CHAPTER 11

India: Stabilizing Inflation

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> *The nominal anchor should be communicated without ambiguity, so as to ensure a monetary policy regime shift away from the current approach to one that is centered around the nominal anchor . . . The nominal anchor should be defined in terms of headline CPI inflation, which closely reflects the cost of living and influences inflation expectations . . . — Reserve Bank of India (2014)*

India's history of inflation targeting is very short. An expert panel recommended its introduction in 2014, and formal adoption came through an amendment to the Reserve Bank of India Act in May 2016, which formally established an inflation target of 4 percent (and a tolerance band of ±2 percent). This chapter outlines the analytical framework for the implementation of the young policy, and describes some of the background to this development.[1]

Three specific challenges make monetary policy more difficult to manage in India than in more advanced economies. The policy transmission mechanism is weaker, food prices have a larger impact on the dynamics of inflation, and the economy has a long history of unstable prices and drifting inflation expectations. The chapter shows how a strategy of flexible inflation targeting by the Reserve Bank of India (RBI) may, over time, mitigate these problems.

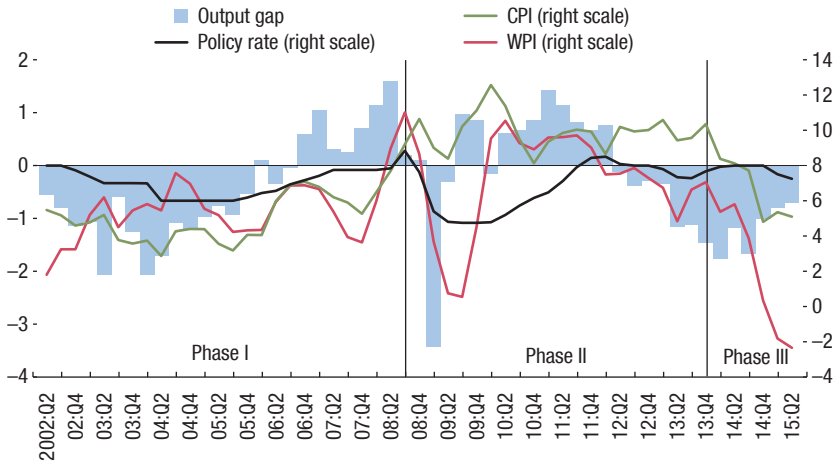
In simple terms, the RBI's main job is to stabilize long-term expectations at the 4 percent target rate and thereby to install a firm nominal anchor to the economy. Svensson (1997) shows that in systematic, operational terms, efficient flexible inflation targeting amounts to inflation-forecast targeting. Policy simulations using an RBI macroeconomic model illustrate inflation-forecast-targeting policy options for dealing with different kinds of shocks, including food price shocks, in a situation where the RBI is still in the process of building credibility for its inflation target.

THREE PHASES OF INFLATION: A MACROECONOMIC VIEW

After 2000, there were three distinct phases in the RBI's policy responses to inflation (Figure 11.1).

[1]This is an abridged version of Benes, Clinton, George, John, and others (2016), which contains full references to the supporting technical work and official documents.

Figure 11.1. A Macroeconomic Narrative of Inflation in India, 2002–15
(Percent)



Source: Reserve Bank of India.
Notes: The consumer price index (CPI) inflation rates are on a year-over-year basis. The combined CPI since 2012; pre-2012, backcast using reweighted CPI-industrial workers data. WPI = wholesale price index.

Phase I: Moderate Inflation and Strong Growth, 2000–08

The RBI followed a multiple-indicator approach, with low and stable inflation as just one of the objectives.[2] To gauge inflation, the RBI used a slew of sectoral consumer price indexes (CPIs), but in its monetary policy communication it highlighted the all-India wholesale price index. The various price indexes can show quite different rates of inflation from one year to the next. With respect to instruments, the RBI regarded interest rates as the primary source of monetary policy transmission but did not focus on a single policy-controlled rate in the way that other major central banks have done for many years.

