka by introducing money in an ad-hoc manner in an otherwise standard new-Keynesian model outlined in section II (See Appendix I for details) suggest that an open-economy Taylor-rule (as in Section II) would do better in terms of minimizing macroeconomic volatility than a monetary-targeting framework.[8] This is not to say that Sri Lanka should transition to a fully-fledged IFT regime overnight. Also, monetary aggregates could continue to play a role as in the European Central Banks' (ECB) two-pillar framework where the ECB announces a reference value for a monetary aggregate. In fact, the CBSL's roadmap for Monetary and Financial Sector Policies for 2011 and beyond suggests a gradual move towards such a two-pillar approach.

There are the many challenges for an emerging market non-inflation targeting country to develop a more systematic approach to monetary and exchange policy (see Stone and others, 2009). This involves developing a more open and market-friendly approach focused on a single operating target, fostering financial and external stability, and developing the institutional setting and political backing, to transition to a single nominal anchor. These changes lead to consistency between objectives and over time and, ultimately, more policy credibility. The next section addresses how Sri Lanka can improve policy effectiveness and, ultimately, transition to inflation targeting, particularly with respect to the role of exchange rate and deepening financial markets.[9]

A. The Role of the Exchange Rate in IFT

Sri Lanka like many other emerging market inflation targeting countries has a managed float exchange rate regime and intervenes relatively frequently. Foreign exchange intervention is difficult to explicitly model in DSGE models (see Stone and others, 2009). Therefore, in order to investigate the role of the exchange rate, we draw on the empirical literature on foreign exchange intervention which attempts to shed light on the behavior of central banks in the foreign exchange market and to test certain theoretical predictions concerning intervention (Taylor and Sarno 2001).[10] In this literature, it is common to investigate the

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[8] Berg and others (2010) also assess whether money has an informational role by introducing a simple type of information incompleteness in an otherwise standard new-Keynesian model. However, their assumption that the interest rate that the central bank observes—and can control—is a noisy indicator of the rate relevant for policy decisions in Sub-Saharan Africa is less relevant in Sri Lanka where monthly policy interest rate decisions are well-established and domestic money/debt markets are more developed.

[9] This section does not deal with laying down the all of the policies that make up the foundation for moving to a full-fledged inflation targeting which encompasses: political support for the inflation target, a strong fiscal position, institutional independence of the central bank, flexible prices and wages, a sound financial system, and reasonably well-developed monetary policy implementation tools (IMF, 2005, Carare and others, 2002). Of course, most of these ingredients are important for any successful monetary policy framework, especially for countries for which the adoption of full-fledged inflation targeting is not feasible.

[10] The rationale for intervention is the so-called "wrong rate" argument, which provides a case for intervention based on the assumption that an inefficient foreign exchange rate market may tend to generate episodes of large exchange rate misalignment or overshooting. This argument calls for the Central Bank to pursue a policy of "leaning against the wind" by buying the currency when it is depreciating and vice-versa.

extent to which official intervention in the foreign exchange market—captured by changes in official reserves—is determined by changes to the nominal exchange rate and/or the deviation of the actual exchange rate from a target level, although the latter is not included in our analysis given the absence of an explicit target in Sri Lanka. We also include the volatility of the exchange rate (3-day standard deviation) and lagged intervention to capture attempts to mitigate "excessive" volatility and to smooth intervention operations.[11] The results suggest that the CBSL attempts to lean against the wind and resist abrupt changes in the exchange rate (see Appendix table 3).

Frequent interventions and the absence of a transparent implementation framework can make it more difficult for the markets and public to assess the objectives of foreign exchange interventions. While the CBSL publishes foreign intervention data regularly with a short lag, the relative lack of transparency on the objectives of foreign exchange market intervention whether they are aimed at supporting inflation targeting or managing the exchange rate in and of itself is not clear. For example, it could be difficult for the markets and public to assess whether excess volatility or the level of the exchange rate is the focus of interventions because what is regarded as excess volatility is usually not defined and the intervention pattern is not always consistent with volatility developments.

