LUND UNIVERSITY
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Master Thesis

February 2009

Rule-based Monetary Policy for Developing Countries, Evidence from Developed Countries

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Abstract: Price and output stabilities determine the success of monetary policy in either economy. This paper briefly examines the monetary policy strategies of three developed countries (USA, UK, Sweden) and three developing countries (Bangladesh, India, Pakistan). It is found that the developed countries follow some rule-based monetary policy whereas the developing countries with ill-organised monetary system do not follow the rule-based policy, rather they often formulate and launch policies under some discretionary framework. The fundamental objective of this study is to examine the performance of rule-based monetary policy in developing countries by extracting experience from developed ones. Since its inception in 1993, Taylor rule has become synonymous to monetary policy. But it is a matter of fact that this rule was grounded on the developed economies and numerous researches have been carried out with the same respect disregarding the applicability of this rule to the developing economies. In this paper, I use one simple macroeconomic model to simulate the economies with the Taylor rule as monetary policy. Counterfactual simulation confirms that macroeconomic performance of developing economies can be improved, in terms of stability in inflation and output, when simple Taylor type rule is followed and it further improves the performance with some degree of smoothing in the instrument. Using data for the period 1984-2008, this study proposes a set of optimal parameter values for Taylor rule and coefficients of lagged interest rate for different countries.

Keywords: Developing Countries, Monetary Policy, Taylor Rule, Counterfactual Simulation

Acknowledgement: Utmost patience and guidance of Klas Fregert enabled me to carry out this research. I am ever-grateful to him for his intensive and generous supervision.

1. Introduction

John B. Taylor defined monetary policy rule as a description- expressed algebraically, numerically, graphically- of how the instruments of policy such as the monetary base or the interest rate, change in response to economic variables. In the context of developing country, Rangarajan (1997) views monetary policy as just a tool to achieve the broad economic policy objectives of faster rate of economic growth, a reasonable degree of price stability and promotion of distributive justice. Most of the developing countries formulate monetary policy employing their discretion. Because of the complex structure of the economy it is often difficult to follow some simple rules. Developing countries have weak institutions, small information set, low capacity of professionals and monetary policy having multiple objectives without clear prioritisation (Malik and Ather, 2007). Calvo and Mishkin (2003) indentify five fundamental institutional problems in developing countries: weak financial institutions, low credibility of monetary institutions, currency substitution, liability dollarisation and sudden stops in capital inflows. These practicalities induce the policy makers of developing countries employ their discretion but Kydland, Presscott (1977) argue that policy makers should follow rules, rather than have discretion. The reason that they should not have discretion is not that they are stupid or evil but, rather, that discretion implies selecting the decision which is best, given the current situation. Such behaviour either results in consistent but suboptimal planning or in economic instability. The interest rate behaviour of six different countries of this study shows that developed economies follow some rules that generate frequent changes in interest rate whereas the developing countries keep interest rate unchanged for quite longer period of time although the economic conditions change.

Figure 1

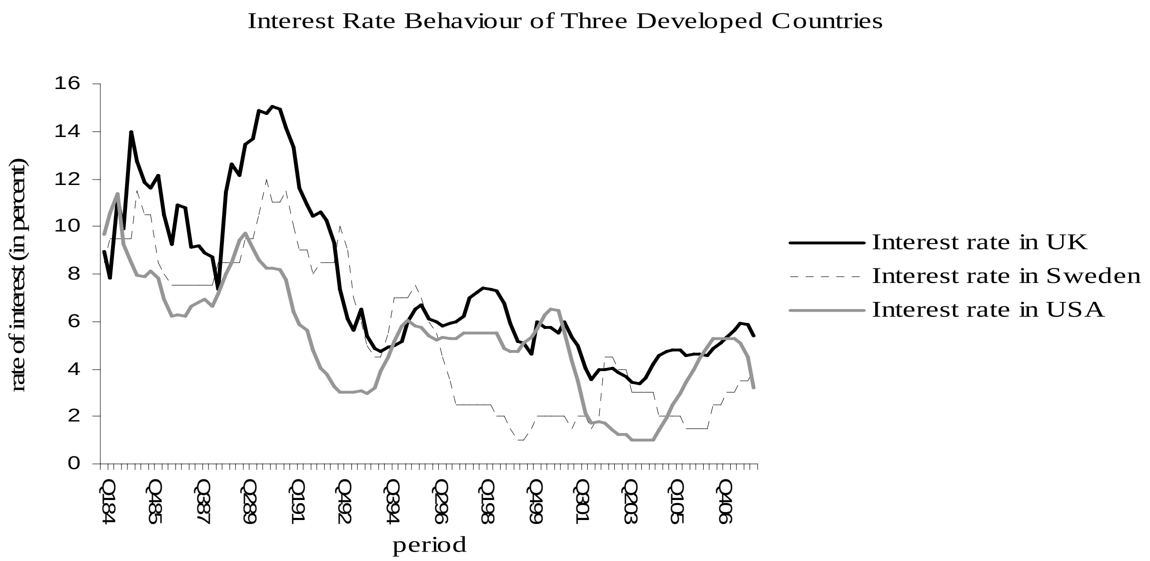


Figure 2

Interest Rate Behaviour of Three Developing Countries

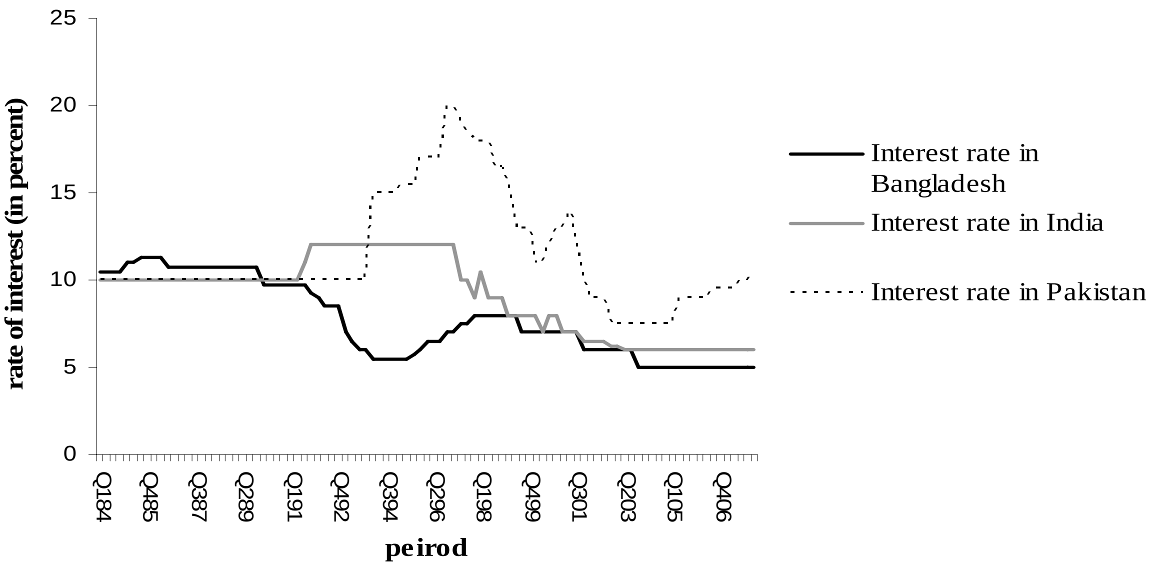


Figure 1 plots interest rate of three developed countries and Figure 2 of developing countries. It is clear that there are repeated changes in interest rate of the developed countries relative to the developing ones. Of course, developing countries have to pay for keeping their discount rates less reactive to the changes in economic conditions. Following table demonstrates the social loss (SL) defined over the variability in inflation and output gap.

Table 1

Components of Existing Social Loss in Six Countries for the period 1984-2008

	Bangladesh	India	Pakistan	Sweden	UK	USA
σ_y^2	13.87	6.22	13.81	8.03	2.47	3.09
σ_π^2	5.85	11.16	11.13	8.75	4.12	1.10
Social Loss	25.58	28.55	36.07	25.52	10.70	5.30

The underlying social loss function is $SL = \sigma_y^2 + 2\sigma_\pi^2$, where σ_y^2 and σ_π^2 represent variance of output gap and variance of inflation respectively. Social loss of Bangladesh seems to be comparatively small but this is surely due to the small size of data on inflation. Due to the unavailability of data, inflation rates of Bangladesh have been calculated during the periods between 1997:Q1 and 2008:Q1. All other variables have been evaluated by using the data for the period 1984:Q1-2008:Q1. It is clear that social loss of three developing countries is larger than three developed countries. USA has the minimum social loss which is followed by UK and out of six countries these two countries follow Taylor rule as monetary policy. This finding inclines me to examine whether Taylor rule can be adopted as the monetary policy rule by the developing economies.

The organisation of this paper is as follows. In the next section, I describe different monetary policy rules where in a subsection the insights of Taylor rule are discussed. Section 3 presents the source of data and methodology used. Estimated Taylor rules for all the sample countries are given in section 4. Section 5 discusses the model that is used for simulation purpose and section 6 is about simulation results. Section 7 focuses the performance of augmented Taylor rule with interest rate smoothing and section 8 concludes the paper.

2. Monetary policy for developing countries

There is little evidence that developing countries follow any specific rule in implementing monetary policy even there is a dispute over if the developed countries follow any rule of strict nature. But whatever the case, it is strongly argued that the policy rules have greater advantages over discretion in improving economic performance. In the academic literature on monetary policy in general, and inflation-targeting strategies in particular, two different models of rule-based monetary policy have been applied (Berg, Jansson, Verdin 2004). Those are targeting rules and instrument rules.

2.1. Targeting rules

This approach describes monetary policy in terms of objectives and constraints the policy makers face. The ‘‘targeting-rules’’ approach has been advocated by Svensson (2002) on the grounds that it better captures the essence of monetary policy making in inflation-targeting countries. Inflation targeting was first introduced in New Zealand in 1990 without any prior specific academic research. It spread very quickly to an increasing number of countries: Canada 1991, the UK 1992, Sweden, Finland and Australia 1993. Brazil was the first developing country to introduce full-fledged inflation targeting. Israel and Chile have gradually developed into inflation targeters. To be inflation targeter, there should have a numerical inflation target, in the form of either a point target or a target range. Achieving inflation target is the primary objective of monetary policy. There is no other nominal anchor, like an exchange rate target or a money-growth target. The central bank is accountable for achieving the inflation target and provides transparent and explicit monetary-policy reports presenting its forecasts and explaining and motivating its forecasts.

According to Svensson (1997) and Bernake *et al*. (1999), among others, the essence of inflation targeting is to formulate explicit objectives and to create institutional mechanism in order to achieve those objectives. Such a strategy may be difficult to capture in terms of simple instrument rules, like Taylor’s. There are two types of targeting rules, ‘‘general targeting rule’’ and ‘‘specific targeting rule’’. A general targeting rule specifies an operational loss function, which the monetary policy is committed to minimise. In specific targeting rule, a condition for setting the instrument is specified (Malik and Ahmed, 2007). It gives an implicit reaction function of the monetary authority that needs not to be announced. According to this type of framework, central banks collect large amount of data and then formulate the policy in a complex way. Such a framework can best describe the strategy adopted by most of the inflation targeting central banks. The Bank of England and Sweden’s Riksbank have formulated a simple specific targeting rule to guide policy which can be expressed as ‘‘set interest-rates so the inflation forecast about two years ahead is on target’’ (Goodhart, 2001 and Heikensten, 1999). This type of rule has good theoretical base, as there is no simple representation of reaction function. Specific targeting rule is both simple and operational, it is not necessarily optimal[1].

2.2. Instrument Rules

Instrument rules define policy instrument as an explicit function of the information available to the central bank. McCallum (1988) rule is one of this variety where the money-base growth rate changes in response to deviation of the nominal GDP growth rate (or the level) from a desired target value that grows at a specified rate. In this rule policy instrument is the money base. Many researchers suggest that the McCallum money-base targeting rule has undesirable stabilisation properties. Blinder (1994) provides arguments against the money-base rule. Apart from McCallum rule, there are some other instrument rules namely Meltzer (1987), Taylor (1993), Henderson and McKibbin (1993). Taylor rule attracted the researchers’ interest enormously and my study is also to examine whether such a rule can be proposed for the developing economies.

[1] See Lars E.O. Svensson (2002), NBER working paper 8925, p.6

Taylor rule

Taylor rules recommend a setting for the level of nominal interest rate based on the state of the economy. The rules assume that policy makers seek to stabilise output and prices about paths that are thought to be optimal. For instance, they may recommend raising the federal fund rate when inflation is above target or lowering the federal fund rate when recession appears to be more of a threat. The famous Taylor rule suggested by John Taylor in 1993 represents a monetary policy strategy for achieving price stability and maximum employment by considering interest rate as the policy instrument. In particular, Taylor rule is a linear algebraic rule described by equation (1) below that specifies how the Federal Reserve must adjust its funds rate according to the inflation rate and the output gap:

$$i_t = \bar{r} + \pi_t + h(\pi_t - \pi^*) + by_t \quad \ldots\ldots \quad \ldots\ldots\ldots\ldots \quad (1)$$

where, i_t is the nominal rate of interest, $\bar{r}$ is the long run equilibrium real rate of interest, π_t is the year on year inflation rate, π^* is target inflation rate and y_t is percentage deviation of real output from potential output.

Equation 1 recommends a target level of nominal interest rate that is equal to the sum of equilibrium real rate of interest and current rate of inflation provided that current rate of inflation is equal to target rate and there is no output gap i.e., real GDP is same as potential GDP. More formally, setting $\pi_t = \pi^*$ and $y_t = 0$ into equation 1, it follows $i_t = \bar{r} + \pi_t$. This rate of interest can be termed as the benchmark recommendation for the nominal rate of interest. If this benchmark recommendation is denoted as i_{tb}, then $i_{tb} = \bar{r} + \pi_t$.

$$\text{If } \pi_t \rangle \pi^*, \Rightarrow \pi_t - \pi^* \rangle 0$$

Equation 1 becomes $i_t = i_{tb} + (positive\, term)$. In words, this equation illustrates that the current rate of inflation being above targeted inflation, Taylor's recommended interest rate should be above the benchmark interest and vice versa. The same holds true for a nonzero output gap.

If the economy is operating at its potential i.e., $\pi_t = \pi^*$ and $y_t = 0$ then $i_t = i_{tb} = \bar{r} + \pi_t$

$\frac{\partial i_t}{\partial \pi_t} = 1$. This explains the important feature of Taylor rule. A one percent increase in current inflation rate calls for a one percent increase in nominal interest rate such that the real interest rate is constant. This is real rate of interest that should be cared when monetary policy is formulated because the real rate of interest affects real economic activity. Real rate of interest, however, is not the policy instrument, rather policy makers adjust nominal rate of interest as policy instrument. If there is inflationary pressure, interest rate should be increased such that it dampens demand and hence inflation. Similarly, a positive output gap can be vanished through the increase in rate of interest and a negative output gap through the decrease in rate of interest. Taylor rule incorporates both short-run and long-run goals of monetary policy. The short-run goal is reflected in output gap adjustment factor and long-run goal in inflation gap adjustment factor.

Taylor (1993) sets both the long run equilibrium real interest rate and the target inflation rate equal to 2, and h and b are set equal to 0.5. Using these values, equation (1) can be rewritten as

$i_t = 1 + 1.5\pi_t + 0.5y_t$ ....(2), it follows that $\frac{\partial i_t}{\partial \pi_t} = 1.5 > 1$. This indicates a one percent increase in inflation rate results in more than one percent increase in nominal rate of interest and vice versa. This is termed as Taylor's principle instructing that central bank should react more than 1-1 to inflation in order to lower the current inflationary pressure. The mechanism is straightforward. If nominal rate of interest is increased more than one percent following a one percent increase in inflation, real rate of interest will rise and demand will fall that eventually will dampen inflationary pressure.

Although Taylor rule incorporates many important aspects of policy, it also is based on several oversimplified assumptions. Assumptions are embedded in all components of the rule. Following paragraphs discuss the contemporaneousness of Taylor's variables instead of either lagged or forecasted variables and ignorance of lagged interest rate in current setup.

Contemporaneous versus lagged data: Taylor rule recommendations in a given quarter are based on the contemporaneous output gap and on inflation over the four quarters ending in the same quarter. In this specification, it is assumed that the central bank knows the current quarter values of real GDP and a price index when it sets the nominal rate of interest for that quarter. In most of the countries, central banks do not have data on real GDP for a certain quarter until a month or a couple of months after the end of that quarter. The unavailability of current information to policy makers at the time decisions are made has led to a debate about whether to use current or lagged data in estimating interest-rate rules. To address this timing problem, there are some studies viewing interest rate in a given quarter as a function of output and inflation gap in the previous quarter. In general, the empirical evidence does not show a substantial loss in performance when lagged data are used instead of current data (Levin *et al*. (1999), McCallum and Nelson (1999), Rudebusch and Svensson

(1999)). The costs are small because inflation and output are persistent enough such that lags of the inflation rate and the output gap are good proxies for current values (Hamalainen, 2004). Also, it is reasonable to claim that the central bank has more information about the state of the economy at the time interest rate changes are made than is captured by inflation and output alone (Batini and Haldane (1999)). It has been argued on this premise that using contemporaneous data instead of lagged data can be thought to implicitly include information that is not reflected in inflation and output measures (Kozicki (1999), Rudebusch and Svensson (1999)).

Contemporaneous versus forecasted data: Some researchers prefer forward looking, or forecast-based interest rate rules, to contemporaneous rules like Taylor's. They argue that monetary authorities generally make policy decisions based on economic conditions expected in the future. But the same argument of persistence of inflation and output holds true in supporting contemporaneous rules over the forward-looking rules. It is not clear that forward-looking estimates have any advantage over contemporaneous or backward-looking versions of the rule. Although there are conceptual benefits to using forecast-based rules, the choice of an optimal rule still depends on the structure of the model under consideration, particularly the specific wage-price contracting process. In cases where wage bargaining is backward looking, Batini and Haldane show that forward-looking rules serve as stabilising mechanisms to counter-balance the backward-looking behaviour of the private sector. On the other hand, when wages are fully flexible, there is no need for forward-looking elements in the policy rule. However, Batini and Haldane caution that in extreme cases where the monetary authority and the private sector have an excessive degree of forward-looking behaviour, forecast-based rules could be destabilising. Using a backward-looking model, Rudebushch and Svensson (1999) find forecast-based rules outperforms the contemporaneous Taylor-type rule. The advantage, however, is only marginal. In fact, their results suggest that contemporaneous rule is a very close second to the most favourable forecast rules. Smets (1998) uses a model based on that of Rudebusch and Svensson (1999) with the exception that potential output is endogenous. With this modification, he finds that contemporaneous rules perform similar, and marginally superior, to forecast rules. Taylor (1999a) also concludes that forecast-based rules have little advantage over contemporaneous rules after he fails to find much difference between the performance of inflation forecasts and actual inflation in his policy rule. Taylor (2000) notes that as long as forecasts are not too far out into the future, they will be very close to their contemporaneous counterparts.

Interest Rate Smoothing: Taylor rule does not take into account the smoothing behaviour of central bank. But there is evidence that central banks have the tendency of smoothing interest rate such that the possibility of instability in the financial markets is minimised. Absence of smoothing implies a policy action on the basis of current inflation and output gap. Smoothing, on the other hand, relates current policy action to inflation and output gaps of several quarters rather than just a single quarter. Sometimes it may happen that the economic impact of change in nominal interest is uncertain. In such case it is reasonable to recommend smoothing. Taylor-type rules are commonly modified to incorporate interest rate smoothing by including a lagged interest rate term. Sack and Wieland (1999) question whether interest rate smoothing is deliberate or simply the result of monetary policy reacting to persistent macroeconomic conditions. If interest rate smoothing reflects the reaction of monetary authorities to persistent macroeconomic variables, one would expect the coefficient on the lagged interest rate to be small or insignificant. However, estimated Taylor-type rules that include a lagged interest rate typically yield large and significant coefficients, indicating that interest rate smoothing is deliberate.