In the early 2000s output decelerated because of a combination of domestic and external factors, and this opened a negative output gap. Despite the fact that 2002 and 2004 brought deficient monsoons, food price inflation remained steady, in part because of the weakened demand and negative output gap. As headline inflation stayed inside its comfort zone, the RBI could support the recovery, reducing policy rates by 300 basis points in the period 2001–05.

[2]Under the multiple-indicator approach, policy perspectives were drawn by juxtaposing output data against interest rates or rates of return in different markets, along with movements in currency, credit, fiscal position, trade, capital flows, inflation rate, exchange rate, refinancing, and transactions in foreign exchange.

Output accelerated strongly, with GDP growth reaching almost 10 percent during 2006–08. As the output gap closed, the RBI began to tighten in 2005. Following passage of the Fiscal Responsibility and Budget Management Act, fiscal policy also tightened: the central government deficit was reduced from 4.3 percent in 2003–04 to 2.5 percent in 2007–08. In addition, steady capital inflows contributed to a real appreciation of the currency. These factors helped to moderate inflation pressures. Although commodity prices started to rise in 2005, the pass-through to consumer prices was temporarily muted by administered pricing of many products, especially fuel (Khundrakpam 2008). But as global commodity prices continued to rise strongly, especially crude oil prices, inflation accelerated, and in 2008 wholesale price inflation surged above 10 percent. Consumer prices also increased sharply. Second-round effects fed into the underlying inflation process, as workers sought to maintain real wages and firms to maintain profits. Large capital inflows led to an excess of liquidity in the banking system, fueling credit growth and an asset price boom. Although the RBI raised the policy rate, interest rates remained quite low in real terms, because of the increase in inflation. To contain domestic liquidity, the cash reserve ratio was increased. And to rein in the expansion of credit, macroprudential regulations were tightened, with higher risk-weighted capital requirements and stricter provisioning for bank lending.

Phase II: Persistently High Inflation, 2008–13

In the aftermath of the global financial crisis, GDP growth in India plummeted. In addition to a sharp contraction in external demand, the freeze in foreign financial markets quickly transmitted to a temporary disruption in short-term lending by banks, hurting domestic activity as well as foreign trade. However, as financial markets calmed and liquidity returned, growth rebounded by the second half of 2009. Countercyclical fiscal and monetary policies then kicked in, boosting growth to about 9 percent in 2010–11. The output gap turned from a large negative at the start of 2009 to a positive by the end of the year.

Inflation as measured by consumer and wholesale prices diverged during the crisis. This reflected the high share in the wholesale price index of primary commodities, which slumped in price after the global financial crisis. A series of commodity price shocks pushed the index up by about 10 percent in 2010, about the same increase as consumer prices that year. One of the proximate causes of the upturn was the deficient monsoon rains of 2009. Yet food prices continued to rise relatively quickly even after the monsoon shocks faded. This reflected three factors. The first was the impact of government interventions in the agricultural product and labor market—such as a sharp increase in minimum support prices, and enhanced coverage under the Mahatma Gandhi National Rural Employment Guarantee Act. The second was the pass-through of rapidly increasing world oil prices (agriculture and fertilizer production is highly energy intensive). The third were longer-term trends in food consumption in response to rising incomes, which led to demand-supply mismatches in specific food groups.

More generally, the increase in inflation reflected overall pressure on demand. Because of the postcrisis slowdown in potential output, strong acceleration of output opened a substantial positive output gap. Wages and materials costs rose quickly, and firms could pass on increased costs to consumers. Low monetary policy credibility led to drift in inflation expectations, contributing further to overall inflation persistence.[3]

Monetary policy during this period saw a normalization, from crisis-driven expansionary policies to a calibrated tightening in response to the resurgence of inflation. Policymakers were mindful that the durability of the postcrisis recovery was not assured. The uncertain extent of the loss of potential output implied by the global recession, and data issues, added to the difficulties of assessing the state of the economy. The continuation of the expansionary postcrisis fiscal stance added a further complication. As it became clearer that the inflation pressures were persistent, the RBI tightened more aggressively through 2011. However, following a slowdown in the economy and moderating commodity prices, policy rates were eased somewhat during 2012 and the first half of 2013.