A large operational role for the exchange rate can weaken the effectiveness of its operations. For example, Wijesinghe (2006) and Peiris and Saxegaard (2008) highlight that money market interest rate volatility was higher during periods of tight exchange rate management in Sri Lanka. Moreover, Peiris and Saxegaard (2008) show that greater interest rates volatility in turn reduced the effectiveness of the interest rate channel of monetary policy in Sri Lanka using a threshold Vector Autoregression approach. Foreign exchange interventions that are not coordinated with domestic monetary operations complicates' the attainment of policy objectives and communication (e.g., unsterilized intervention is inherently inconsistent with an IFT regime).

The conflicts that can arise from the more active role of the exchange rate for open economy inflation targeting countries can be alleviated to some extent by a well-designed implementation framework (Stone and others 2009). Transparency of the role of the exchange rate with respect to objectives, procedures and ex post evaluation offers important advantages for open economy inflation targeting countries. Central banks can explicitly communicate that foreign exchange intervention aimed at influencing the exchange rate is separate from domestic monetary operations intended to steer expected inflation, including by conducting sterilization separately from foreign exchange intervention. Transparency facilitates the signaling channel of intervention. Central bank communication of the purposes of interventions for purposes other than monetary policy (reserve management, fiscal agent transactions, foreign exchange market development) can ensure that these actions are not seen as related to policy. Of course, there are limits to the transparency of foreign exchange implementation. Real time reporting of intervention operations during periods of high

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[11] The sample includes daily foreign exchange intervention data from March 2005 provided by the CBSL.

uncertainty, and in the context of relatively thin markets, can lead to speculative behavior that contributes to exchange rate volatility, and compel the central bank to react to market expectations, either to validate them or to counteract them (Stone and others 2009).

Developing an integrated and systematic approach to the role of the exchange rate in policy decision-making can facilitate the transition to inflation targeting. This requires setting up a more systematic process for integrating the analysis of economic and financial developments into the policy decision-making process (see Laxton and others, 2009). In this context, a FPAS model can play an extremely useful role in bringing together information and judgment in a coherent and logical manner. Effective use of the model in the policy process requires establishing good two-way communications between the senior management of the central bank and the economists involved in forecasting and policy analysis (see Laxton and others, 2009). Reducing the weights of the exchange rate in the reaction function over time can help transition towards inflation targeting. For an open economy inflation targeting approach, this means reducing the importance of the exchange rate and output and raising the weights on the inflation target in interest rate policy. Extending a FPAS or DSGE model to encompass foreign exchange interventions may also be a useful direction for research.

In many emerging market non-inflation targeting countries like Sri Lanka, asymmetric financial market development leads foreign exchange interventions to play a more important role than domestic operations. Although the foreign exchange markets of many emerging market non-inflation targeting countries are thin and underdeveloped compared to those of inflation targeting countries, they are more developed relative to their own domestic markets. The use of foreign exchange operations by the central bank as the main instrument can lead markets to assume that exchange rate management is a priority even when this is not the case. Financial market development facilitates policy implementation and can reduce policy conflicts at relatively minimal costs and effort. The payoff for market reforms is especially high for Sri Lanka given the relatively low level of money and bond market development.