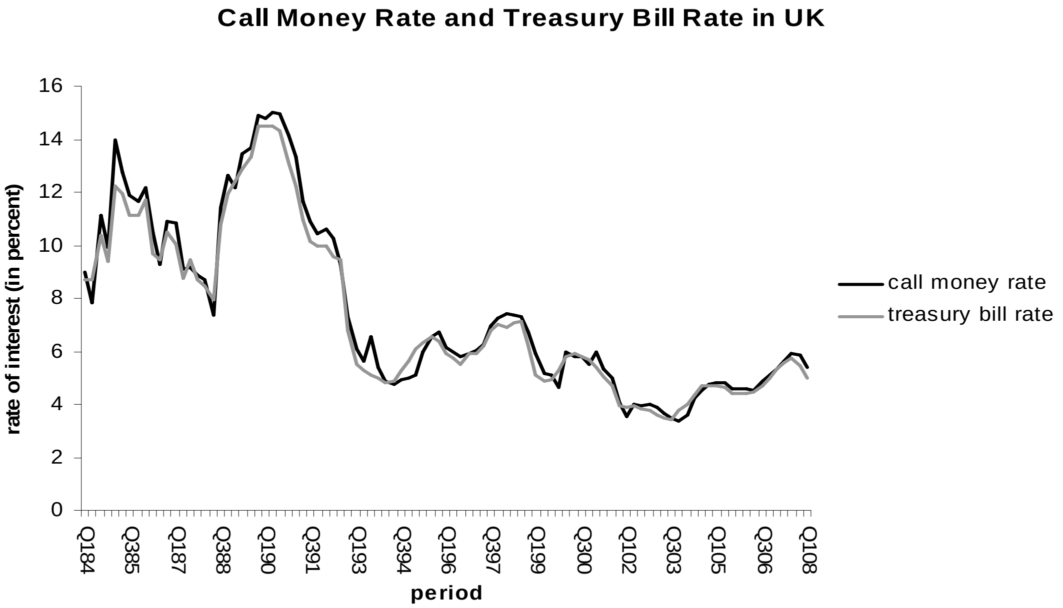
The Taylor rule, however, incorporates many of the features of good monetary policy like transparency, accountability and credibility. Especially, a central bank that adheres to a Taylor rule reveals to the public that it is committed to price stability and systematically takes step to achieve it. The public therefore keeps its expectation of inflation low and stable, and financial markets, in addition anticipate the Federal Reserve's next move and increase market interest rates immediately when inflation goes up. The origin of Taylor rule is really federal specific and it is true that many of the developed economies follow Taylor-type monetary policy rule implicitly or explicitly. Surprisingly, there is a vast amount of literature dealing with suitability and implementability of Taylor rule in developed countries but little is known about developing countries. For example, there is no study specific to Bangladesh, only one study by Malik and Ahmed (2007) about Pakistan and one study by Vineet Virmani (1992-2001) about India have been undertaken so far. Besides, some researches have been performed on individual underdeveloped countries without any generalisation. However, examining the features of all developing economies is beyond the capacity of one short thesis, rather effort has been put to draw conclusion on the basis of three countries.

3. Data and Methodology

Quarterly data for six countries have been retrieved from the online version of International Financial Statistics (IFS) from IMF for the period between 1984:Q1 and

2008:Q1. Interest rate used for the purposes of this analysis is the bank rates of USA (Federal fund rate), Sweden, Bangladesh and India, call money rates of Pakistan and UK.

Figure 3



I could use Treasury bill rate as the instrument for UK but data demonstrate that treasury bill rate and call money rate have approximately same plot that is revealed in Figure 3. CPI series of entire sample period are available for all the countries except for Bangladesh. For this country CPIs are available from 1993:Q3. Inflation rate for each quarter has been computed by using CPI on yearly basis. Four quarter inflations have been averaged and called it π in order to estimate the Taylor rule. Seasonally adjusted industrial production index has been used to construct output gap. Following the previous literatures on the estimation of Taylor rules, I constructed the output gap in percent using the Hodrick-Prescott cyclical component of the logarithm of industrial production. Constructions of different series and estimations have been carried out in EViews 6.

4. Estimation Results of Taylor Rule

In this section I estimate Taylor rule for six countries as a positive analysis in order to examine which countries are following this rule and if it is followed then what proportion of the variation in instrument is explained or unexplained. Estimable form of the Taylor rule is $i_t = \beta_0 + \beta_1\pi_t + \beta_2 y_t$ which is derived from equation (1) by setting $\beta_0 \equiv \bar{r} - h\pi^*; \beta_1 \equiv (1+h); \beta_2 = b$. Table 2 contains estimated Taylor rules of the six sample countries. Estimation results primarily show that UK and USA follow Taylor rule explicitly.

Low R^2 may question the goodness-of-fit in case of USA, in particular, because Taylor rule is Federal specific hence one may argue that R^2 should be as large as possible. But Judd and Rudebusch (1998) undertake estimates for the US, using various sub-samples and alternative measures of inflation and real activity over the period 1970-1997. All in all, they estimate 24 different rules for the changes in the Federal funds rate. Their top-performing rule has an R^2 at 67 percent. Most of their rules, however, have R^2 around 50 percent. Thus by this measure, the explanatory power of my estimated rule, has to be judged to be plausible.

Table 2

Estimated Taylor Rule, Goodness-of-fit and Test Results for Unit Root

Country	Estimated Taylor Rule[2]	Adjusted R^2	ADF test statistic for residuals
Pakistan	$i_t = \underset{(5.92)}{3.91} + \underset{(6.50)}{0.55}\pi_t - \underset{(-0.70)}{0.05} y_t$ ………..(3)	0.33	-3.74
India	$i_t = \underset{(10.20)}{4.70} + \underset{(10.12)}{0.61}\pi_t - \underset{(-0.35)}{0.02} y_t$ ……….(4)	0.53	-3.34
Bangladesh	$i_t = \underset{(14.74)}{6.89} - \underset{(-1.81)}{0.14}\pi_t - \underset{(-0.67)}{0.04} y_t$ ………(5)	0.04	-1.74
Sweden	$i_t = \underset{(8.27)}{2.10} + \underset{(16.04)}{1.02}\pi_t - \underset{(-1.94)}{0.11} y_t$ ………(6)	0.74	-2.76
	$i_t = \underset{(4.71)}{1.95} + \underset{(5.40)}{1.01}\pi_t - \underset{(-1.95)}{0.14} y_t$ (1993-2002)	0.46	-2.74
UK	$i_t = \underset{(4.85)}{1.69} + \underset{(17.74)}{1.54}\pi_t + \underset{(1.83)}{0.19} y_t$ ………(7)	0.78	-3.19
USA	$i_t = \underset{(2.80)}{1.50} + \underset{(6.78)}{1.16}\pi_t + \underset{(6.12)}{0.54} y_t$ ………(8)	0.51	-2.87

Equation (3) in Table 2 is the estimated Taylor rule with adjusted data between 1985:Q4 and 2008:Q1 for Pakistan that is consistent with the finding of Malik and Ahmed (2007) where they used the data between 1991 and 2005. Before estimating the equation, call money rate of Pakistan has been seasonally adjusted in order to avoid the influence of any seasonal component since it is most likely that in some underdeveloped countries this rate shows unusual fluctuation on the eve of public holidays. Residuals series from this estimation is stationary as the null of the unit root in ADF test can easily be rejected at any level of significance since the P-value of ADF test statistic is 0.005. As Enders (2004) argues if the estimated residuals are stationary then OLS estimates are super consistent and integration of the variables in the equation does not create any problem. Estimated equation confirms that

State Bank of Pakistan (SBP) which is the central bank does not follow Taylor rule. Because, to be consistent with Taylor rule coefficient of π_t should be larger than unity and coefficient of y_t should be positive. Low value of R^2 indicates that output gap and inflation can poorly explain the overall variation in short term interest rate. Furthermore, the value of Durbin-Watson statistic is 0.55 which clearly indicates that there is high degree of autocorrelation in the estimated interest rate reaction function. This is a clear signal that either SBP has the objective of interest rate smoothing or there are missing variables in the above regression.

Table 3 along with Figure 4 shows that the rule induced and the actual short term interest rate have visibly different behaviour. In the sample period, actual rate of interest has smaller mean and variation than the rule induced interest. It implies that State Bank of Pakistan responded less aggressively to output and inflation than what rule would have suggested. This is not unrealistic for a developing country because developing countries have different monetary policy objectives like, interest rate smoothing, exchange rate stability, financial sector stability etc.

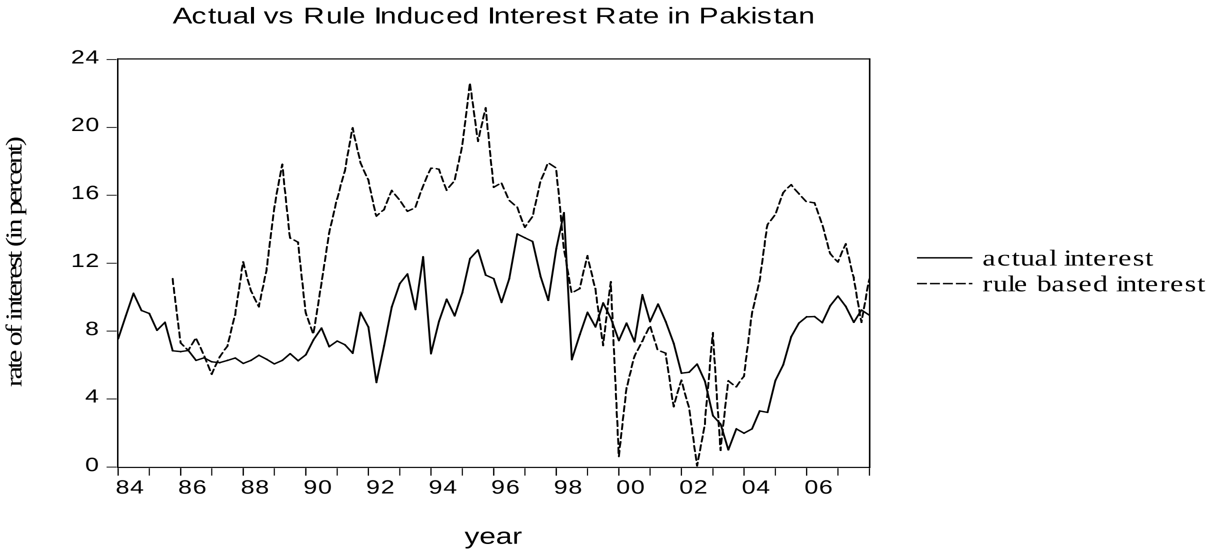
Table 3

Actual and Taylor Rule-induced Short term Interest Rate in Pakistan

	Actual	Rule Induced
Mean	7.98	11.76
Median	8.18	11.82
Maximum	14.97	21.70
Minimum	1.01	4.85
Range	13.96	16.85
Std. Dev.	2.69	4.38

[2] numbers in parentheses indicate *t*-statistics

Figure 4



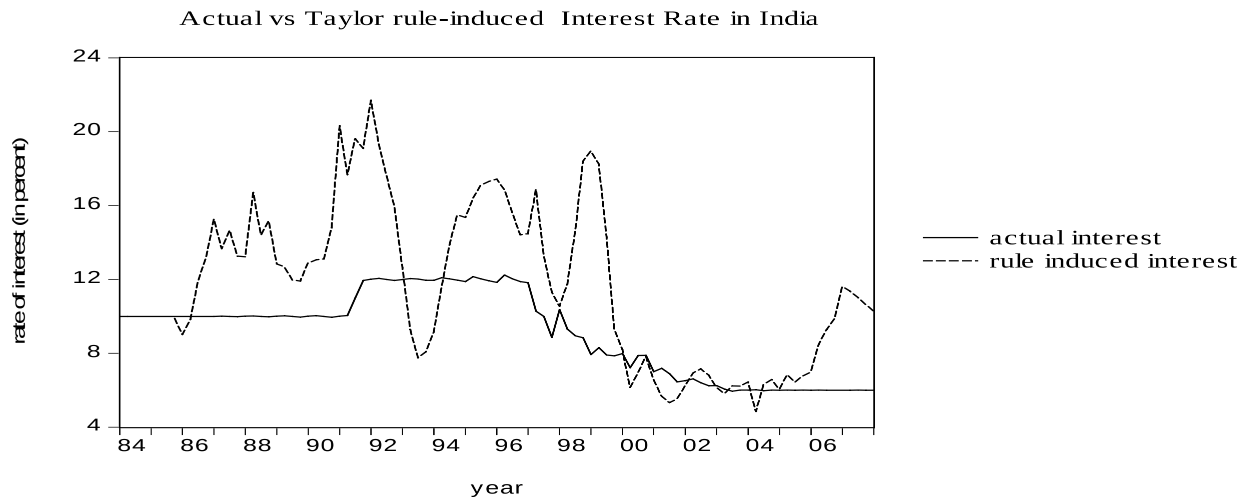
It is clear from equation (4) that India is not following Taylor rule in setting rate of interest. There is no consensus if they follow any specific rule for conducting monetary policy. In an attempt, Vineet Virmani tried to operationalise Taylor-type rules for the Indian economy by using the data between 1992Q3 and 2001Q4 but the conclusion was that McCallum rule augurs well for the conduct of monetary policy in the Indian context but there is ambiguity if they really follow any such rule. Had they followed Taylor rule, time path of interest rate would have been like the dashed line in Figure-5. In constructing the following Table and diagram, Taylor's original formulation is used, i.e., $\bar{r} = 2, \pi^* = 2, b = 0.5, h = 0.5$.

Table 4

Actual and Taylor Rule-induced Short term Interest Rate in India

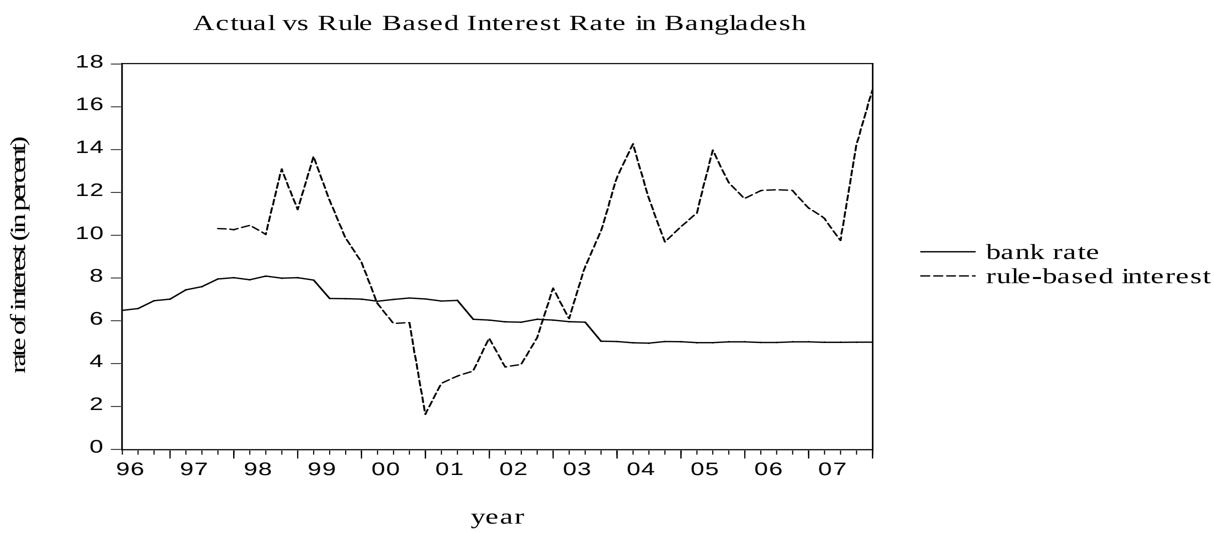
	Actual Interest	Rule Induced Interest
Mean	9.11	11.76
Median	10.00	11.83
Maximum	12.24	21.70
Minimum	5.94	4.85
Range	6.30	16.85
Std. Dev.	2.23	4.38

Figure 5



Equation (5) is the estimated Taylor rule of Bangladesh for the period 1996Q2-2008Q1. Negative coefficients of both inflation and output gap imply that central bank does not follow Taylor rule in setting interest rate. Adjusted R^2 is 0.04 implying that inflation and output stabilisation together explain merely 4% of aggregate variability in monetary policy instrument. There may have also the possibility of spurious regression because ADF test for residuals cannot reject the null of unit root with substantial confidence. Advanced regression techniques can be employed with necessary correction in the time series properties of interest rate, inflation and output gap in order to estimate the Taylor rule for Bangladesh but the monetary policy statement of the central bank does not reveal any information supporting Taylor rule in their setup.

Figure 6



Since my objective is to examine the suitability of Taylor rule, I have created one series of interest rate by mechanically following the rule and graphed it jointly with actual rate of interest in Figure 6. It is quite obvious that rule-based interest is far from actual rate.

Estimated Taylor rules with either full sample or sub-sample do not show that Sweden follows a generalised Taylor[3]. This finding is not surprising because previous researches do not conclude that Sweden is the follower of Taylor rule being even successful inflation-targeting since 1993. This is in line with the argument of Svensson (2001) that the simple Taylor rule does not give right insights about what inflation-targeting central banks are doing. In a working paper ''How Useful are Simple Rules for Monetary Policy? The Swedish Experience'' Berg, Jansson and Verdin (1994) concluded that on certain occasions, policy seems to have been more expansionary or contractionary than what is implied by most relevant simple rules. They found that Riksbank from time to another deviates from the simple rules for reasons that are usually neglected in models of monetary policy. To them, when uncertainty about he macroeconomic conditions has been perceived to be unusually large, a cautious policy has been followed and the repo rate has been left unchanged despite changes in the expected rate of inflation.

Figure 7

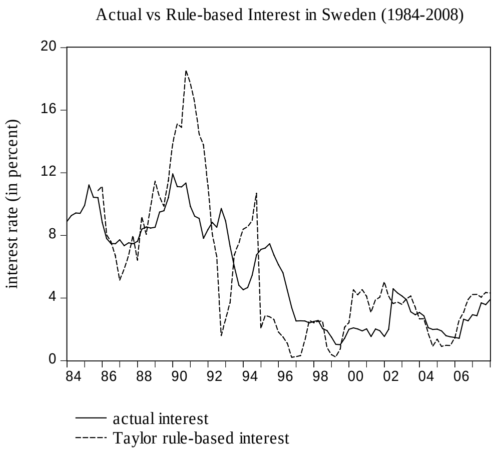
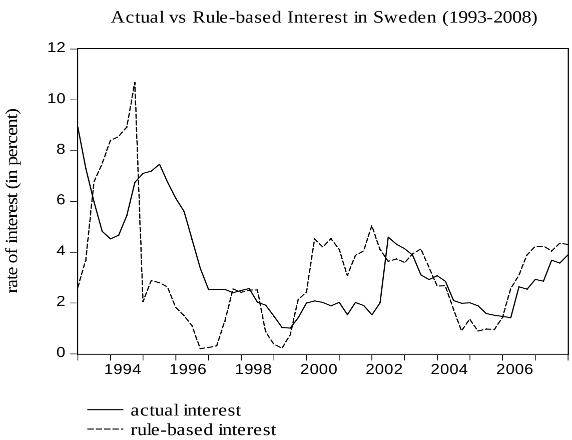


Figure 8



Diagrams above demonstrate that in recent years actual rates of interest are close to the simple Taylor rule-based interest. Maybe Sweden is now following Taylor-type monetary policy rule. Table 5 also gives some signs of convergence of Sweden toward

[3] Coefficient of inflation is matching with Taylor rule but negative coefficient of output gap is not. It can still be argued that Sweden follows Taylor rule with zero weight on output stabilisation because coefficient of output gap is not statistically different from zero.

Table 5

Actual and Taylor Rule-induced Short term Interest Rate in Sweden

	Mean	Median	Maximum	Minimum	Range	St. dev.
Actual interest	3.35	2.57	8.92	1.02	7.90	1.92
Rule-based interest	3.19	2.80	10.68	0.20	10.48	2.23

Taylor rule-based policy because average actual interest rates and average rule-based interest rates are almost equal with alike standard deviations in both cases. Table 5 uses data between 1993 and 2008. If the whole sample period is taken into account, it is found that standard deviation of actual interest rate is 3.28 and of rule-based interest rate is 4.44 that may authenticate the phenomenon stated earlier that recent monetary policy of Sweden is in the net of Taylor's although not from the beginning.

Equation (7) is the estimated Taylor rule for UK using the whole sample consisting of 97 quarterly observations. This equation is simplified below to make it more explicit as the simple Taylor rule:

$i_t = 1.69 + 1.54\pi_t + 0.19y_t$, comparing this equation with $i_t = \beta_0 + \beta_1\pi_t + \beta_2 y_t$

where, $\beta_1 \equiv 1 + h = 1.54 \Rightarrow h = 0.54$; $\beta_2 = b = 0.19$ and

$\beta_0 \equiv \bar{r} - h\pi^* = 1.69$; $\Rightarrow h\pi^* = \bar{r} - 1.69$; $\Rightarrow \pi^* = 4$ (using sample $\bar{r} = 3.85$ and $h = 0.54$).

Finally, equation (7) takes the form of Taylor rule $i_t = 3.85 + \pi_t + 0.54(\pi_t - 4) + 0.19y_t$ that is equivalent to $i_t = \bar{r} + \pi_t + h(\pi_t - \pi^*) + by_t$. Underlying target rate of inflation is calculated 4 percent which is not too unrealistic because the last observed inflation rate is 3.90 percent. It is clear that UK follows Taylor-type monetary policy rule. This result is not controversial because in an investigation by Mark P. Taylor and Emmanuel Davradakis (2006) it is concluded that interest rate setting behaviour of Bank of England appears to be well captured by Taylor rule with some degree of nonlinearity in policy setting.