Elevated inflation meant that real interest rates on bank deposits were negative and led to an erosion of savings. Higher demand for gold, which the population used as a hedge against inflation, worsened the trade deficit and diverted savings from productive investment. Concerns about macro-financial stability manifested in the market turmoil of the 2013 taper tantrum, when sovereign risk premiums rose abruptly and the rupee depreciated sharply on unfounded concerns that the US Federal Reserve was going to raise interest rates more rapidly than the market had anticipated.

These unsettled circumstances suggested a need to review the monetary policy framework. For this purpose, the RBI set up the Expert Committee to Revise and Strengthen the Monetary Policy Framework, which reported in 2014. Its report underlines that a fundamental factor underlying the unsatisfactory macroeconomic environment was the lack of a credible nominal anchor—that is, shifting long-term inflation expectations after what should have been one-off shocks to the inflation rate. The report notes that the large historical role of food price shocks in Indian inflation dynamics does not mean that monetary policy is not responsible for inflation over the longer term. It underscores the need for monetary policy to establish a firm nominal anchor so that changes in relative prices caused by real factors can take place without changing long-term inflation expectations.[4] The experience following the deficient monsoons of 2002–04 and 2009 suggested that a serious supply shock need not set off an outbreak of inflation if overall demand pressure was weak. After reviewing the economic history and the

[3]Studies on the inflation process in this period include Patra and Ray 2010; Basu 2011; Gokran 2011; Darbha and Patel 2012; Nadhanael 2012; Patra, Khundrakpam, and George 2014; Gulati, Jain, and Nidhi 2013; Sonna and others 2014; Mohanty and John 2015; Bhattacharya and Gupta 2015.

[4]See Rajan 2014; and Anand, Ding, and Tulin 2014.

feasibility of other options to establish a firm nominal anchor, the report recommends a flexible inflation-targeting framework.

Phase III: Disinflation and a New Framework, after 2014

The RBI began informally to put the Expert Committee recommendations into practice by endorsing a glide path for the reduction in CPI inflation—to 8 percent by January 2015 and 6 percent by January 2016. CPI inflation remained elevated through 2013, as the pass-through of exchange rate depreciation following the taper tantrum played out through the economy. But aggregate demand had started to wane, partly because of the tighter monetary policy, and a negative output gap had opened, creating sustained disinflation pressure. A fall in commodity prices, especially crude oil, and a more stable exchange rate, triggered a steep drop in inflation. Despite deficient monsoons, food price increases moderated toward the end of 2014 on a combination of better supply-management policies and a moderate increase in support prices. As a result, the 12-month CPI inflation rate dropped from 10 percent in December 2013 to 4 percent in December 2014, a significantly faster fall than had been expected in the glide path. Household inflation expectations moderated somewhat, and the expectations of professional forecasters became better anchored to the glide path. In 2015, inflation evolved roughly in line with the policy objective and was slightly below the target of 6 percent in January 2016. To moderate the disinflation pressure still evident in the domestic economy, and to resist the headwinds of a slowing global economy, the RBI cut the policy repo rate by 150 basis points between January 2015 and April 2016.

In the meantime, an agreement in February 2015 between the RBI and the government formalized the new approach. The Finance Act of 2016 amended the Reserve Bank of India Act to identify price stability as the primary objective of monetary policy, and to adopt flexible inflation targeting as the nominal anchor for monetary policy. The law also established a six-member monetary policy committee with responsibility for achieving the inflation objective. In August 2016, the government announced a CPI inflation target of 4 percent, with 6 percent and 2 percent as the upper and lower tolerance levels. The target applies until 2021.