Government Bond Turnover Ratios in 2009

1/ Left scale.
2/ Latest available data.
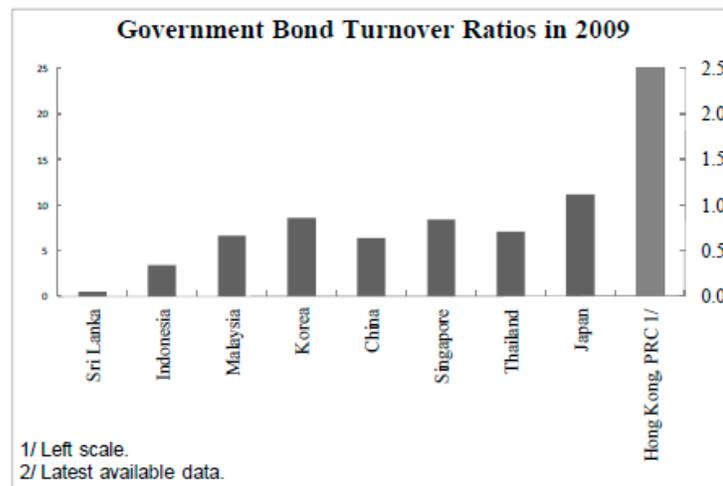
Foreign exchange market development often requires changing the central bank's role from market-controlling to market-supporting (Ferhani and others, 2009). Reducing the role of the central bank often involves moving toward more market-supporting trading mechanisms e.g., eliminating or widening exchange rate bands), shifting market-making from the central bank

to commercial banks, and developing a market-supportive framework for the central bank's own foreign exchange operations. However, emerging market non-inflation targeting countries often face a "chicken and egg" dilemma of market development against exchange rate policy flexibility (Ferhani and others, 2009). The dilemma is that foreign exchange market development is inhibited by lack of movement in the exchange rate, but moving toward a more flexible exchange rate regime is constrained by the thin market. The active management of the exchange rate also creates a disincentive for the development of banks risk management instruments. This dilemma can be addressed by market development measures to develop risk management instruments. Further, financial regulation and supervision should continually account for foreign exchange risk. Market players should begin to find it in their interest to drive development as the central bank reduces its role and the exchange rate becomes more flexible. Forwards and other foreign exchange derivatives (e.g., FX swaps) should also be encouraged to facilitate hedging of foreign exchange risks and support market liquidity. These instruments also require a deep money market.

Money and bond market development reduces the need to use foreign exchange intervention for reasons unrelated to monetary policy and facilitates sterilization. Ferhani and others (2009) identify a sequence of reforms needed to support the development of money market operations which must be tailored to each country's particular circumstances. A liquid money and government market is necessary to develop a benchmark yield curve for the effective transmission to monetary policy. The call money market rate has been very volatile in Sri Lanka in the past due to weaknesses in the monetary policy and liquidity management framework, which to a large extent has been addressed through reforms to the open market operations and standing facilities in 2008-09 (see Saxegaard and Peiris 2008). However, the term money market remains illiquid and interest rate swaps benchmarked to the Sri Lanka Inter- Bank Offered Rate, (SLIBOR) are permitted but inactive (Peiris 2010). Reviewing and improving the Master Repo agreement and primary dealer (PD) system, particularly allowing PDs to diversify activities by consolidating their accounts could help. While the size of the government securities (G-Sec) market in Sri Lanka is quite large, liquidity remains very low due to a lack of benchmark issues and the prevalence of buy-and-hold investors.[12] With regards to the former, the size of each benchmark security needs to be sufficiently large, usually a significant multiple of the average transaction size. Banks face a 20 percent Statutory Liquid Ratio held mostly in G-Secs without marking-to-market while institutional investors such as the Employees Provident Fund, Employees Trust Fund and National Savings Bank hold a large share of its assets in Government securities and until maturity, thus hindering active trading (Peiris 2010).

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[12] Progress has been made in developing a benchmark yield curve by concentrating issues (and reopening) to a few bond series but consideration could be given to conducting debt-swaps to expedite the process and lengthen the maturity structure.

IV. CONCLUSIONS AND POLICY RECOMMENDATIONS

Sri Lanka has been broadly following a monetary-targeting framework, particularly since the adoption of the more flexible exchange rate regime in 2001. Inflation control has, however, remained somewhat elusive. Headline inflation has averaged above 10 percent since 2001 and peaked at 28 percent in 2008 before falling to single-digit levels in 2009-10. Now that the central bank has built credibility by bringing inflation under control, the central bank could move toward a less rigid monetary policy framework that targets inflation more directly taking into account a wide range of factors including exchange rate movements. The CBSL's medium-term strategy considers such a transition and thus this paper develops a forecasting and monetary policy analysis model to support an IFT regime.