It is unimportant to estimate the Taylor rule for USA because this rule is federal specific that recommends a setting for the level of the federal funds rate based on the state of the economy. Nevertheless, I estimated the equation depicted as (8) in Table 2 using whole sample and there is no deviation from Taylor's suggestion at least with respect to sign of the coefficients. In addition to econometric evidence, figures 9 and 10 illustrate the fact that both USA and UK are consistently following Taylor rule since the rule induced interest and actual interest have close plot. Empirical finding displays that rule-based monetary policy in UK and in USA keeps inflation and output variability quite low. It can be convincingly

Figure 9

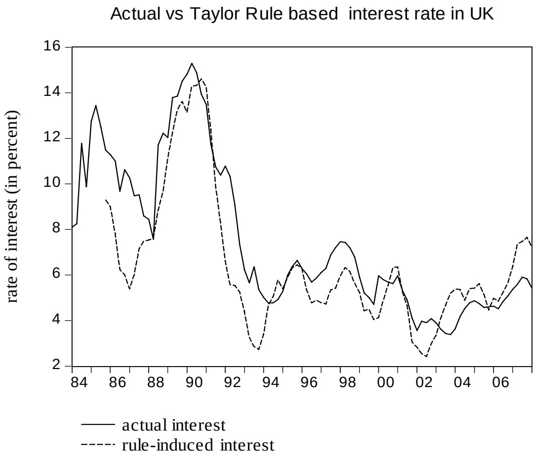
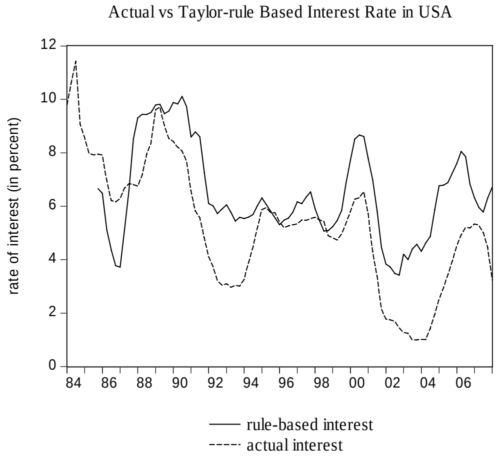


Figure 10



argued that this is the virtue of Taylor rule that could keep combined variability of two fundamental macroeconomic indicators at a minimum. With this motivation, this paper examines if such a simple monetary policy rule can be proposed for the developing countries.

5. Model Specification and Simulation

This section deals with the normative analysis of this study. In order to check whether macroeconomic performance of developing countries can be improved through the implementation of Taylor rule as monetary policy, economies have been simulated on the basis of Rudebusch-Svensson model along with the Taylor rule.

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} - \beta_3(\bar{i}_{t-1} - \bar{\pi}_{t-1}) + \varepsilon_t \quad .... \quad ....(9)$$

$$\pi_t = \gamma_1 \pi_{t-1} + \gamma_2 \pi_{t-2} + \gamma_3 \pi_{t-3} + \gamma_4 y_{t-1} + \eta_t \quad .... \quad ..(10)$$

Rudebusch and Svensson (1998) used this small Neo-keynesian type empirical model[4] of the US economy consisting of equations (9) and (10) to examine the performance of policy rules, where y_t is output gap in percent, $\bar{i}_t$ is four-quarter average interest in percent at an annual rate, π_t is quarterly inflation in percent at an annual rate and $\bar{\pi}_t$ is four-quarter average inflation. ε_t and η_t are demand and supply shocks respectively. I have found that for some countries the model works reasonably well with one lag in both output gap and inflation hence it has been further simplified as

[4] This model is shorter version of Svensson (1997) where he used the following three equations:

$$y_t = \beta_1 y_{t-1} - \beta_2(i_{t-1} - \pi_{t-1}) + \beta_3 x_{t-1} + \varepsilon_t;\ x_t = \gamma x_{t-1} + \theta_t$$

$$\pi_t = \pi_{t-1} + \alpha_1 y_{t-1} + \alpha_2 x_{t-1} + \eta_t;\alpha_1, \beta_2 > 0; \beta_1 < 1; \gamma < 1$$

$$y_t = \beta_1 y_{t-1} - \beta_2(\bar{i}_{t-1} - \bar{\pi}_{t-1}) + \varepsilon_t \; .... \; ....(9.1); \; (0 < \beta_1 < 1, \beta_2 > 0)$$

$$\pi_t = \gamma_1 \pi_{t-1} + \gamma_2 y_{t-1} + \eta_t \; .... \; .... \; ....(10.1); \; (0 < \gamma_1 \leq 1, \gamma_2 > 0)$$

(ε_t and η_t are i.i.d. shocks)

The first equation relates output gap to its own lag and to the difference between average interest rate and average inflation over the previous four quarters-an approximate ex post real rate. This equation can be treated as the IS equation or aggregate demand equation showing an inverse relation between real rate of interest and output. The second equation, in contrast, can be treated as the aggregate supply equation relating inflation to a lagged output gap and to lag(s) of inflation. In this model π_t is quarterly inflation in percent at an annual rate, i.e., $400(\ln CPI_t - \ln CPI_{t-1})$; $\bar{\pi}_t$ is four-quarter inflation, i.e., $\frac{1}{4}\sum_{j=0}^{3}\pi_{t-j}$; i_t is quarterly average interest rate in percent at an annual rate and $\bar{i}_t$ is four-quarter average interest rate, i.e., $\frac{1}{4}\sum_{j=0}^{3} i_{t-j}$ .The above specification would make sense only if β_2 is positive because an increase in real average rate of interest routinely lowers output that is a simple representation of the monetary transmission mechanism. The lags of inflation are autoregressive or adaptive representation of inflation expectation. In their empirical analysis, Rudebusch and Svensson imposed the restriction that coefficients of inflation lags sum to one. Since there is only one lag in the simpler model, I have performed the Wald test $H_0 : \gamma_1 = 1$ for each country. Nonrejection of this null corresponds to Rudebusch-Svensson model's restriction. This restriction, however, only applies if there is no constant term in the right hand side of equation (10.1).

Equation (10.1) shows that output affects inflation with one period lag and (9.1) shows that interest rate affects output with one period lag, i.e., interest rate affects inflation with two-period lag. The crucial property of the model is that the instrument (interest rate) affects inflation with a longer lag than it affects output. According to Svensson (1997), although simple, the model has good theoretical properties and captures essential features of the more elaborate models, which some of the central banks are using for policy analysis (Malik, 2007).

I have simulated all the economies in sample except UK and USA in order to investigate macroeconomic performance with Taylor rule. Simulation was accomplished through Excel that required the following steps:

1) Equations (9.1) and (10.1) have been estimated in Eviews;

---

x_t is an exogenous variable. ε_t, η_t and θ_t are i.i.d. shocks at period t that are not known at period $t-1$

2) Residuals (demand and supply shocks) have been stored in two columns of excel sheet;
3) Interest rate (i) has been computed by employing the Taylor rule with different plausible $\bar{r}$, π^*, h and b. Simulated π and y have been used instead of actual π and y;
4) Current π and y have been computed by using the coefficients obtained in step 1, residuals in step 2 and computed values of lagged i, π and y.
5) Actual social loss and simulated social loss have been computed by using the following social loss (SL) function:

$$SL = \sigma_y^2 + \kappa\sigma_\pi^2 \text{ ....(11)}$$

This social loss function is robust in ordering for different values of κ that measures the degree to which society values stable inflation relative to output stability. In this study κ is assumed equal to 2. Lower social loss is an indicator of improved macroeconomic performance hence parameter values of Taylor rule are set in a way that minimises social loss.

6. Simulation Results

6.1. Developing Countries

Pakistan

Estimated Rudebusch-Svensson (1999) model for Pakistan is described by equations (12) and (13). Before estimation, I checked the time series properties of the variables by examining if they are stationary or not. Most of the variables are stationary although not all but residuals from OLS regression are stationary that may perhaps ensure nonspuriousness.

$$y_t = 0.24 y_{t-1} - 0.20(\bar{i}_{t-1} - \bar{\pi}_{t-1}) \text{....... .... (12)}$$

(2.36) (-1.83)

S.E.=3.47 DW= 2.08

$$\pi_t = 0.86\pi_{t-1} + 0.14 y_{t-1} \text{ ....(13)}$$

(15.47) (1.07)

S.E.=4.63 DW= 2.13

All the coefficients have right signs and magnitudes to be compatible with the economic theory. With this estimated model and assuming Taylor rule as monetary policy strategy, I have simulated the economy, incorporating in each period the estimated shocks (to output and inflation) from equations (12) and (13). Counterfactual simulation shows that Taylor rule performs better in the context of macroeconomic performance of Pakistan because social loss substantially falls once the rule is implemented. Following table depicts the actual and simulated values of inflation, output variability and corresponding social loss:

Table 6

Actual and Simulated Social Loss in Pakistan (b=0.71, h*=1.56)*[5]

	Actual	Simulated
Variance of inflation	9.60	7.16
Variance of output gap	13.81	12.43
Social Loss	33.01	26.75

In the above computation target rate of inflation is assumed 8%. Optimal weights on inflation and output gap stabilisation have been evaluated by using the Solver function in Excel. Those values are 1.56 and 0.71 respectively. Real rate of interest is assumed 0.5 percent. It is clear that both output and inflation variability are lower under rule based policy.

Depending on the state of the economy, it may be desirable to keep the inflation target as small as possible. But none of the central banks, with any monetary policy strategy, targets zero inflation as central banks are not inflation nutters in King (1997) terminology[6]. Too low inflation may badly affect economic growth of a developing country. Therefore, inflation target should be set at a positive level. However, Khan and Senhadji (2001) estimated threshold level of inflation for developing countries that ranges between 7 and 11 percent. Mubarik (2005) estimated 9 percent threshold level of inflation for Pakistan. Actual data reveals real interest rate equal to 0.66 percent and thus simulation is done with and around this value.

Apart from the optimal weights on inflation and output, simulation is done with different pairs. Simulation results are summarised in Table 7.

There are several salient features of this table:

(1) Rule induced average rate of interest is smaller than the actual average whereas rule-based interest rate has higher variability. This implies that monetary authority in Pakistan kept interest rate higher with a low response to the changes in economic conditions. This was perhaps to avoid any sudden instability arising from frequent changes in interest rate. Rule, on the other hand, proposes aggressive changes in instrument with respect to the economic conditions.

[5] * indicates optimum values.

[6] See Malik, Ahmed 2007

Table 7

Simulation of Pakistan Economy with Different Sets of Parameter Values

	actual	with optimal weights (b=0.71, h=1.56)	with equal weights (b=0.5, h=0.5)	Full weight on inflation (b=0, h=1.56)	Full weight on output (b=0.71, h=0)
Interest rate					
Average	7.98	7.02	7.40	6.90	7.67
Standard deviation	2.69	6.33	4.16	6.77	3.52
Outuput gap					
Average	3.8E-11	0.32	0.18	0.37	0.08
Standard deviation	3.72	3.52	3.41	3.59	3.39
Inflation					
Average	7.27	7.33	7.20	7.38	7.11
Standard deviation	3.10	2.68	2.80	2.64	2.89
Social Loss	33.01	26.75	27.30	26.83	28.20

(2) Rule induced interest rate has maximum standard deviation when all the weights are given to inflation. This indicates that if the central bank's objective is to stabilise inflation around the target by disregarding output, they should change interest rate repeatedly that eventually yields bigger standard deviation.

(3) Table 7 also signals that if the aim of monetary policy is to achieve lowest output variability then whole weights should be given to output gap with zero weight to inflation and vice versa. Figures A5 and A7 in Appendix A correspond these cases.

(4) In any case, loss to the society is smaller if rule based policy is in practice. This is in accordance with the findings of Malik and Ahmed (2007) who used Pakistani data for the period 1991-2005 and came to the conclusion that macroeconomic performance, in terms of less variability of output and inflation and small value of the loss to the society, could be improved significantly. In their calculation loss drops from 12.32 to 7.48. But they computed social loss as the simple arithmetic mean of two variances. If the same formula is followed then in my calculation social loss drops from 11.72 to 9.79 for the whole sample period 1984-2008.

I find it reasonable for Pakistan to follow the Taylor rule as Monetary policy because previous study with 15 years of data and my study with 24 years of data exhibit the common feature of improvement in performance of the economy under Taylor rule. This is worth mentioning that counterfactual historical simulation gives the expected result but stochastic simulation does not. I let the Random Number Generator of Microsoft Excel generate repeated series of shocks for Svensson model's inflation and output with standard deviations being equal to standard errors of regression but the resulting loss to the society with these generated shocks appears larger than the actual ones in most of the cases. This is conflicting with the finding of Malik and Ahmed (2007) where they used Pakistani data between 1991 and 2005. Their claim was that only 20 out of 1000 times, standard deviation of simulated output gap greater than or equal to that of the actual data and for 100 times for inflation series. This contradiction may arise from methodological difference as they performed it by bootstrapping the standard deviation of output and inflation which is an advanced econometric technique rather than what is done by Random Number Generator.

India

In this study I estimate the Rudebusch-Svensson model for India by using the full sample 1984-2008. Estimated y and π are described as equation (14) and (15).

$$y_t = 0.61 y_{t-1} + 0.02(\bar{i}_{t-1} - \bar{\pi}_{t-1}) \text{....... ....} (14)$$

$$\pi_t = 0.98\pi_{t-1} + 0.04 y_{t-1} \text{...... ....}(15)$$

Equation (15) is consistent with economic theory but equation (14) is not because it indicates an increase in output following an increase in real rate of interest. It reminds me one feature of underdeveloped economy where a low rate of interest increases the availability of credit to the unproductive sector hence reduces credit expansion to actual investors that eventually lowers overall output. If central bank, on the other hand, imposes some restrictions on credit expansion toward unproductive sectors, it can work successfully in favour of increment in output. When the economy is simulated with the Taylor rule jointly with (14) and (15), it shows an improvement in macroeconomic performance with respect to loss to the society. In this case Excel Solver gives some negative optimal parameter values for India which is clear contradiction to Taylor's suggestion. Data from 2000-2008, however, give meaningful results throughout. Estimated Svensson model is described by the following two equations:

$$y_t = \underset{(6.41)}{0.72}\, y_{t-1} - \underset{(-0.47)}{0.03}(\bar{i}_{t-1} - \bar{\pi}_{t-1}) \quad \text{......... ......} (16)$$

$$\pi_t = \underset{(6.40)}{7.84} - \underset{(-1.35)}{0.21}\,\pi_{t-1} - \underset{(-3.52)}{0.55}\,\pi_{t-2} + \underset{(0.59)}{0.24}\, y_{t-1} \text{...... ....} \ (17)$$

Taylor rule with optimal weights on inflation and output stabilisation results in a loss to the society equal to 31.33 whereas actual loss is 35.57. Since the weights are bigger in magnitudes one can argue to use the relative weights[7]. In line with this reasoning, when I put 0.5 weight on inflation and 2 weight on output stabilisation social loss is 31.94. Table 8

[7] Optimal weights are found as $h = 9.34$ and $b = 50.13$

contains different values of explained and explanatory variables, and accompanying social loss computed for a variety of parameter values in Taylor rule. In this construction, I set real equilibrium interest and target inflation rate equal to 2 and 9 percent respectively. For India

Table 8

Simulation of Indian Economy with Different Sets of Parameter Values

	actual	with optimal weights (b=2, h=0.5)	with equal weights (b=0.5, h=0.5)	Full weight on inflation (b=0, h=0.5)	Full weight on output (b=2, h=0)
Interest rate					
Average	6.38	4.13	4.17	4.17	6.05
Standard deviation	0.62	6.36	5.92	5.87	4.62
Outuput gap					
Average	-0.11	-0.02	-0.05	-0.07	-0.19
Standard deviation	1.51	1.16	1.20	1.21	1.20
Inflation					
Average	4.37	4.45	4.45	4.45	4.43
Standard deviation	4.08	3.91	3.91	3.91	3.91
Social Loss	35.57	31.92	32.02	32.04	32.04

observed data reveal real rate of interest equal to 1.63 and I find infinitesimal change in social loss around this value. Whatever the cases regarding parameter values, real equilibrium interest and target inflation rate, it is quite obvious that Taylor rule can perform better than the existing policy in India since it reduces both inflation and output variability with high degree of robustness.

Bangladesh

Bangladesh is a less developed country (LDC) with an ill-organised and poorly developed monetary system. The monetary sector of Bangladesh is small relative to the size of the total economy. Abject poverty of majority of the people means that they rarely make transaction of monetary nature. Moreover, Bangladesh inherited a number of primitive monetary and fiscal institutions since its independence in 1970. There has been no fundamental improvement in these institutions during the ensuing two decades (Wahid, 1993). Approximately 50 percent of the gross national product still originates in the non-monetised subsistence sector. In this sector the bulk of the output is retained for self-consumption and is not marketed. Under such condition it is widely recognised that the practice of monetary policy may produce disappointing results.

$$y_t = \underset{(1.85)}{0.28} y_{t-1} - \underset{(-0.25)}{0.03} (\bar{i}_{t-2} - \bar{\pi}_{t-2}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (18)$$

$$\pi_t = \underset{(4.39)}{5.39} + \underset{(0.44)}{0.07} \pi_{t-1} + \underset{(0.83)}{0.24} y_{t-2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (19)$$

Equation (18) is the estimated IS equation and (19) is the Phillips curve equation given by Rudebusch and Svensson. Real rate of interest and output gap with one lag do not give right economic sense neither they are statistically significant hence not included in the equations above. It is quite different from either the Pakistan case or Indian case that IS equation becomes sensible if real rate of interest is taken into account with two-period lag and supply equation gets statistical and economic significance if output gap is incorporated with two-period lag as well. This newer phenomenon of the model indicates that policy instrument affects inflation with four-period lag which is the symptom of rigidity in financial sector of Bangladesh or it can be viewed as Friedman's argument that monetary policy tends to affect the real economy with long and variable lags[8]. Simulation with Taylor rule, however, shows an improvement in macroeconomic performance in terms of aggregate variability in output and inflation. Optimal weights for inflation and output are 9.75 and 8.96 respectively that reduce loss to the society from 21.60 to 20.79 with an inflation target of 10 percent and zero real rate of interest. This is noticeable that the above parameter values produce some extreme values in the series of rule-based interest rate. In such case, it can be recommended to use the relative weights instead. In special case of Bangladesh, it is a matter of fact that counterfactual simulation with Taylor rule does not show a large change in overall performance although there is some. There may have several reasons behind, like small size of data, least-developed monetary system and too restrictive and prudential[9] policy formulation.

6.2. Developed Countries

Sweden

Simulation of the economy with Rudebusch-Svensson model described by equations (20) and (21) shows smaller variability in both[10] inflation and output if Taylor rule

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[8] Milton Friedman and Anna Schwartz, A Monetary History of the United States, 1867-1960, Princeton, NJ, 1963

[9] Prudential in the sense that central bank of Bangladesh seldom changes policy decision with the fear of any unforeseen instability.

[10] Taylor suggested equal weights on both inflation and output stabilisation. If this suggestion is followed both output and inflation variability fall but with optimal weights there is a trade-off.

is the interest rate reaction function. Optimal weights on inflation and output are 2.22 and 0.44 respectively.

$$y_t = \underset{(6.13)}{0.54} y_{t-1} - \underset{(-0.98)}{0.08} (\bar{i}_{t-1} - \bar{\pi}_{t-1}) \quad \ldots\ldots\ldots\ldots\ldots \quad (20)$$

$$\pi_t = \underset{(8.26)}{0.64} \pi_{t-1} + \underset{(0.89)}{0.12} y_{t-1} \quad \ldots\ldots\ldots\ldots. \quad (21)$$

Social loss drops from 24 to 21.48 if inflation target is set 3% and real equilibrium rate of interest is 2.35%. Possibility of spurious regression is ruled out because residuals are I(0) in each of the above three equations.

Table 9 compares actual social loss with rule-based loss. It appears that there is a trade-off between inflation and output variability had the optimal set of parameters been chosen. The same holds true if monetary policy is framed only for inflation stabilisation. In both cases variability in output increases and of inflation decreases under rule-based policy.

Table 9

Simulation of Swedish Economy with Different Sets of Parameter Values

	actual	with optimal weights (b=0.44, h=2.22)	with equal weights (b=0.5, h=0.5)	Full weight on inflation (b=0, h=2.22)	Full weight on output (b=0.44, h=0)
Interest rate					
Average	5.49	5.21	5.30	5.20	5.32
Standard deviation	3.28	8.21	4.27	7.88	3.00
Outuput gap					
Average	1.54E-11	0.02	0.005	0.02	0.002
Standard deviation	2.83	2.90	2.77	2.89	2.76
Inflation					
Average	3.08	3.00	7.21	3.00	3.00
Standard deviation	2.83	2.56	2.69	2.56	2.73
Social Loss	24.0	21.48	22.07	21.51	22.51

Simulation results show that Taylor rule with optimal parameter values reduces social loss of Pakistan, India and Sweden by 19%, 12% and 10.5% respectively. Significant fall in loss to the society ultimately indicates the improvement in macroeconomic performance under Taylor rule.