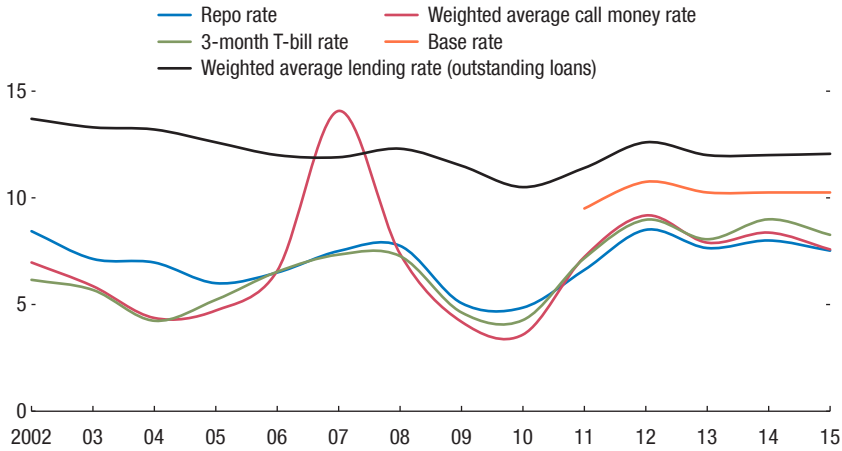
SPECIAL CHALLENGES FOR INFLATION-FORECAST TARGETING IN INDIA

Transmission Mechanism Weaknesses

Empirical studies have focused on various channels of policy transmission for India.[5] These may work through interest rates, through the exchange rate,

[5]For the interest rate channel, see RBI 2005; Mohan 2008; Patra and Kapur 2010; Aleem 2010; Bhattacharya, Patnaik, and Shah 2011; Khundrakpam and Jain 2012; Kapur and Behera 2012;

Figure 11.2. Key Interest Rates in India, 2002–15
(Percent)



Source: Reserve Bank of India.
Notes: All rates other than the weighted average lending rate (WALR) represent the average rate for the month of March. WLAR is computed on March 31 of each financial year.

through easing or tightening of bank lending, and through asset prices. Because India's economy is relatively large, the exchange rate channel is not expected to be very strong. The interest rate transmission channel could in principle be quite strong, but in practice, although transmission of policy rates to money markets and financial market rates has been fairly complete, the transmission to medium-term bank lending rates has been sluggish (Figure 11.2). Changes in the policy rate in India evidently do not exert the immediate, almost one-for-one, effect on the costs of bank borrowing observed in most advanced economies. This implies a weak link in the Indian policy transmission mechanism for any market-based monetary policy regime.

The Expert Committee highlighted several impediments to the transmission of the policy rate to lending rates, the most prominent of which are administered interest rates, statutory preemptions, rigidities in deposit rate structure, and a lack of external benchmarks. Banks compute a lending base rate from the average cost of funds, which is not very sensitive to changes in the policy rate.[6] This may

Mohanty 2012; Kletzer 2012; RBI 2014; Das 2015. For the bank lending channel see Pandit and others 2006; Bhaumik, Dang, and Kutan 2011; Bhatt and Kishor 2013. For the asset price and exchange rate channel see Singh and Pattanaik 2012; Khundrakpam 2007; Bhattacharya, Patnaik, and Shah 2008; Khundrakpam and Jain 2012.

[6]The base rate for commercial bank loans refers to rates based on those elements of the lending rates that are common across all categories of borrowers, and as such it represents the "floor" for

have improved since April 2016, when the RBI made it mandatory for banks to calculate the base rate using the marginal cost of funds. The interest rate on small saving schemes is administered by government policy: it represents a sort of floor for deposit rates. During phases of monetary easing, if time deposit rates of banks fall below the administered small savings rates, a situation could arise wherein bank deposits migrate to small saving schemes in search of higher returns. This could be alleviated by government measures announced on February 16, 2016, to align the small saving interest rates with the market rates of some government securities. Furthermore, a large part of bank deposits are retail based and have a fixed tenure, which gives a rigidity to banks' cost of funds. Creation of floating deposit rate products faces the challenge of the lack of a transparent external money market benchmark for pricing. High statutory pre-emptions (requirements to hold reserves at the central bank or government debt) lead to crowding out of credit and impede transmission of policy rates to longer rates. State ownership of much of the system to some extent may be responsible for some of these rigidities.