The estimated FPAS model sheds new insights on the monetary transmission mechanism and impact of exogenous shocks on the economy, and thus provides a guide to implementing an IFT regime in Sri Lanka. The FPAS model provides a relatively good forecast for inflation and a framework to evaluate policy trade-offs. The model simulations suggest that an open-economy inflation targeting rule can reduce macroeconomic volatility and anchor inflationary expectations given the size and type of shocks faced by the economy. In addition, monetary policy rules can help guide the appropriate monetary stance.

Sri Lanka could aim to target a broad inflation range in the transition to a fully-fledged IFT regime. Although volatility in supply-side prices make it difficult for a country like Sri Lanka to target any precise inflation figure, the central bank can aim to keep headline inflation in the mid-single digits and support the authorities medium-term plan of consolidating macroeconomic stability. The CBSL could also explore the possibility of targeting or referencing a lower and narrower target range for a measure of core or underlying inflation which is less volatile and susceptible to commodity price shocks. Given that Sri Lanka is unlikely to meet key pre-conditions for a formal inflation targeting framework immediately, the central bank can further develop a FPAS model of the form outlined in this paper, which would inform, rather than drive, policy decisions and help gradually transition to a fully-fledged IFT regime over the medium-term.

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Appendix I

To assess whether CBSL monetary-targeting framework could play a useful role in Sri Lanka, we introduce money in an otherwise standard new-Keynesian model outlined in section II. We follow Gerlach and Svensson, (2003) in formalizing the so-called P* model implemented by the CBSL, where the "price gap", or equivalently the "real money gap" (defined as the gap between current real money balances and long-run equilibrium real money balances) could contain considerable information about the future path of inflation. While the microfoundations of the P* model are not clear (to us, at least), the model has been used to account for the behavior of prices in a number of countries, and is typically seen among proponents for monetary targeting as providing a theoretical rationale for focusing policy deliberations on the behavior of monetary aggregates (Jahnke and Reimers 1995). For these reasons and CBSLs articulated policy framework, we use the P*set-up here.

As in Gerlach and Svensson (2003), we can consider a Phillips curve of the form:

$$\pi_{t+1} = \pi^e_{t+1,t} + \alpha_m(\tilde{m}_t - \tilde{m}^*_t) + \alpha_z z_{t+1} + \varepsilon_{t+1}$$

where $\tilde{m}_t - \tilde{m}^*_t$, the real money gap, is defined as the difference between the real money stock, $\tilde{m}_t = m_t - p_t$, where m_t is the (nominal) money stock (for instance, M2 or M3), and the long-run equilibrium (LRE) real money stock, $\tilde{m}^*_t$. The LRE real money stock is in turn defined as:

$$\tilde{m}^*_t = y^*_t - v^*_t$$

where $v_t = p_t + y_t - m_t$ is velocity, and v^*_t is the long run equilibrium (LGE) velocity. Thus, the LRE real money stock is the level of the real money stock resulting with output at its potential level and velocity at its LRE level. In a Phillips curve, the real money gap is the crucial gap variable that indicates demand pressure and generates inflation. We can interpret the real money gap as a measure of real ''money overhang.''