7. Modification of Taylor rule

The findings so far observed reflect that Taylor rule as monetary policy can improve macroeconomic performance by lowering loss to the society. Such improvement can eventually lower the representative consumers' lifetime utility loss because economic instability created from price and output variation generates loss in lifetime utility of the consumer. This issue has recently been addressed by economists Julio Rotemberg and Michael Woodford. They have developed an empirical AS-AD type model for the United States in which the representative consumer's lifetime utility loss from economic instability may be approximated by a social loss function of the same form used in this study: $SL = \sigma_y^2 + \kappa\sigma_\pi^2.$ A rational economic agent makes decision basing on the information of recent past. If there is large deviation in the current period then decision-makers have to face a number of unanticipated events which are the sources of utility loss. Simple Taylor rule does not consider interest rate of previous period directly but for the reasons mentioned above, it may be optimal to incorporate lagged interest rate in the reaction function. Sorensen and Whitta-Jacobsen[11] proposed one modified Taylor rule where the lagged interest rate is included as an explanatory variable:

$$i_t = \bar{r} + \pi_t + h(\pi_t - \pi^*) + by_t + ci_{t-1}, \quad c > 0 \quad \ldots \quad \ldots \quad (22)$$

This equation expresses that central banks tend to engage in interest rate smoothing, that is if the interest rate was high during the last period, it will also tend to be high during the current period and vice versa. It is argued that the central bank can minimise the agents' welfare loss by setting the interest rate as a function of all observed past values of the output gap, all past values of the inflation gap, and all past values of the interest rate, with declining coefficients on past variables observed further back in history. However, Rotemberg and Woodford also find that if the central bank follows a simple interest rate rule of the form (22) with appropriately chosen positive values of the parameters *h*, *b* and *c*, it can ensure almost the same level of consumer welfare as the welfare level attainable under the optimal policy rule. In other words, a modified Taylor rule which includes the lagged interest rate comes close to being optimal, according to Rotemberg and Woodford. Inclusion of the lagged short-term interest rate i_{t-1} in the interest rate reaction function increases the ability of the central bank to influence aggregate demand because the variable i_t appearing in (22) is the short-term interest rate controlled by the central bank and long-term interest rate is an average of the current and expected future short rates. The greater the change in the longer-term market interest rates induced by a change in i_t, the greater is change in aggregate demand caused by a change in the short-term interest rate, since investment in long-lived assets depends mainly on the long-

[11] P.B. Sorensen and H.J. Whitta-Jacobsen, Introducing Advanced Macroeconomics (p. 640)

term interest rate. It can be convincingly argued that augmented Taylor rule of the form (22) becomes a more effective instrument for managing aggregate demand because if the market participants realise that monetary policy follows the rule (22), they will anticipate that an increase in the current short rate will also imply higher short-term rates in the future, all other things remaining unchanged.

Although this paper does not investigate the consumers' welfare measure as a function of policy instrument but it investigates whether loss to the society can be pushed to a minimum by incorporating interest rate smoothing term into the reaction function. I find the justification of including lagged interest rate in the Taylor rule for the developing countries, especially for Pakistan because it significantly lowers the social loss of this country. For example, social loss of Pakistan drops to 23.89 once lagged interest rate with optimal coefficient 0.75 is included in the interest rate reaction function. Without any smoothing, loss was 26.75 under optimal pair of h and b. This is noticeable that optimum values of h and b are quite low in presence of interest rate smoothing that makes economic sense because lagged interest rate captures a substantial portion of inflation and output stabilisation hence stabilisation parameters (h, b) are not likely to be too much. Without smoothing term, optimal h and b are 1.56 and 0.71 respectively whereas in presence of smoothing those are 0.01 and 0.22. If h and b are, however, left unchanged as 1.56 and 0.71 then optimal coefficient of lagged interest rate is 0.37 and corresponding social loss is 26.14 against 26.75 without smoothing. Another experiment of smoothing with h and b being equal to Taylor's suggestion (0.5) results in social loss equal to 24.34 with optimum coefficient of lagged interest being 0.71. It appears that $b=h=0.5$ is a better candidate than too low weights on inflation and output stabilisation as 0.01 and 0.22. Whatever the case, the model is robust in improving overall performance with lagged interest rate. Table 10 presents the comparative pictures of economic stability in Pakistan *with* and *without* interest rate smoothing under different weights on inflation and output stabilisation.

Table 10
Decomposition of Social Loss in Pakistan with Interest Rate Smoothing

	Optimal Weights *(h=0.01, b=0.22)*		Equal Weights *(h=b=0.5)*		Full Weight on Inflation *(h=0.01, b=0)*		Full Weight on Output *(h=0, b=0.22)*	
	with smoothing	without smoothing	with smoothing	without smoothing	with smoothing	without smoothing	with smoothing	without smoothing
Variance of inflation	5.75	7.18	5.73	7.84	5.53	6.97	5.76	8.35
Variance of output gap	12.38	12.39	12.93	11.63	13.02	12.89	12.37	11.49
Social Loss	23.89	26.75	24.39	27.30	24.08	26.83	23.89	28.20

Interest rate smoothing in India shows a minor improvement in performance with optimal coefficient of i_{t-1} being 0.64. On the basis of last eight years data until 2008, actual social loss of India is 35.57. Had the country adopted simple Taylor rule with optimal coefficients (*h=0.5, b=2*), loss would have been 31.92 whereas augmented Taylor rule with interest rate smoothing factor shows social loss equal to 31.81. Interest rate smoothing for Bangladesh, however, does not show considerable improvement in terms of macroeconomic performance. Simulation result shows that overall loss to the society is 20.77 with optimal $h = 9.75, b = 8.96$ and $c = 0.16$ whereas without any smoothing social loss is 20.79 against actual loss of 21.60. Swedish data for the whole sample does not support interest rate smoothing with economic sense[12].

8. Conclusion

This paper investigates the positive and normative issues related to monetary policy of developing countries with experience from developed countries. Although there are numerous literatures exemplifying that Taylor rule gained acceptance among the central banks of developed countries, the issue remained uninvestigated for the developing countries. As a positive analysis, Taylor rule for the sample six countries are estimated and it is quite clear that developing countries do not follow this rule and they end up with higher amount of social loss relative to the developed countries that invariably follow some rules. As a normative counterpart, I backcasted the output and inflation of the respective economies assuming Taylor rule as the monetary policy strategy. Counterfactual historical simulation confirms that total variability in inflation and output decreases with the acceptance of Taylor rule in place of discretionary monetary policy. This finding is compatible with the prior expectation hence it can be confidently suggested for the developing countries to move from discretionary policy toward Taylor rule-based monetary policy.

The study of Malik and Ahmed (2007) also proposes Taylor rule-based monetary policy for Pakistan. Unlike the previous study, my study examines the performance of Taylor rule with interest rate smoothing as an additional factor. In addition, I present optimal parameter values for the Taylor rule using the Solver function in Excel, as opposed to just imposing suggested parameter values as in Malik and Ahmed. The summary information of this paper is that, developing countries can adopt an interest rate reaction function

[12] When I let Excel Solver to find optimal *b*, *h* and *c* for minimum social loss, it results negative b instead.

like $i_t = \bar{r} + \pi_t + h(\pi_t - \pi^*) + by_t + ci_{t-1}$. Plausible values of h, b and c for Pakistan are found 0.5, 0.5 and 0.71; for India those are 0.5, 2 and 0.64, and for Bangladesh 9.75, 8.96 and 0.16 respectively.

The main limitation of this study is that the proposed parameter values are based on historical simulation. It is worth to reconfirm these values through stochastic simulation by utilising the technique of bootstrapping. Besides, small size of data for India and Bangladesh may also question the parameter values. Lack of much attention to time series properties of data may be treated as another limitation of the study.

Above all, this paper finds the prospect for developing countries to get converted into rule-based monetary policy from discretionary policy whatsoever. In this regard, it is necessary to examine the features of other developing countries such that a concrete proposal for the adoption of Taylor-type monetary policy rule can be presented. World Bank (2008) identified a total of 152 developing countries and it is interesting to check the performance of Taylor rule in most of those if not all.

Appendix A

Actual and Rule-based Output Gap and Inflation in Pakistan

Figure A1

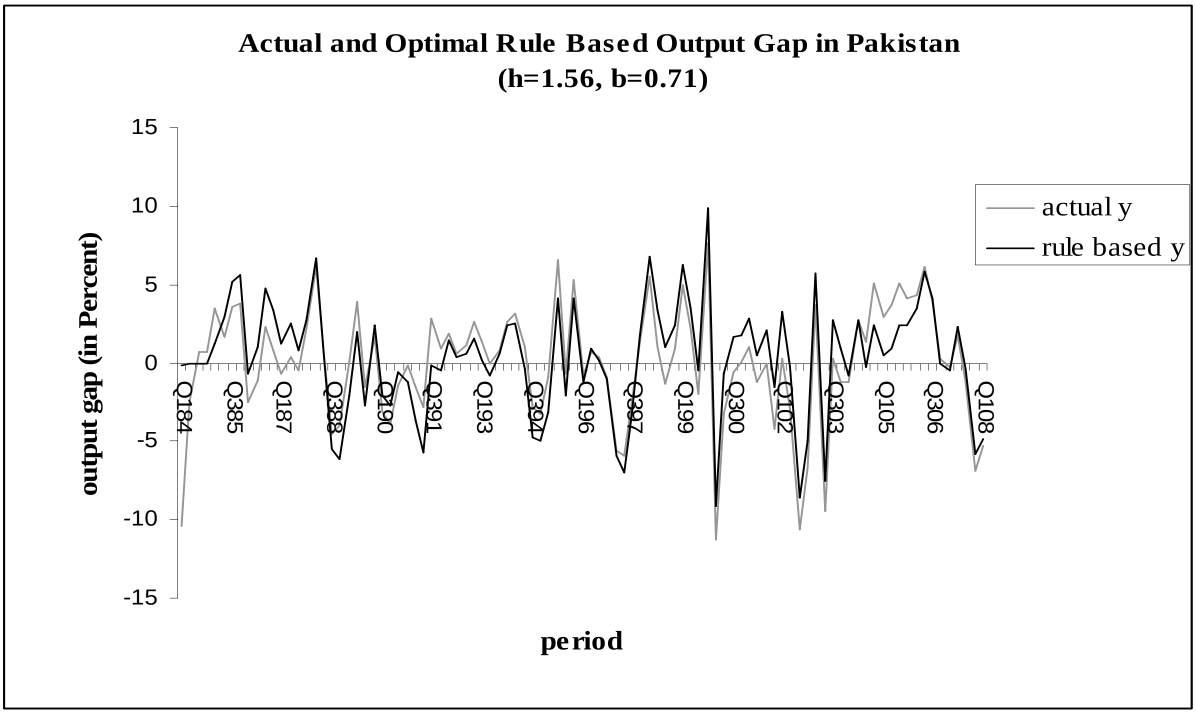


Figure A2

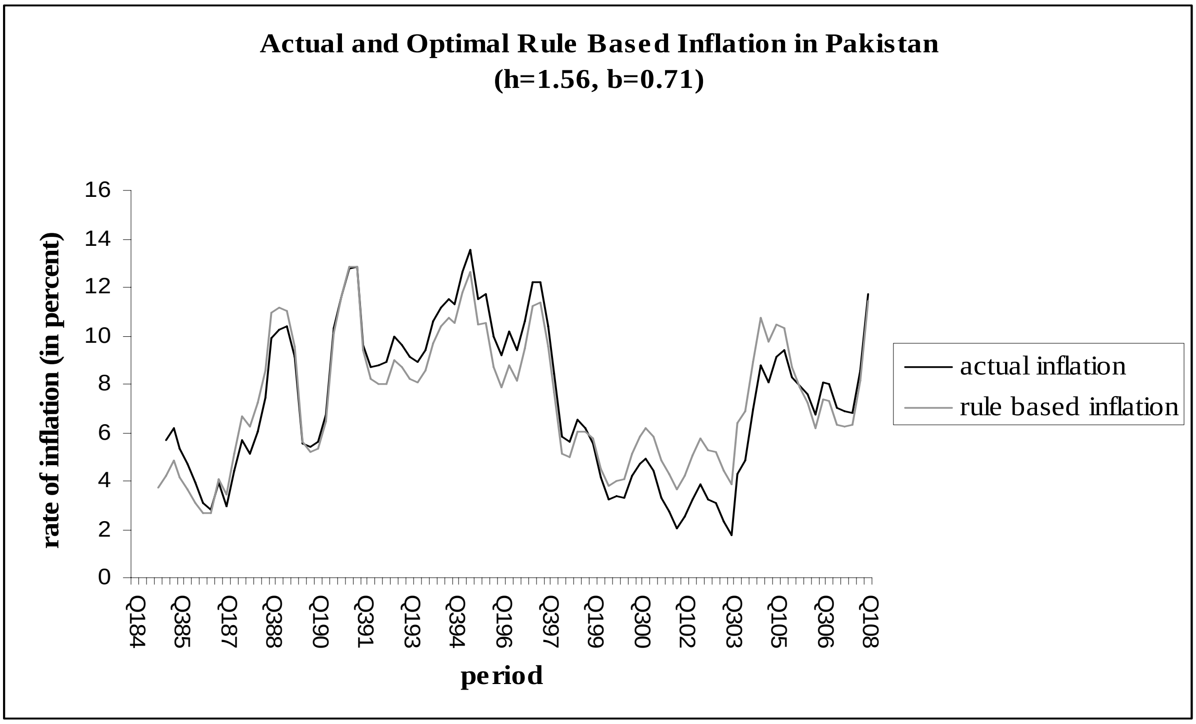


Figure A3

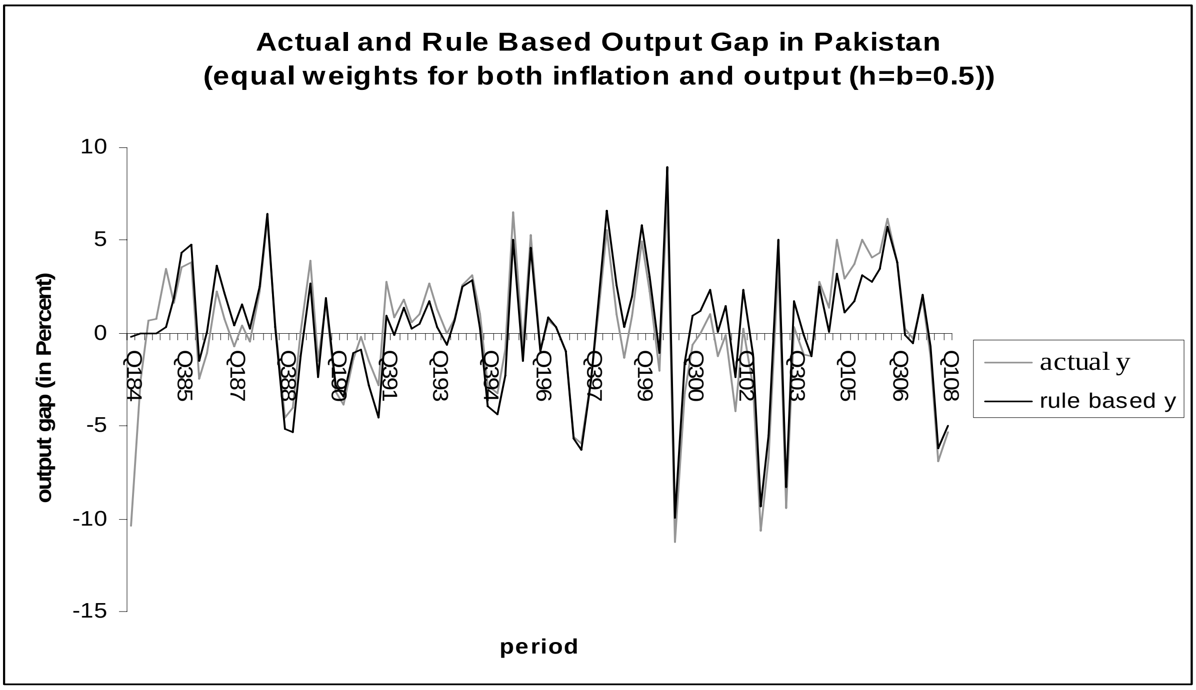


Figure A4

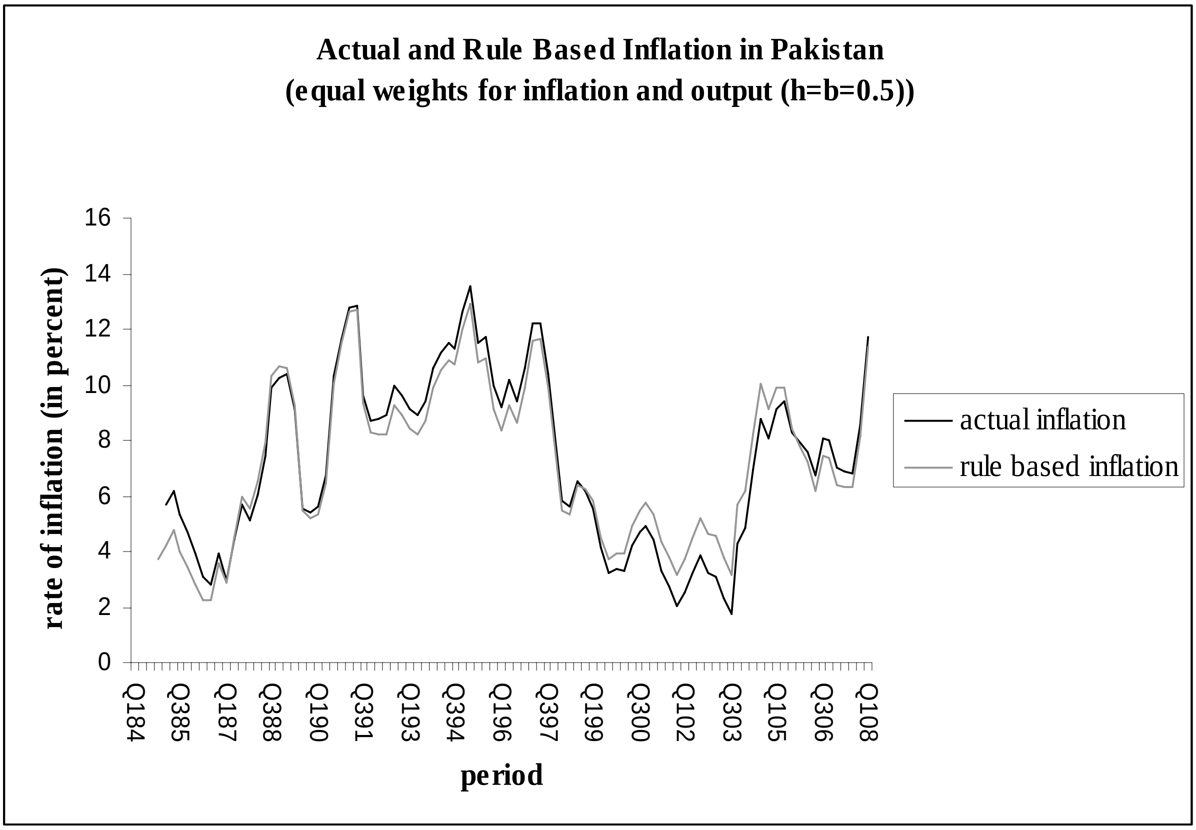


Figure A5

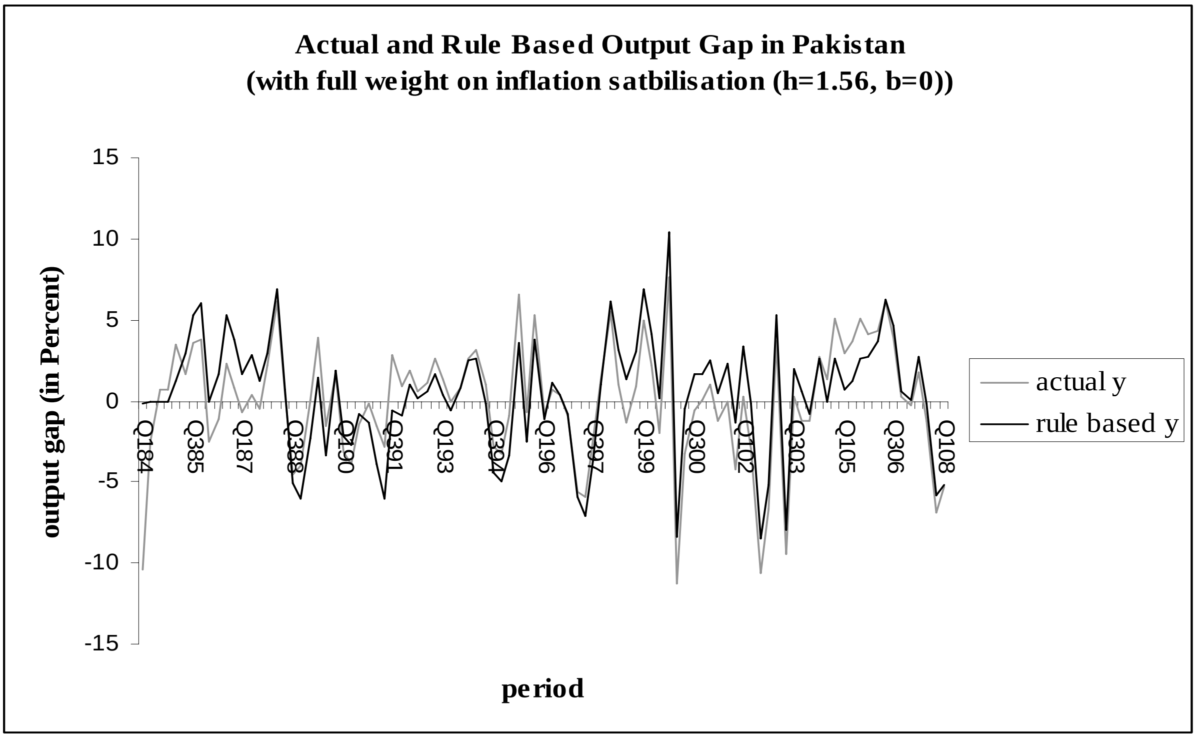


Figure A6

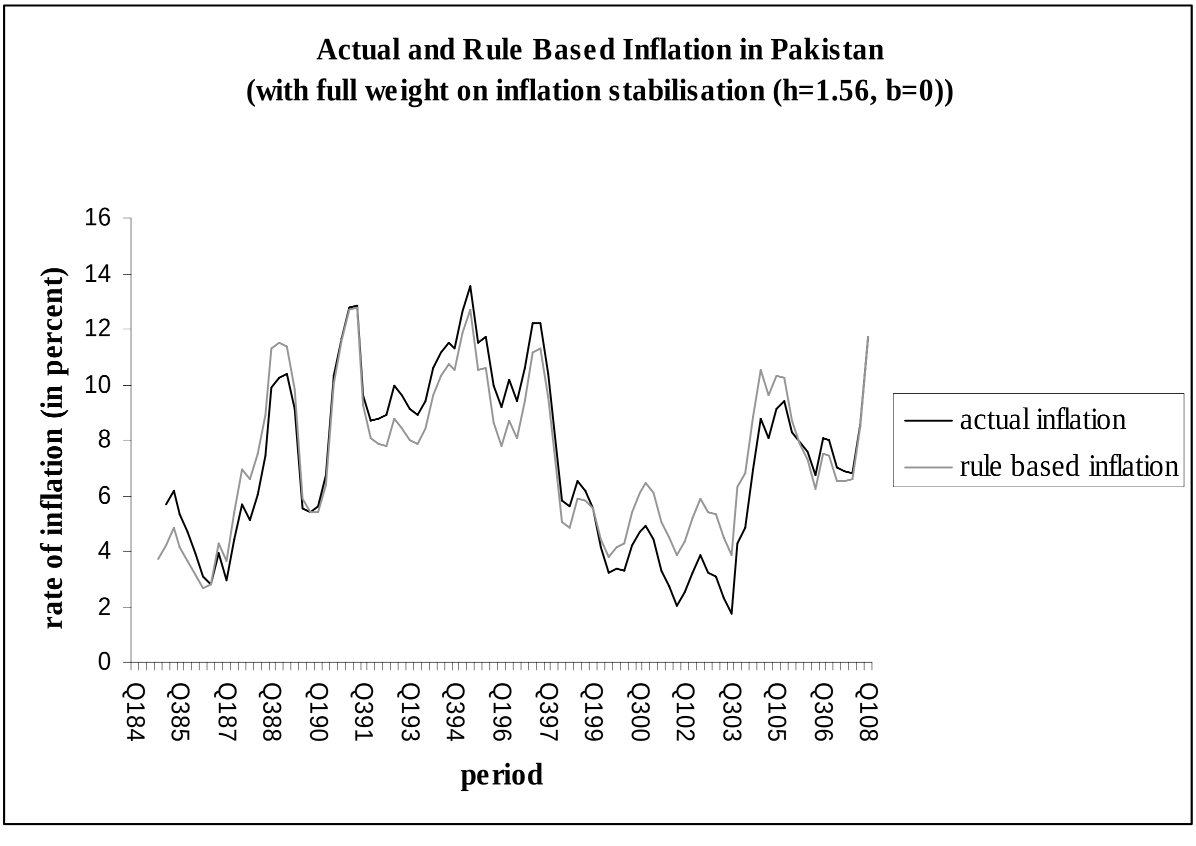


Figure-A7

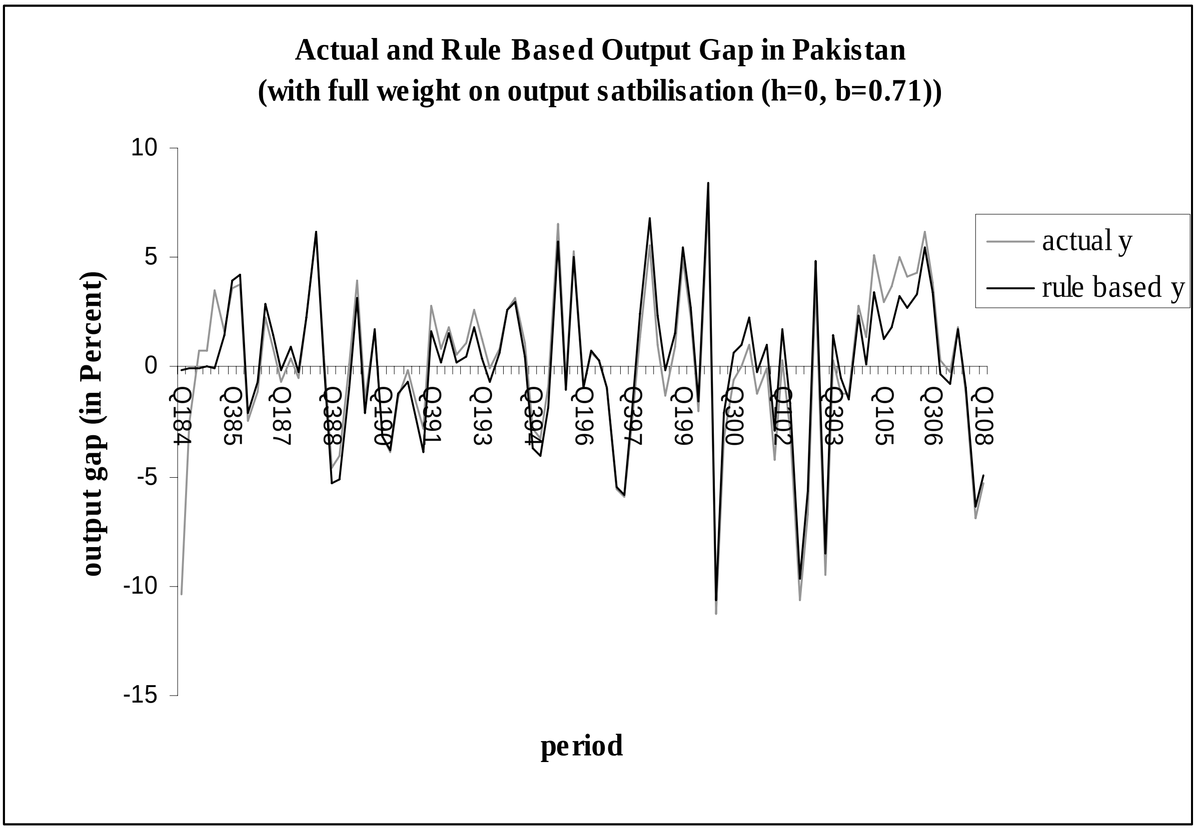
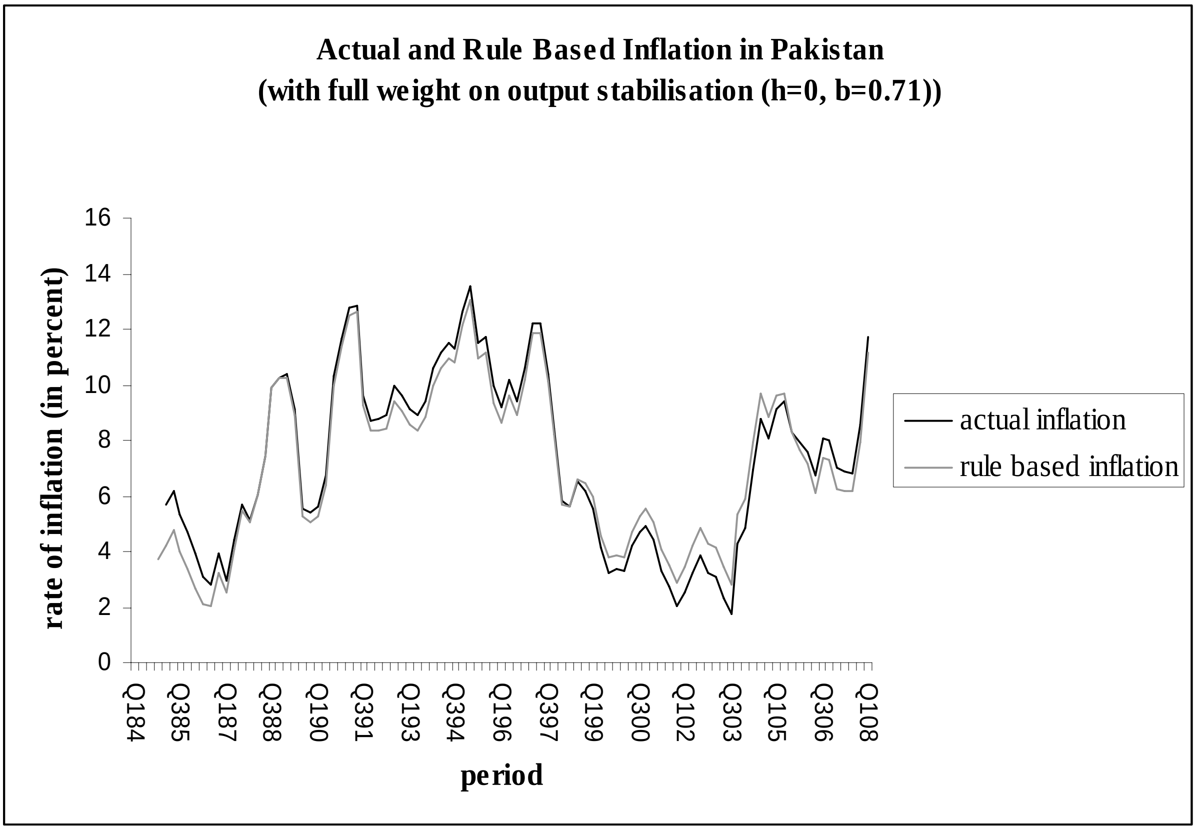