Thus, we can modify the small New Keynesian model by introducing money in the "Phillips" curve and Taylor rule to reflect the CBSLs monetary-targeting framework as:

$$\pi_t = \alpha_{\pi l d}\pi 4_{t+1} + (1 - \alpha_{\pi l d})\pi 4_{t-1} + \alpha_{mgap}\tilde{m}_{t-1} + \alpha_{zgap}(z_t - z_{t-1}) + \varepsilon^\pi_t$$

$$RS_t = \gamma_{RSlag}RS_{t-1} + (1 - \gamma_{RSlag})\left(RR^*_t + \pi 4_t + \gamma_{mgap}\tilde{m}_t + \gamma_{ygap}ygap_t + \gamma_{zgap}zgap_t\right) + \varepsilon^{RS}_t$$

Using the estimates of the models' parameters and the estimated distributions for the stochastic shocks, we compare the standard deviation of inflation and the output gap of the baseline model with "optimal" coefficients of the open-economy Taylor rule in Section II with those estimated from the monetary-targeting model above given the same size and types of shocks faced by the economy. The results clearly show that macroeconomic volatility could be less under an IFT regime in Sri Lanka.

Appendix Table 1. Selected Parameter Priors and Posterior Estimates

Sri Lanka FPAS model estimates

Parameter	Prior	Posterior	Parameter	Prior	Posterior
β_{ld}	0.400	0.360	δ_z	0.400	0.835
β_{lag}	0.100	0.089			
β_{RRgap}	0.100	0.052	γ_{RSlag}	0.750	0.676
β_{Zgap}	0.050	0.043	γ_{π}	1.500	1.308
β_{RWygap}	0.150	0.186	γ_{ygap}	0.500	0.477
β_{FBgap}	0.200	0.221	γ_{zgap}	0.500	0.601
β_{BL}	0.100	0.108			
			θ_{ygap}	0.500	0.368
$\alpha_{\pi ld}$	0.600	0.727	θ_{Dgap}	0.100	0.093
α_{ygap}	0.400	0.451			
α_{zgap}	0.050	0.042	χ_{RRgap}	0.200	0.068
α_{o}	0.050	0.012	χ_{ygap}	0.500	0.323
α_{olag}	0.050	0.013			
			pt	0.750	0.715

Appendix Table 2. Optimal Weights in Taylor Rule

	γ_{RSlag}	γ_{π}	γ_{ygap}	γ_{zgap}
Estimated weights	0.676	1.308	0.477	0.601
Optimal weights	0.749	1.515	0.398	0.342

Appendix Table 3. Dependent Variable: Reserves (ΔR_t)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Δ Exchange rate $_t$	-5.848989	1.515212	-3.860179	0.0001
Exchange rate Volatility $_t$	1.363463	1.790330	0.761571	0.4467
ΔR_{t-1}	0.320745	0.042294	7.583628	0.0000