Figure A8



Appendix B
Actual and Rule-based Output Gap and Inflation in India

Figure B1

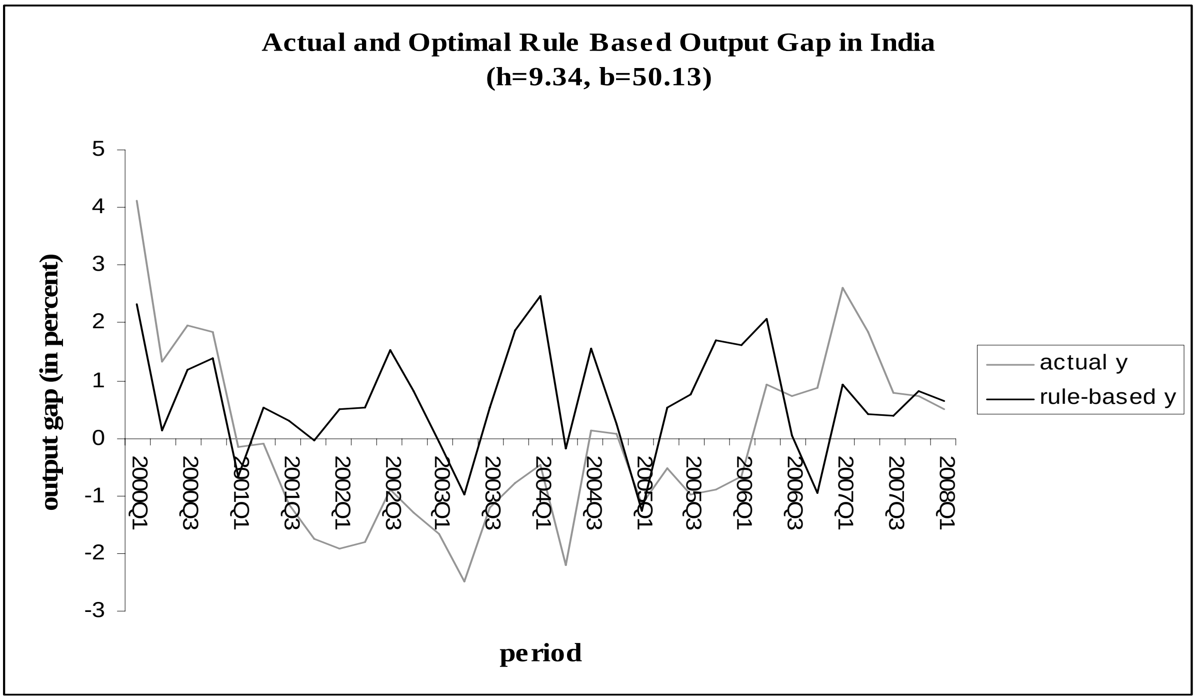


Figure B2

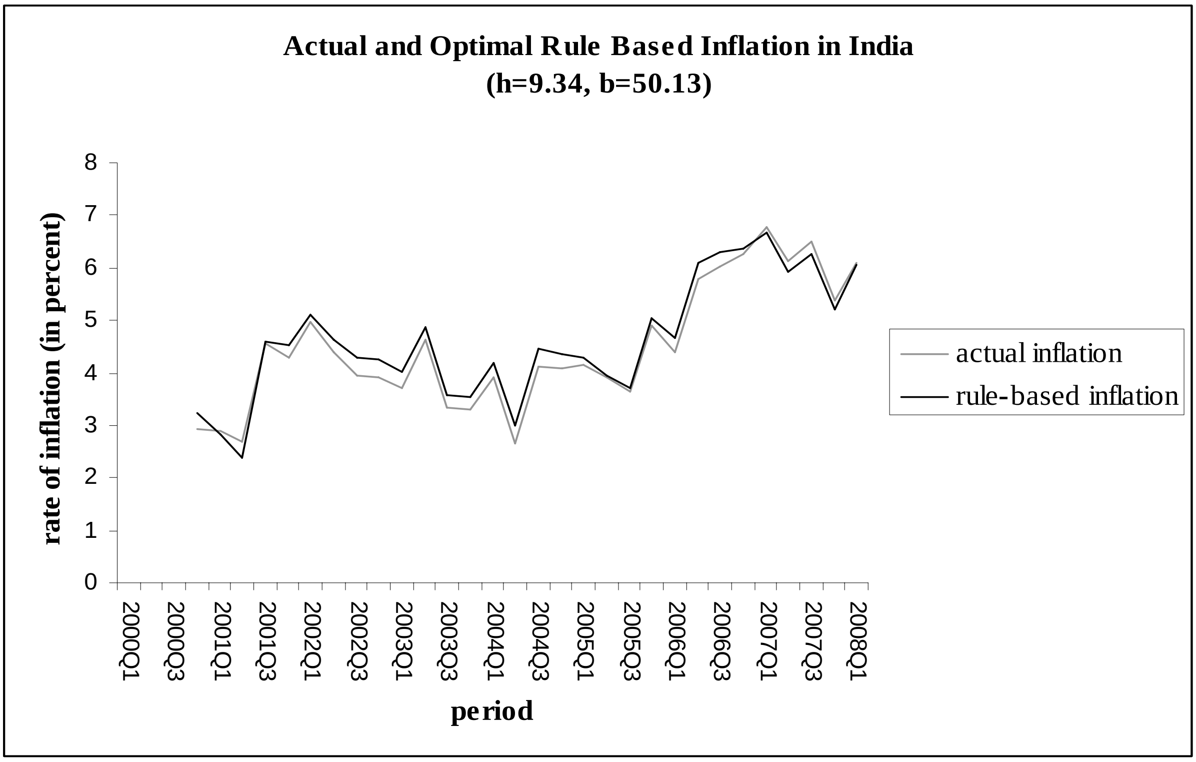


Figure B3

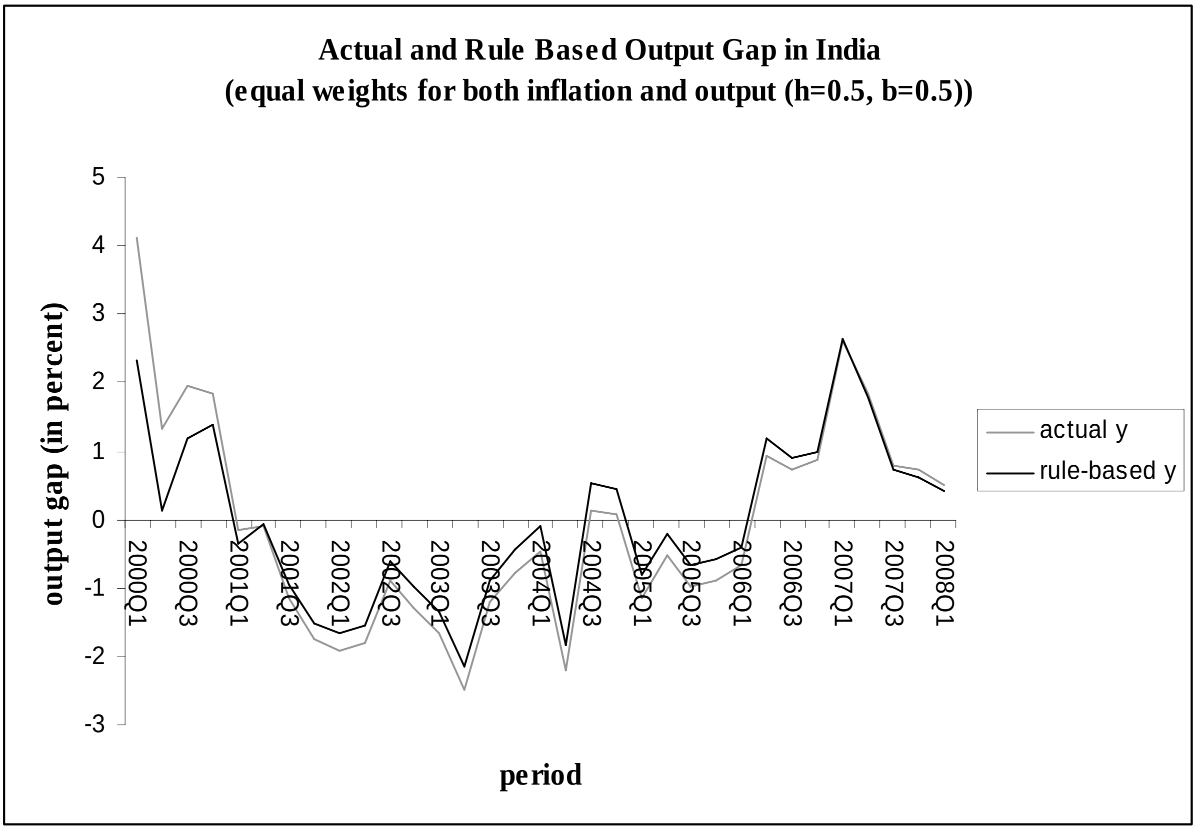


Figure B4

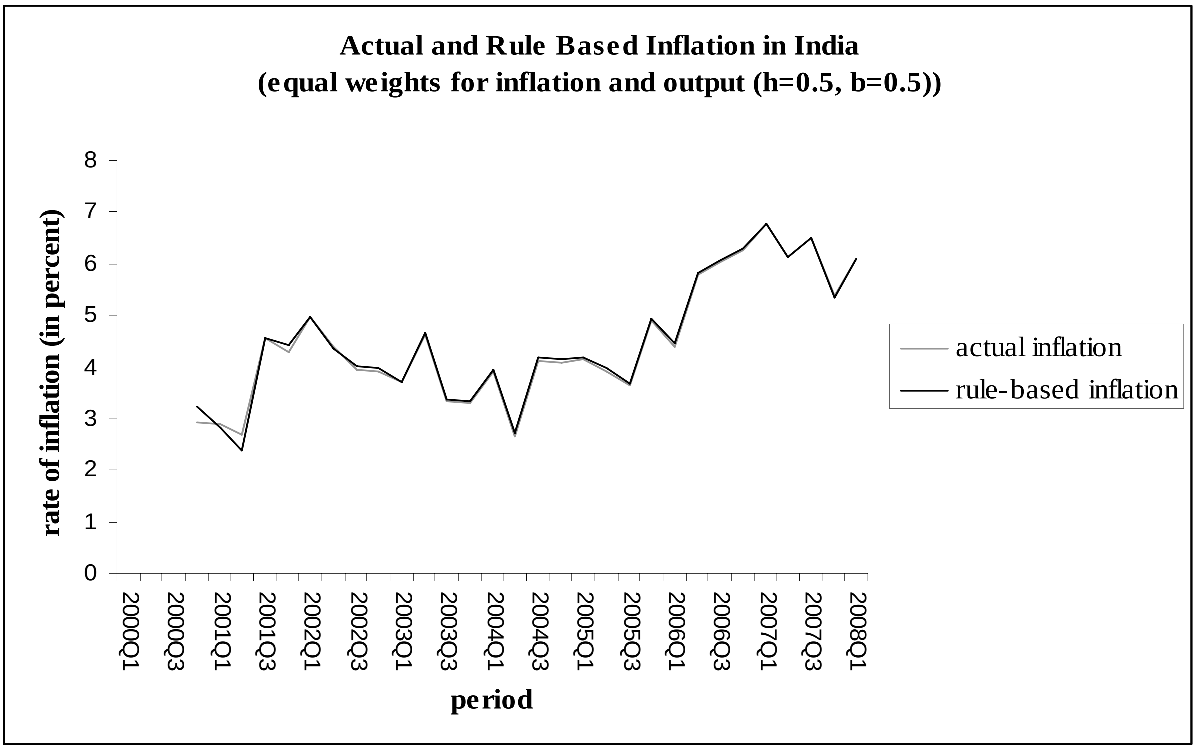
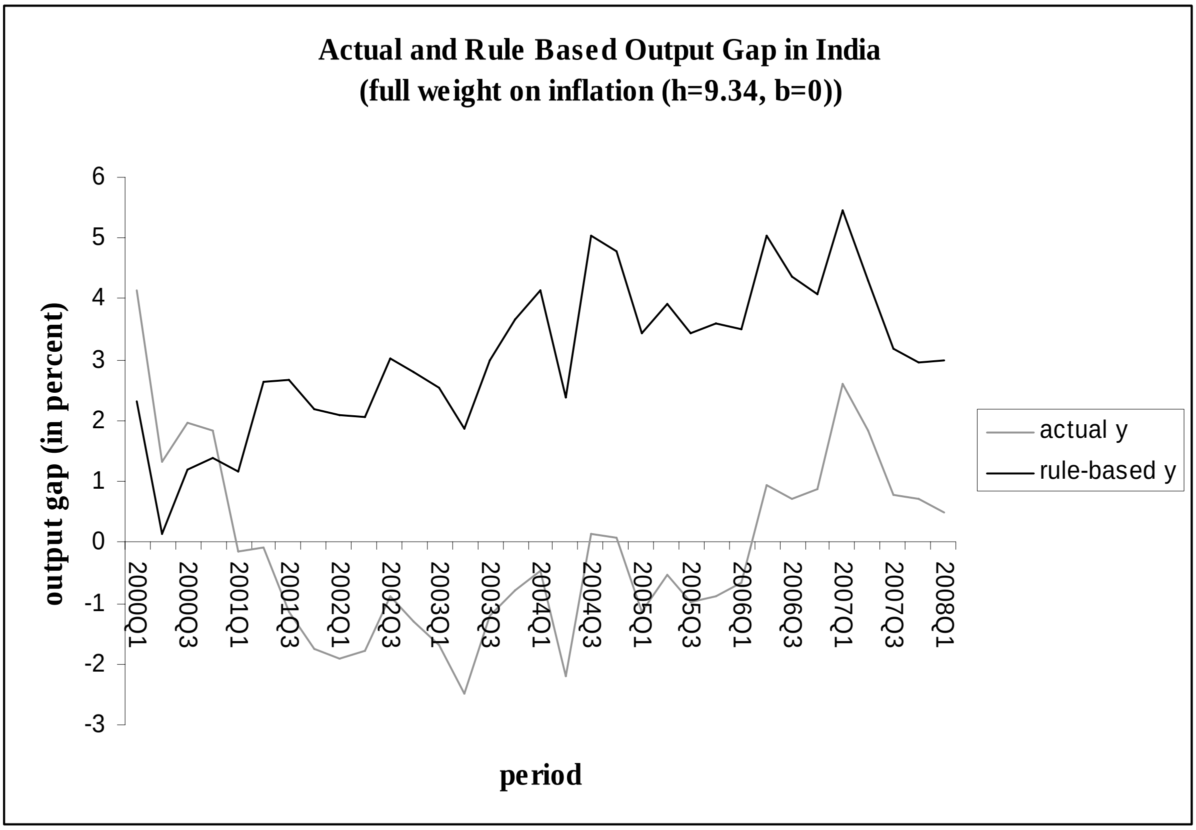


Figure B5



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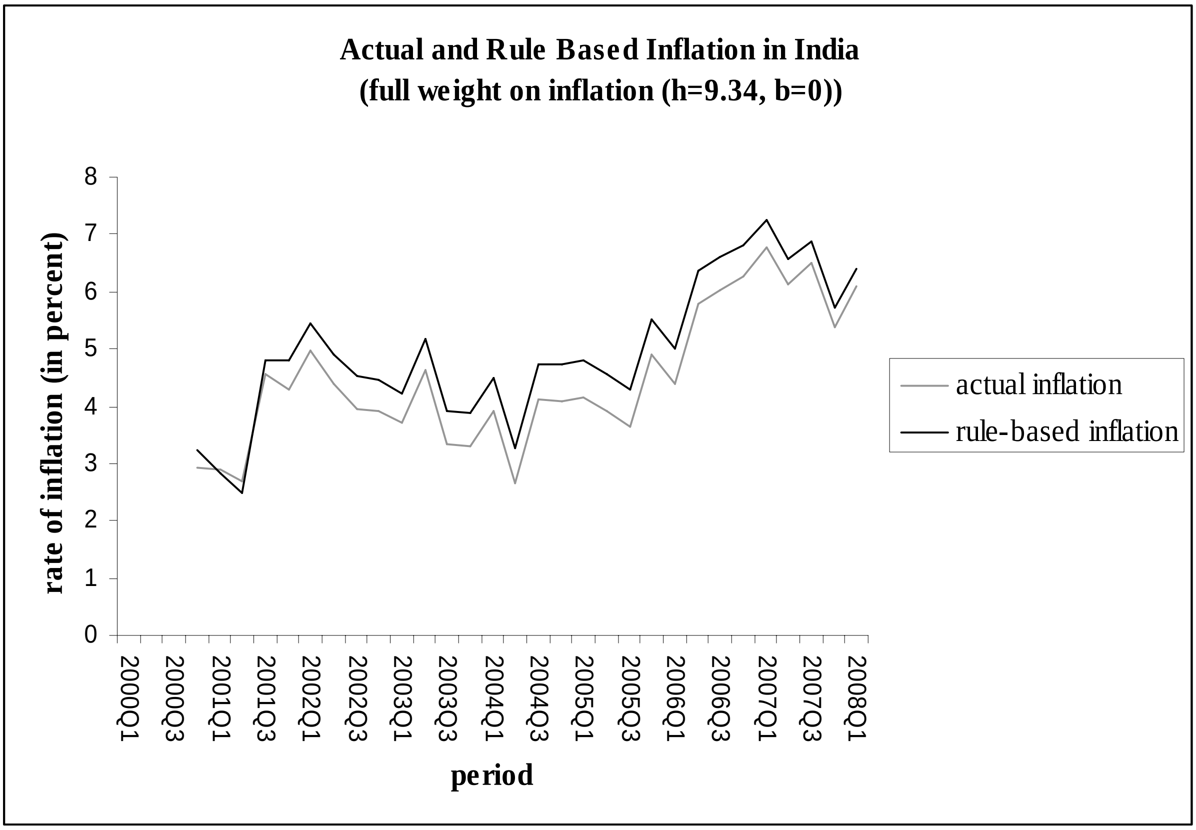


Figure B7

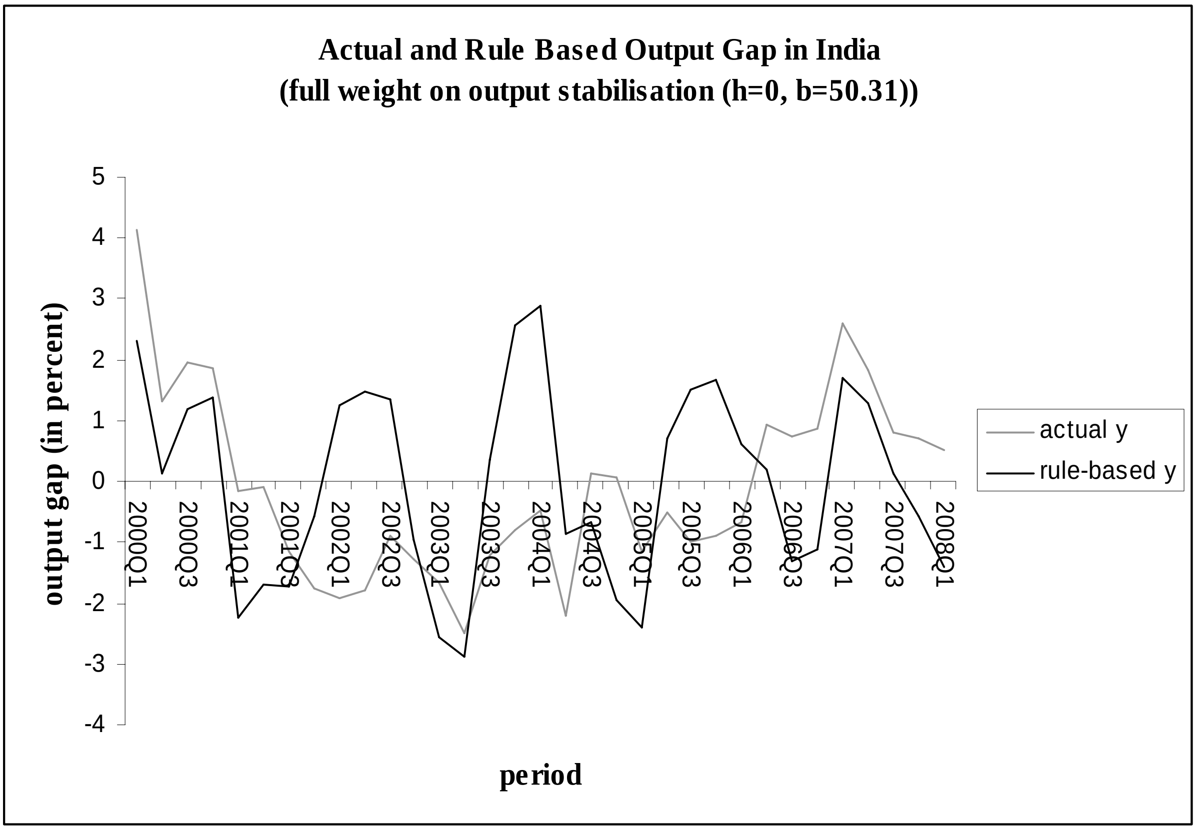
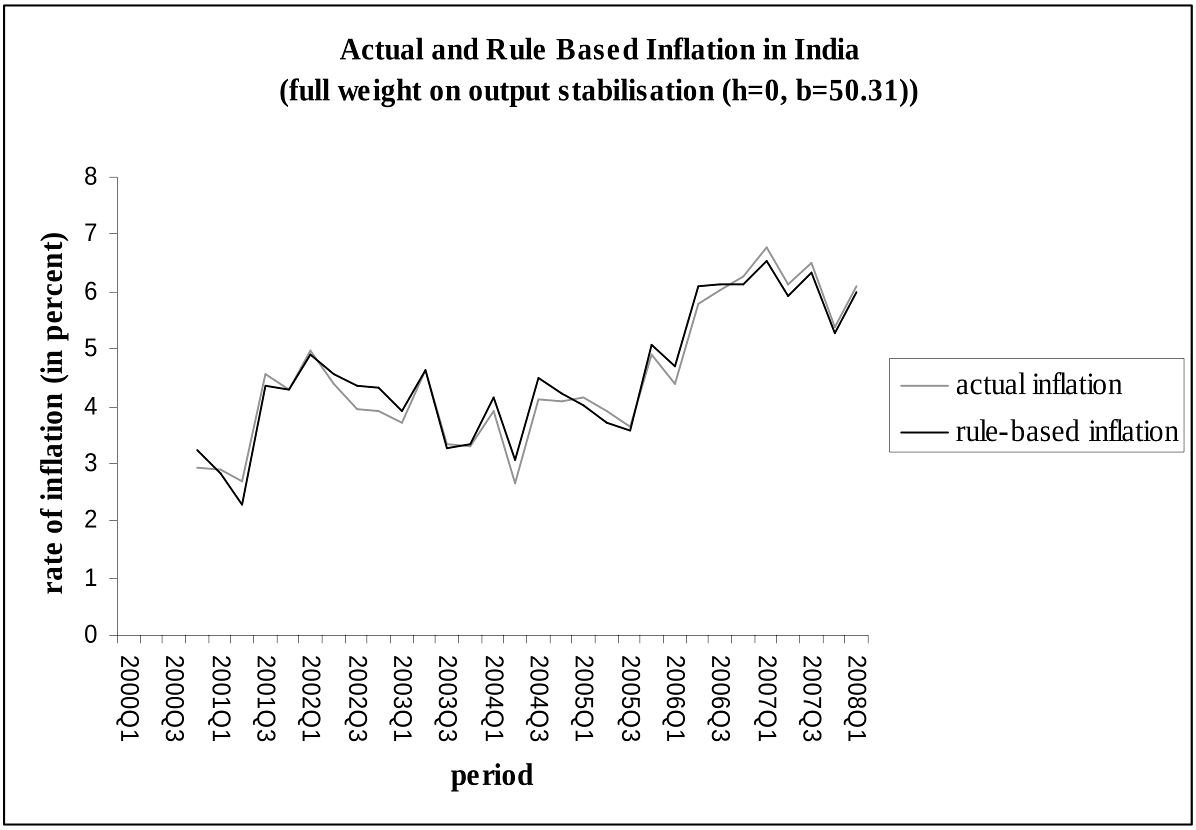