Appendix Figure 1. Impulse Response to a Monetary Policy Shock
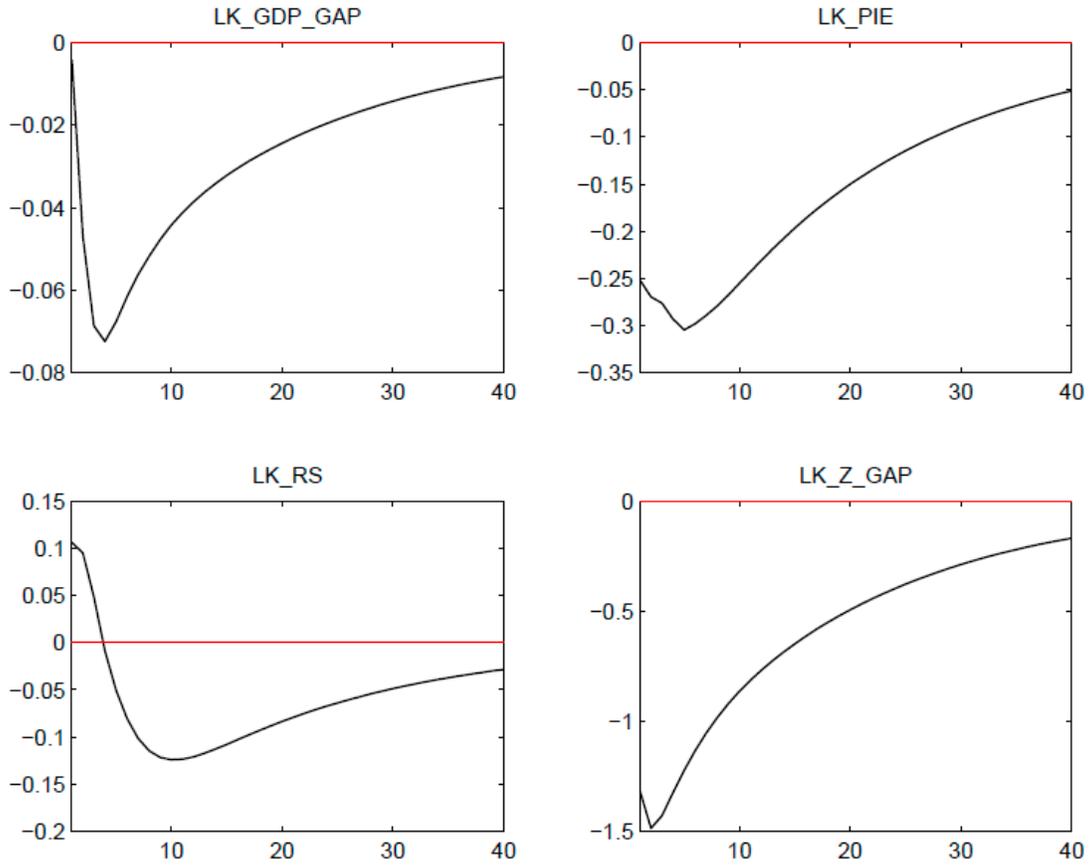
Appendix Figure 2. Impulse Response to a Bank Lending Condition Shock
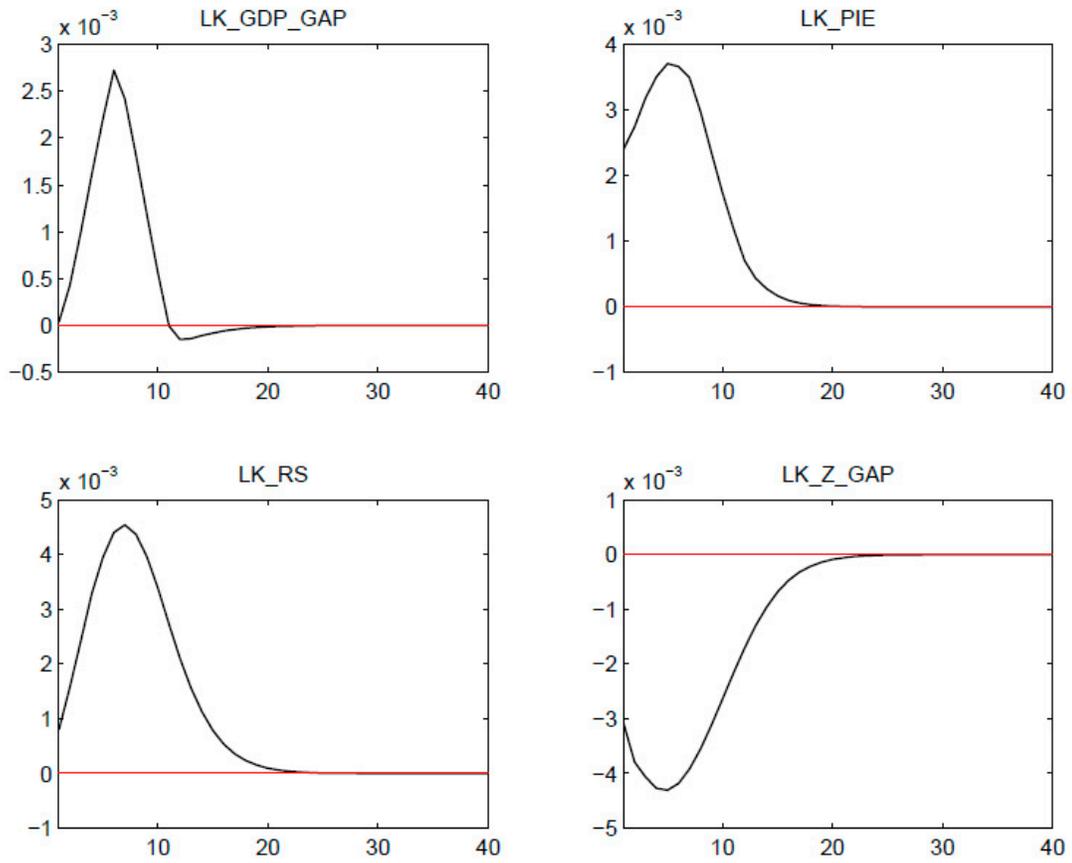
Appendix Figure 3. Impulse Response to a Fiscal Balance Shock
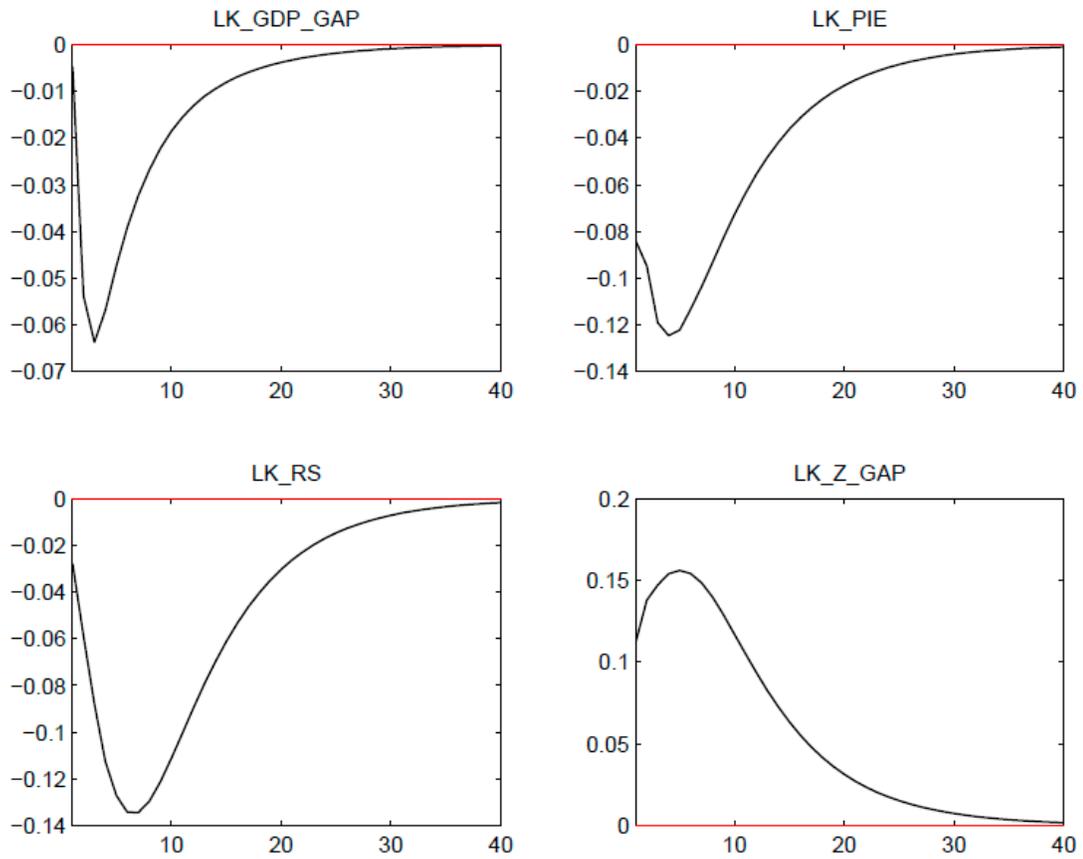
Appendix Figure 4. Forecast for 2010Q4- 2013Q1

GDP Gap

Inflation