Figure B8



Appendix C

Actual and Rule-based Output Gap and Inflation in Bangladesh

Figure C1

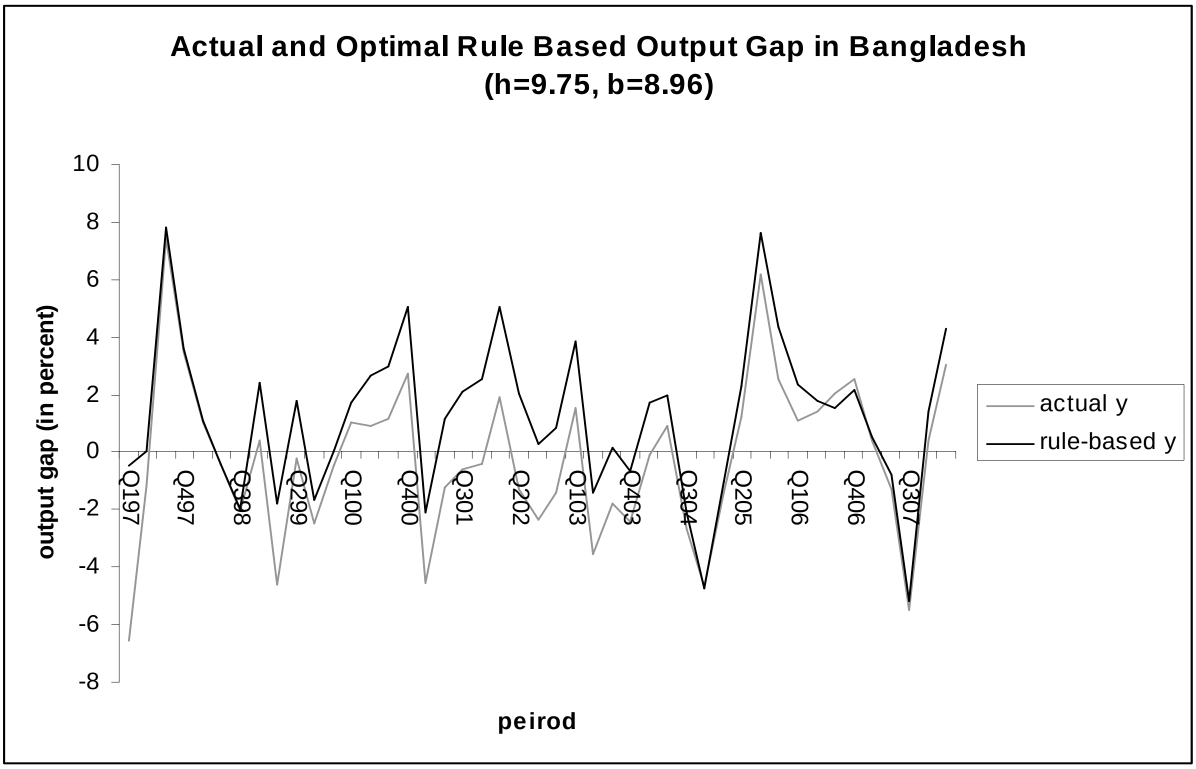


Figure C2

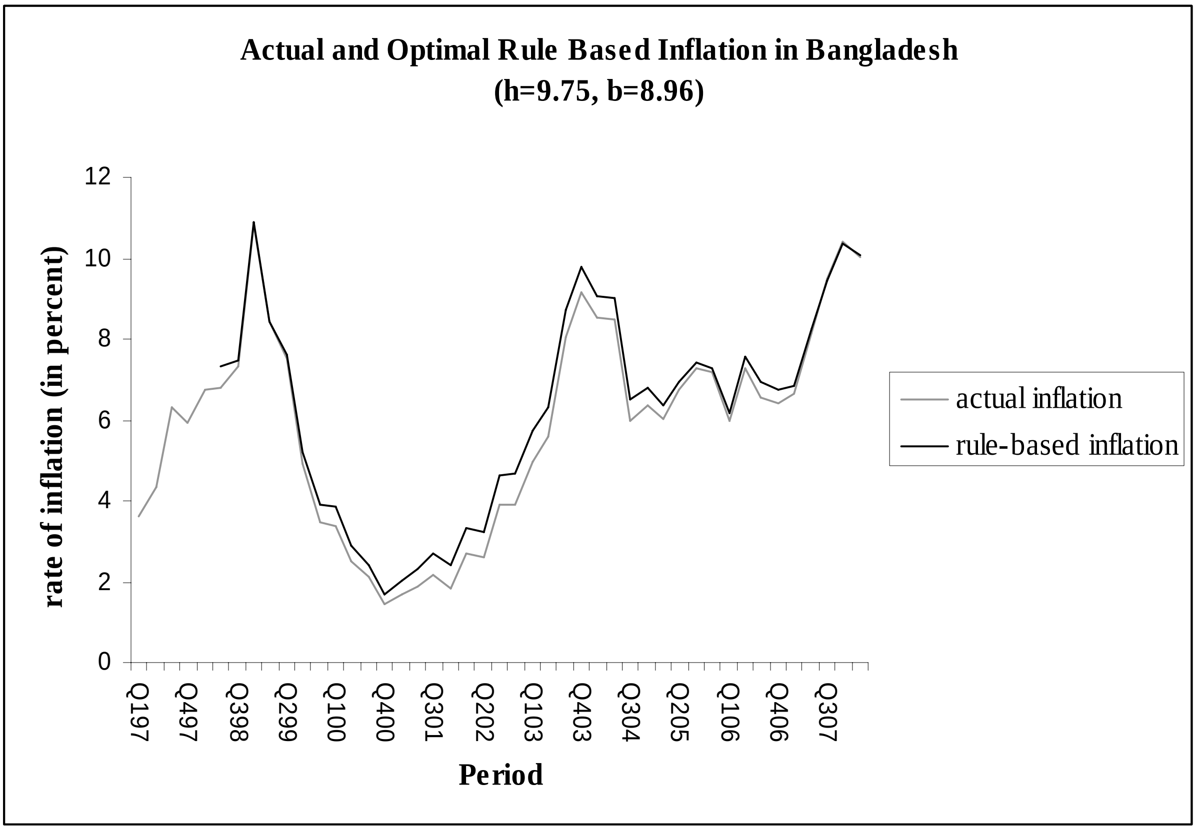


Figure C3

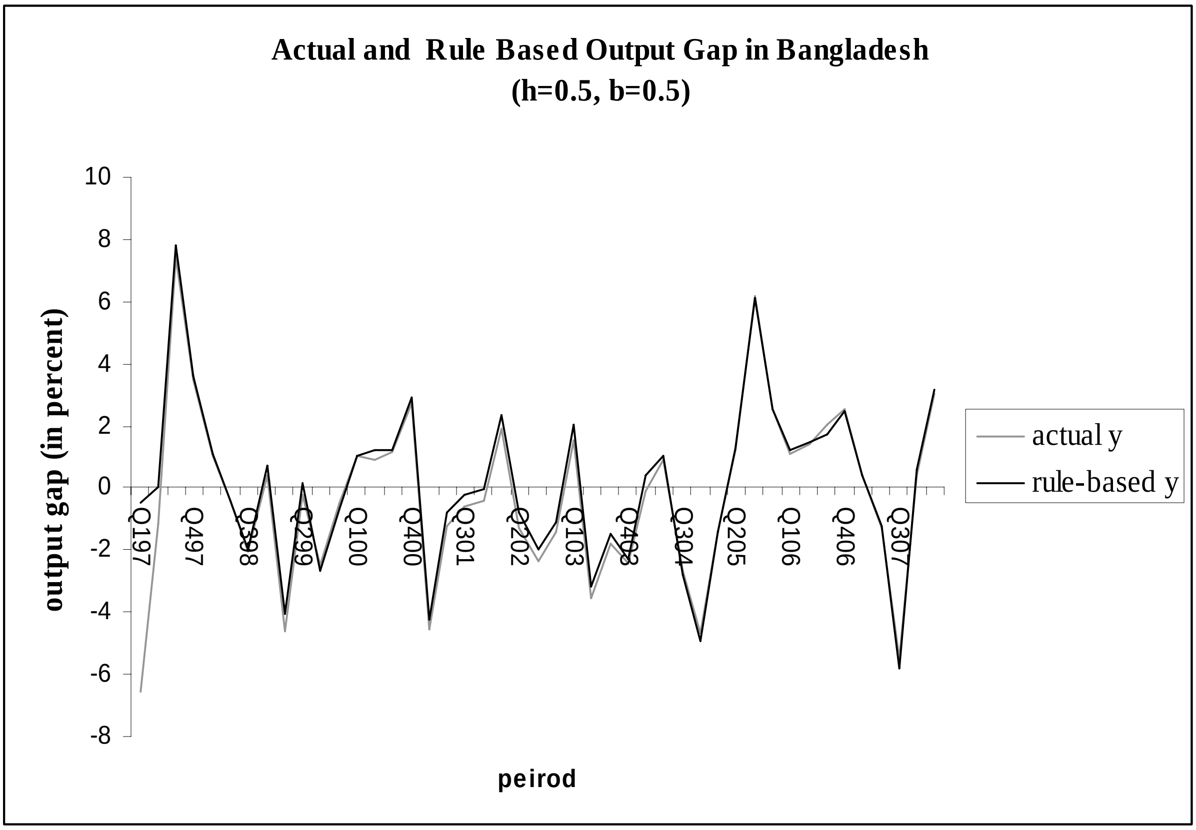


Figure C4

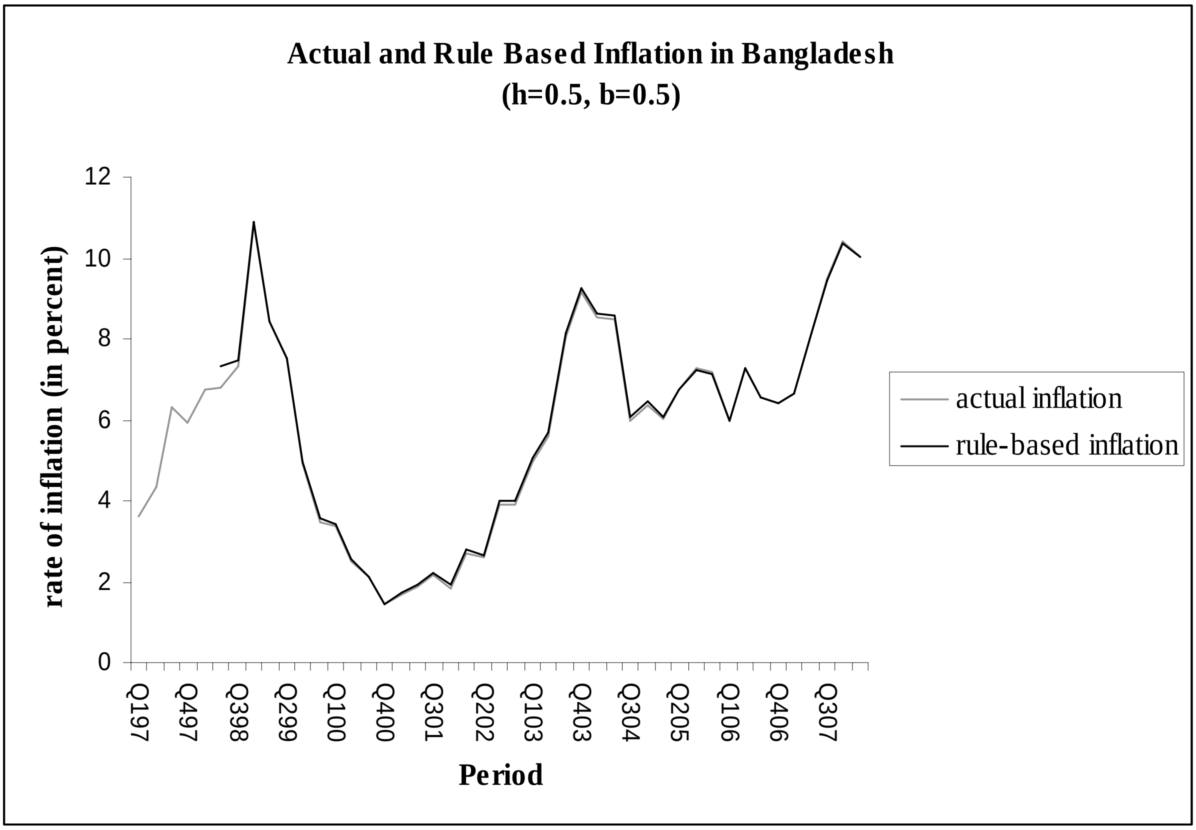


Figure C5

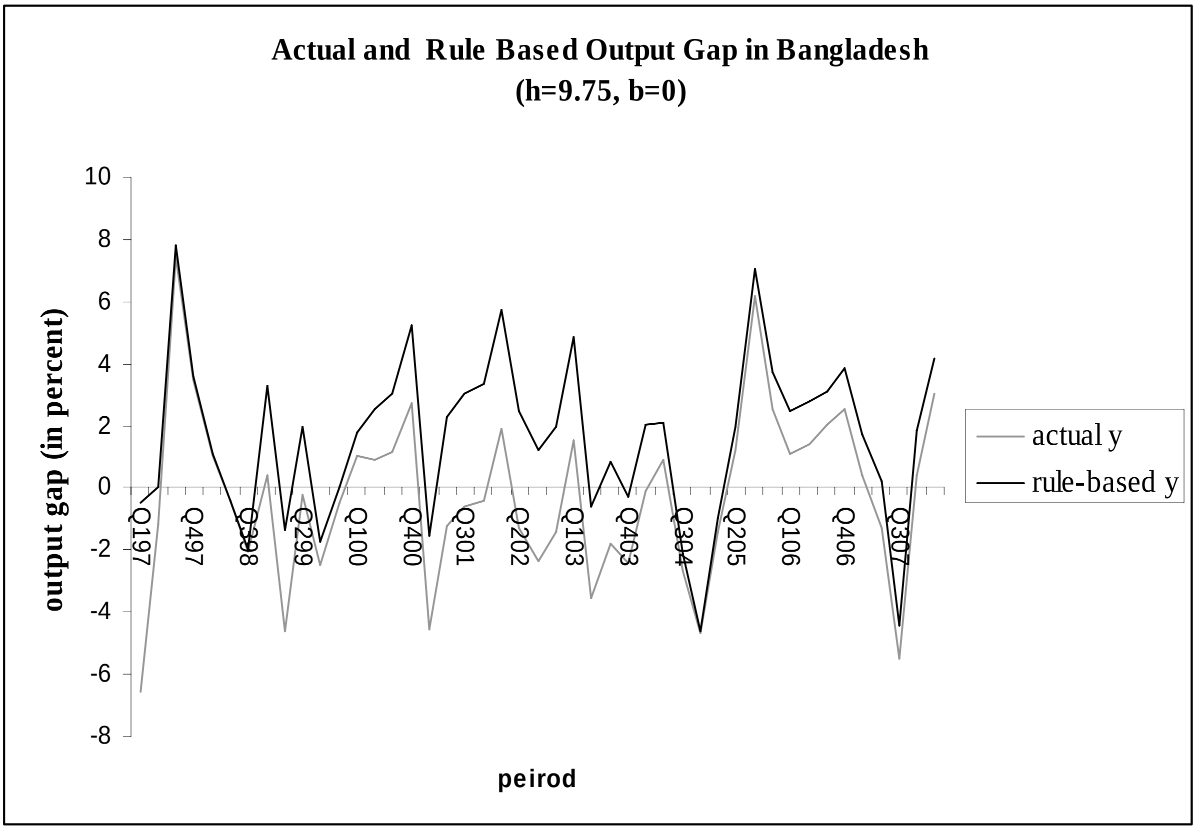


Figure C6

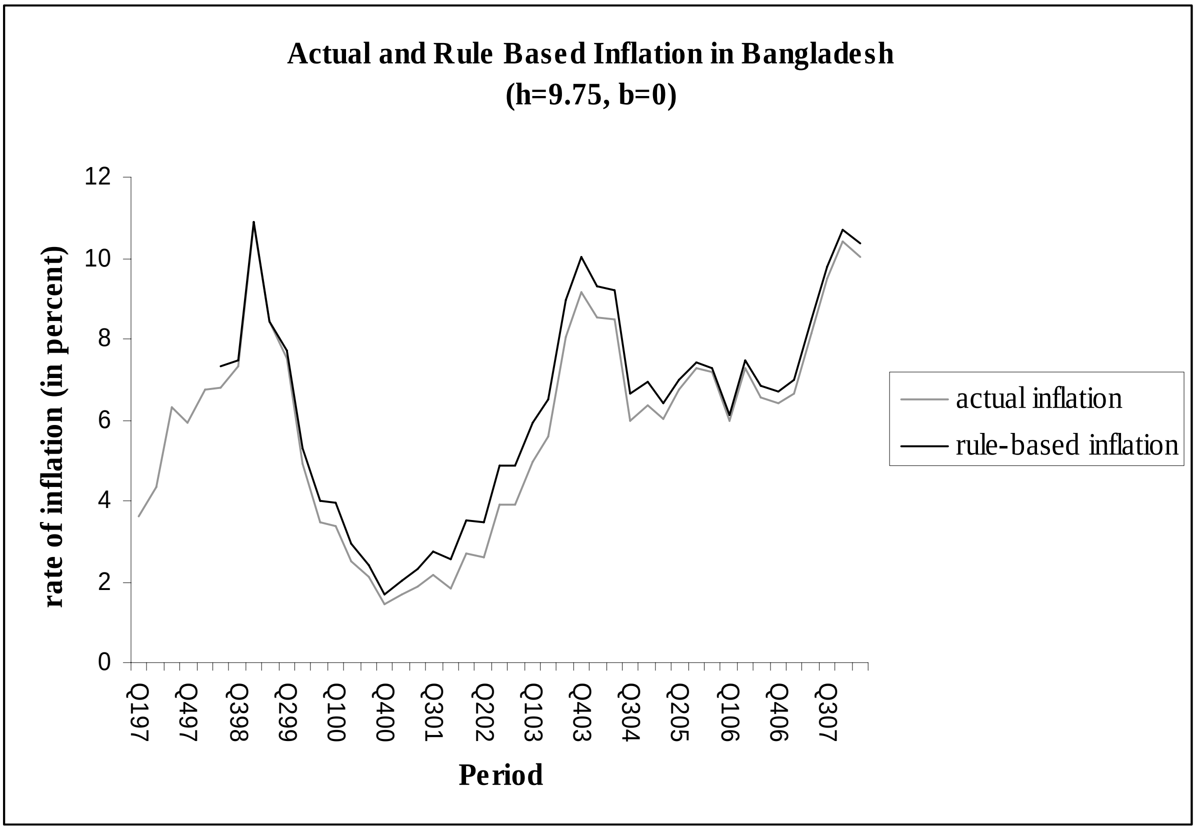


Figure C7

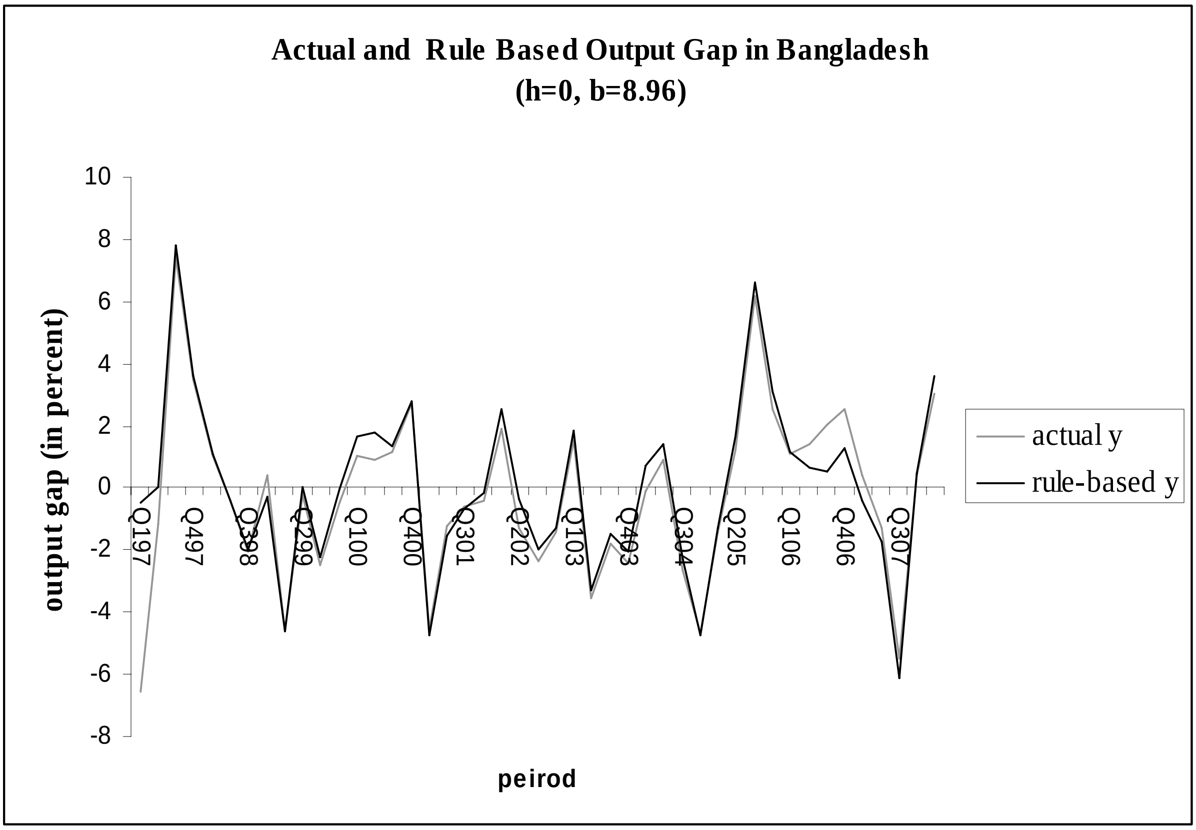
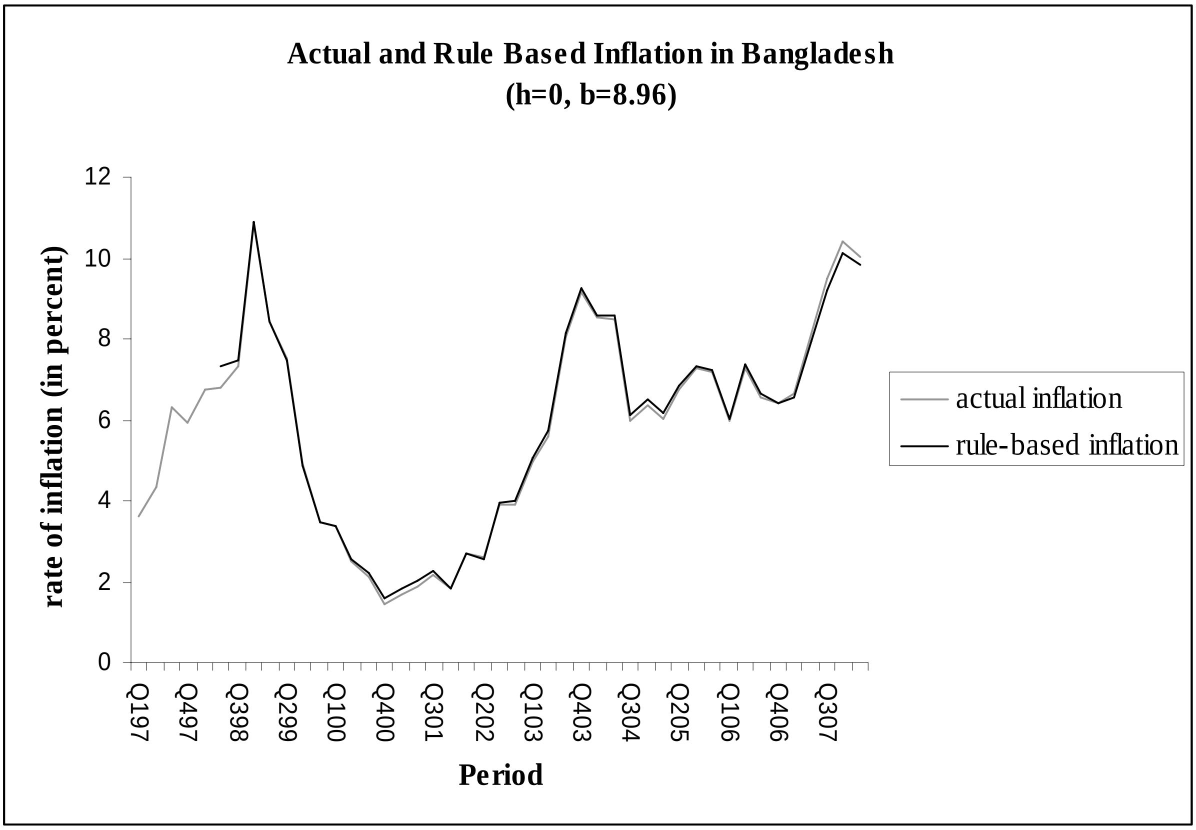


Figure C8



Appendix D

Actual and Rule-based Output Gap and Inflation in Sweden

Figure D1

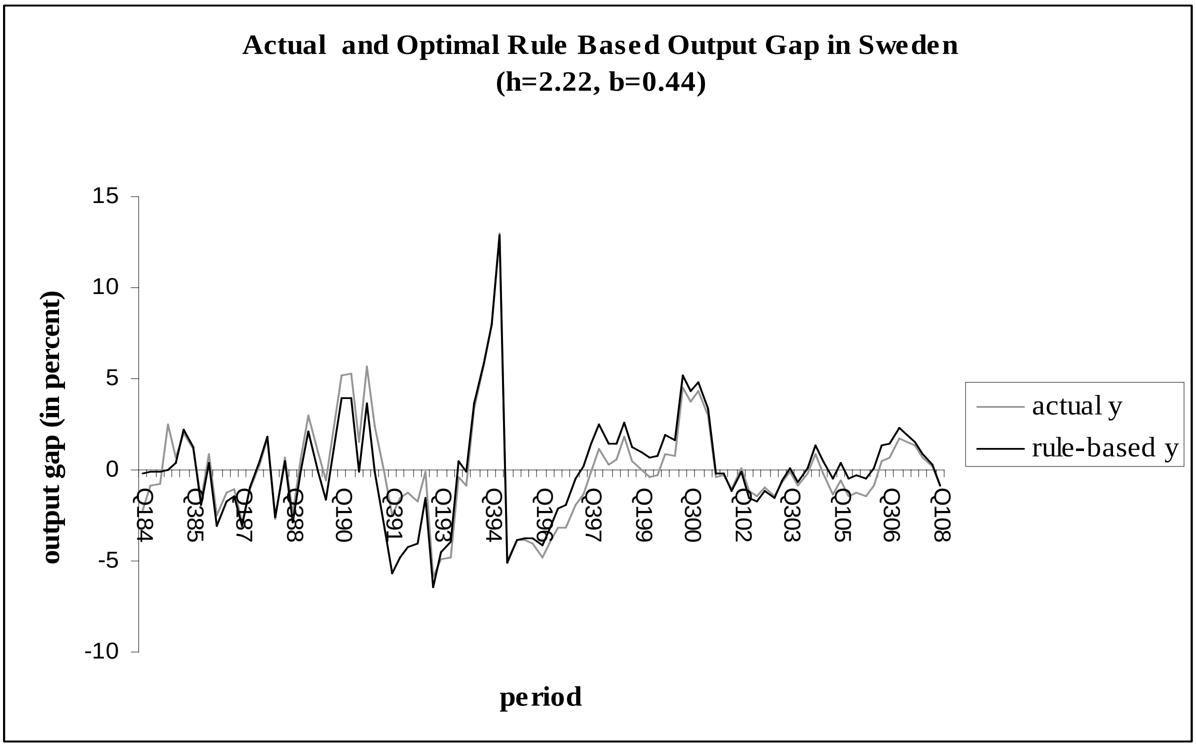


Figure D2

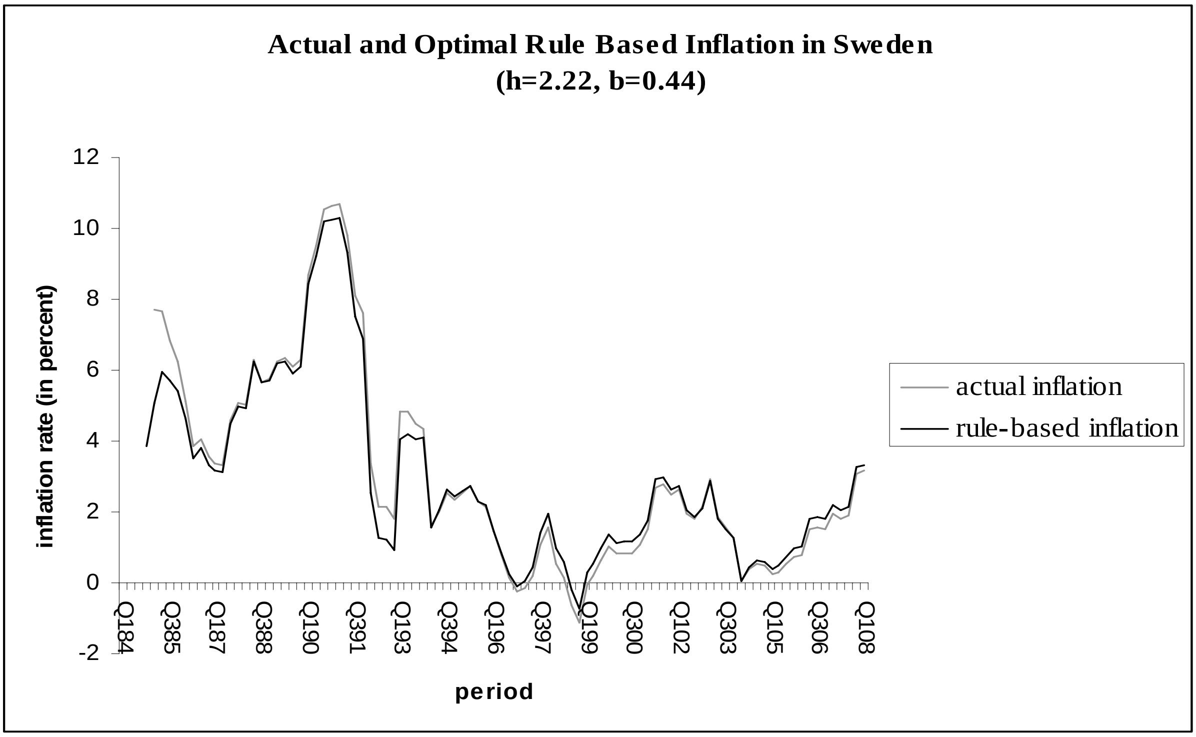


Figure D3

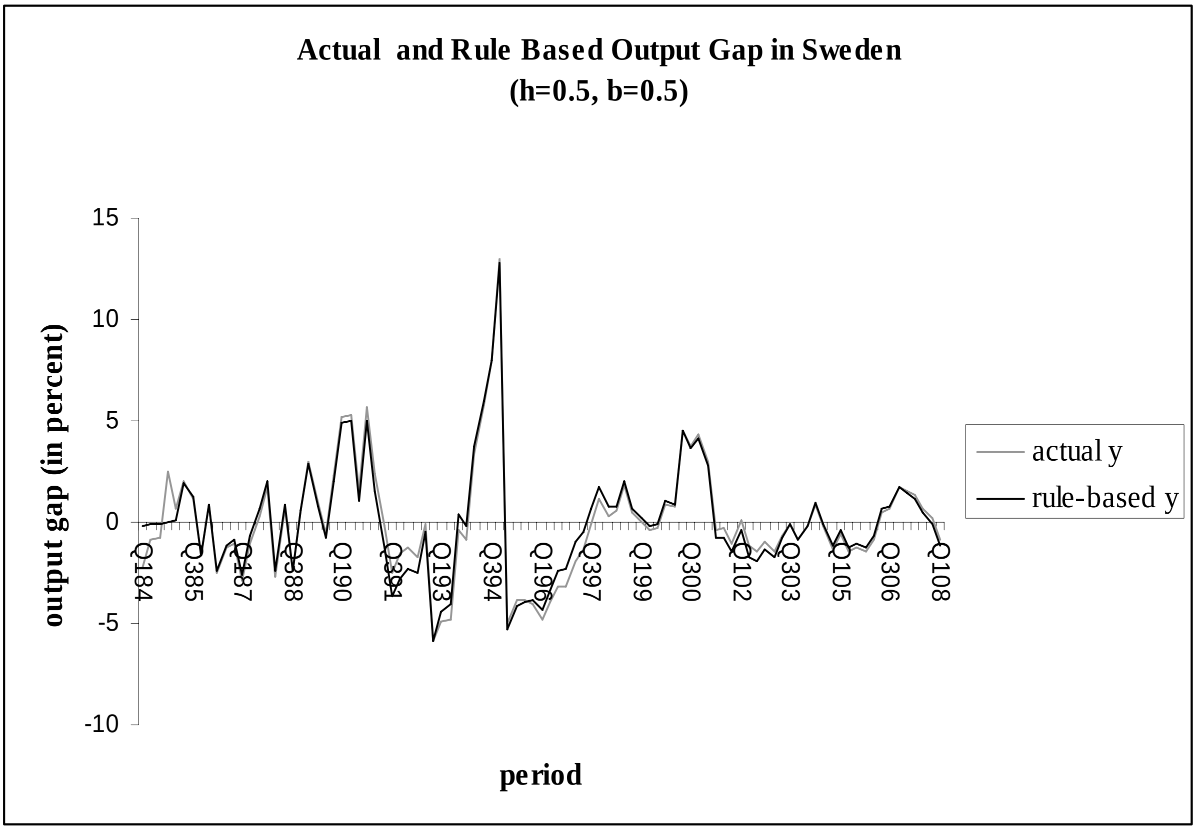


Figure D4

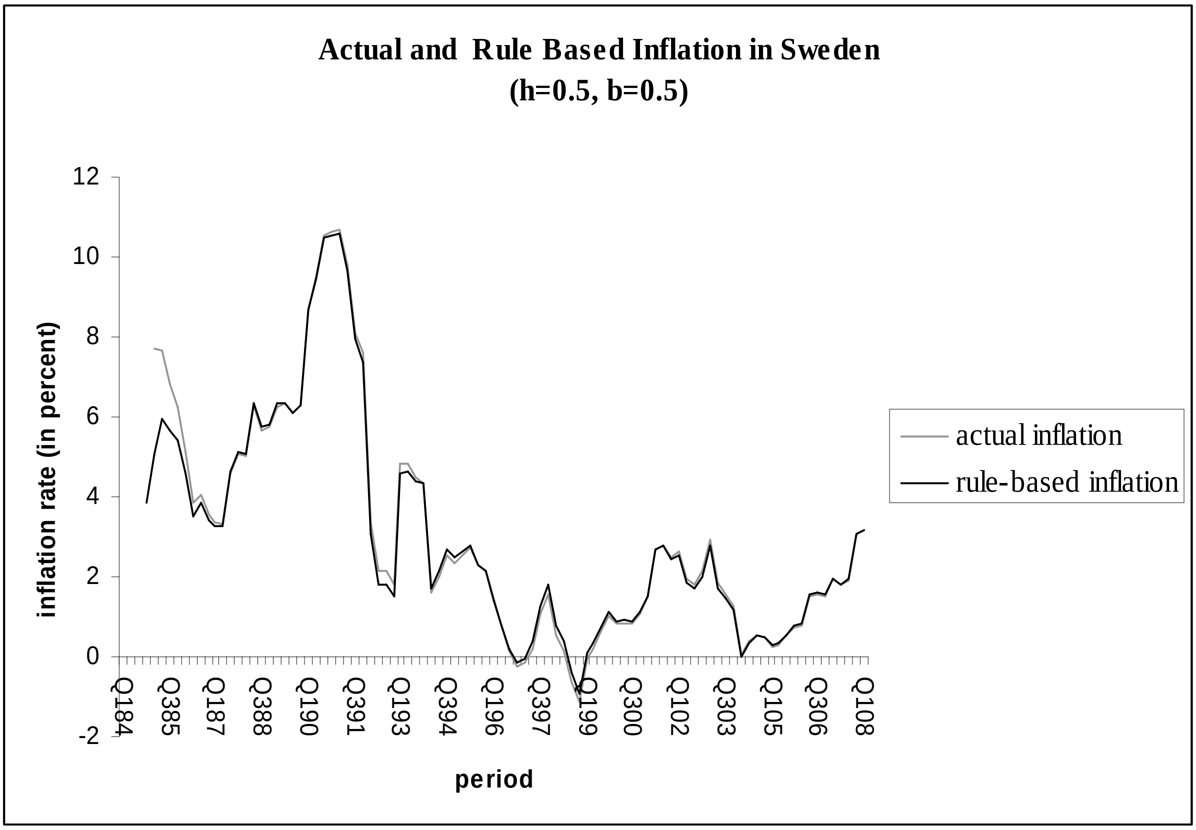


Figure D5

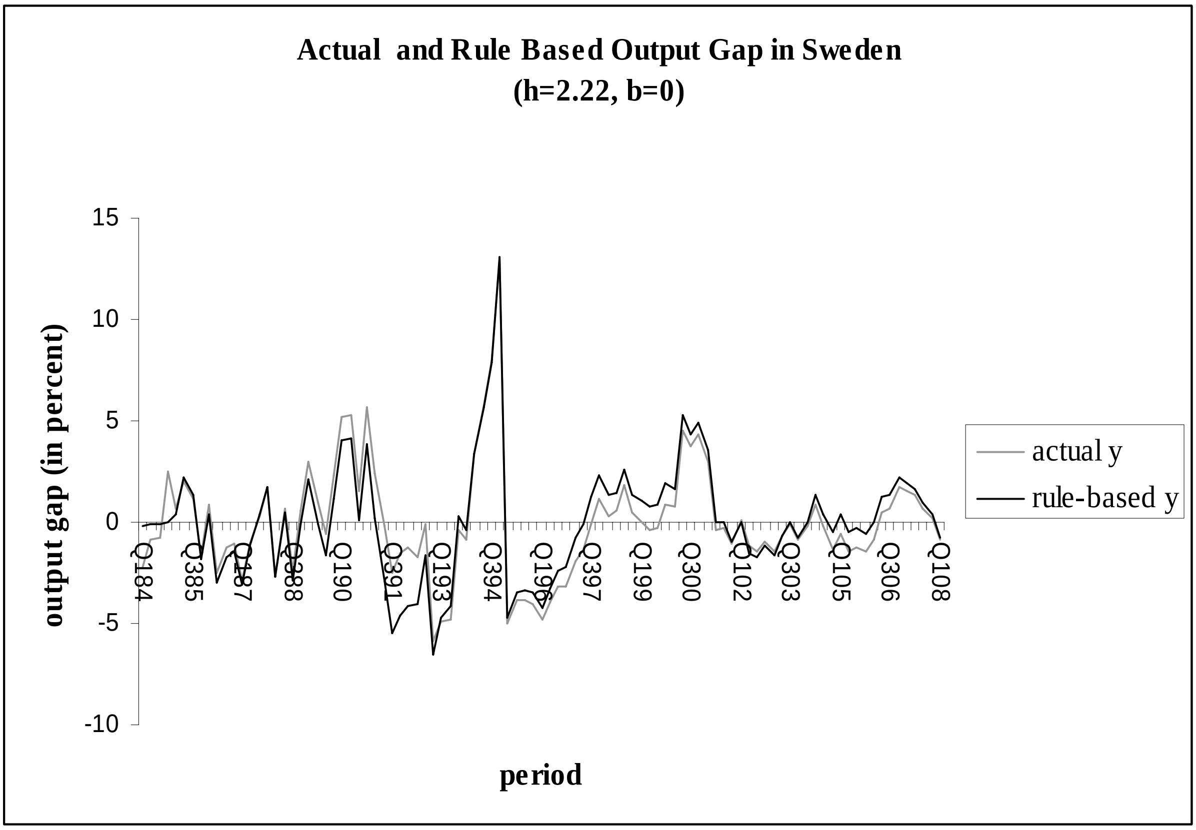
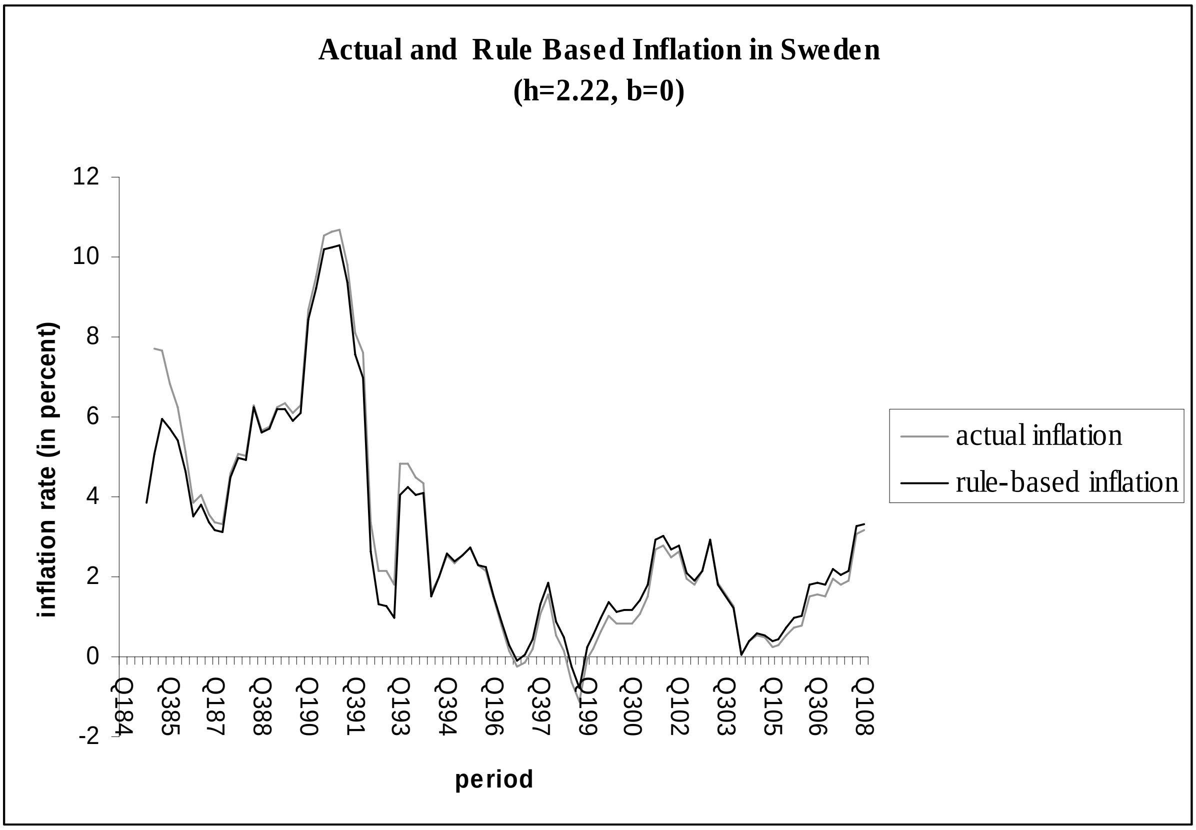


Figure D6



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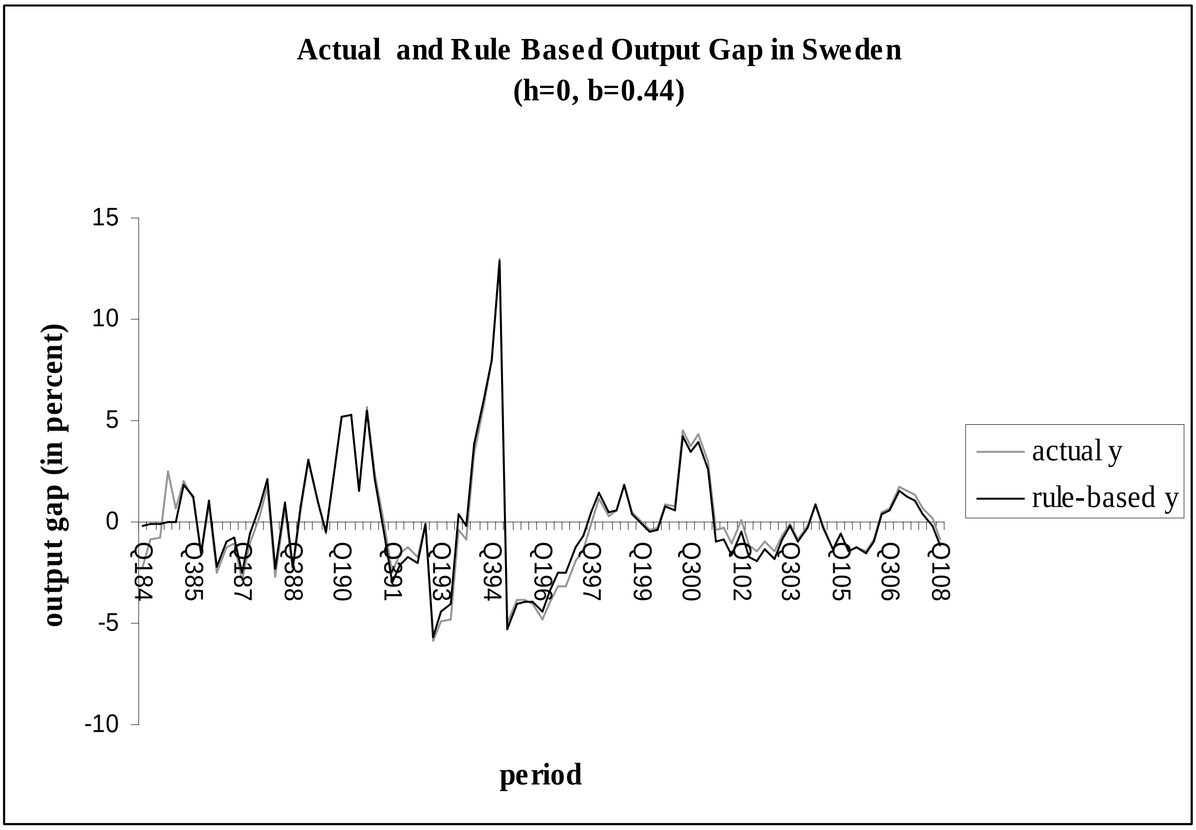
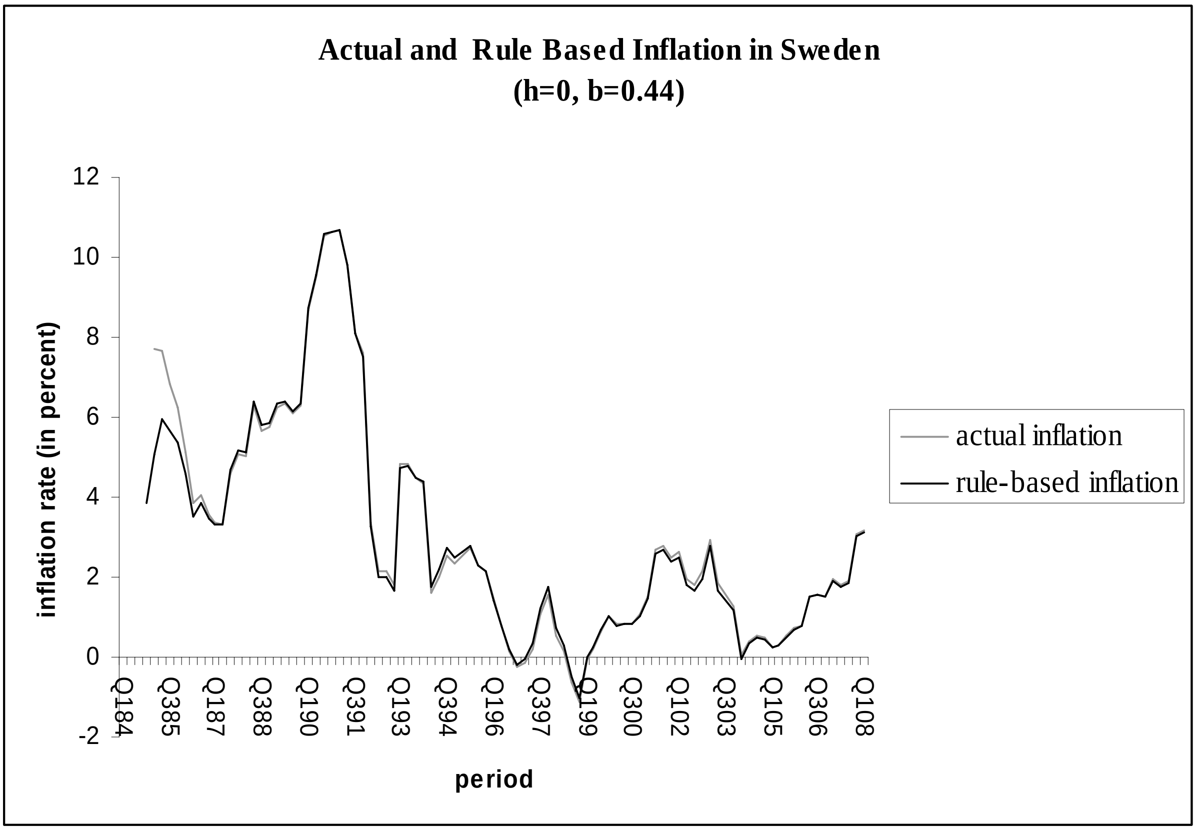


Figure D8



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