Another factor with a significant bearing on the transmission process is the impact of international capital flows. These can be quite volatile, and if the flows are large the RBI may not be able to completely sterilize their impact on domestic liquidity, as occurred in the mid-2000s. At a much broader level, despite improved financial inclusion through institutional sources over the past decade, a considerable section of the population resorts to informal lenders, at interest rates that are not responsive to rates in the organized financial markets.

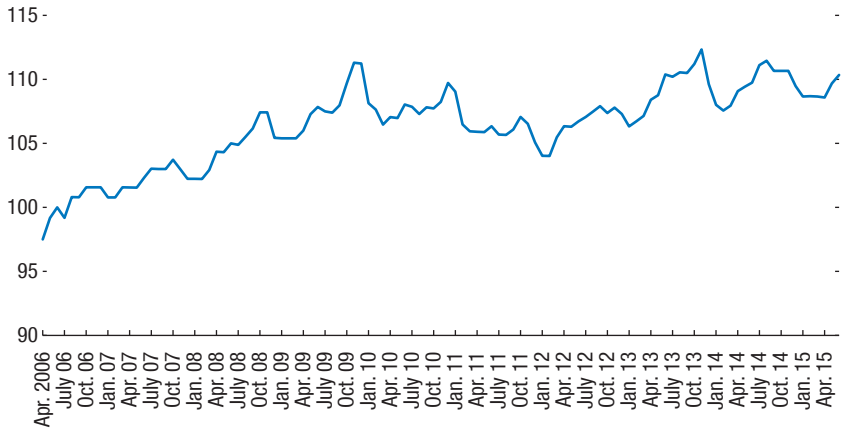
The Dominance of Food Prices in the CPI

Food constitutes about 46 percent of the CPI basket in India. This weight is a challenge to flexible inflation targeting for various reasons. First, food prices are highly susceptible to supply shocks because of the impact of variable monsoon rains on harvests. Second, government intervention—for example, changes to minimum support prices, employment guarantees, and minimum wages—sporadically affects food prices. These factors mean that, year over year, headline inflation can be quite different from measures of core inflation that exclude food and energy prices. And third, over the past decade, changes in the underlying structure of the economy and shifts in the composition of demand have caused food prices to rise faster than other prices (Figure 11.3).

Monetary policy affects the rate of inflation in the short and medium term largely through the effect of the output gap on sticky prices, such as those for services and manufactured goods. Thus, the typical Phillips curve of a macro model has core inflation as the dependent variable. The high weight on food dilutes the medium-term effect of policy rate changes on overall CPI inflation. In addition, the high variance of food prices introduces noise into the inflation rate

bank lending rates. Spread components are then added to arrive at the lending rate for a particular borrower.

Figure 11.3. The Relative Price of Food in India, 2006–15
(Index, 2001 = 100)



Sources: Haver Analytics; and Reserve Bank of India.
Note: The figure shows the ratio of the Food Group Index to overall consumer price index for industrial workers.

that makes it difficult for the public and policymakers alike to distinguish the influence of monetary policy.

This underscores the basic weakness of the former policy regime: it did not provide a firm nominal anchor to prevent the pass-through of food price shocks to a generalized spiral of inflation. With stable long-term inflation expectations, the relative price changes, which monetary policy is powerless to affect, could have taken place through one-off changes in the rate of inflation, without extended pass-through effects. In India, some lag in the adjustment of prices to shocks is inevitable, especially in those administered by the government. This, however, merely spreads out the shock: with stable expectations, the effect of supply shocks on inflation would still be transitory.

Inflation-forecast targeting can provide an effective strategy for minimizing the second-round effects of supply shocks. The central bank earns credibility over time by achieving the announced target for inflation on average. Years may be required for long-term inflation expectations to hold firm at the target rate. After each policy action, publication of a forecast showing a medium-term path back to target, along with an explanation of how policy actions should contribute to this outcome, helps to maintain such confidence. The medium-term path is conditional on events, but the ultimate target is not. Policymakers need flexibility to change interest rates in response to unforeseen developments. The important thing is not that they adhere to the medium-term path envisaged by a previous forecast, but that they consistently act to return inflation to target following shocks. Once long-term expectations are stabilized, this itself helps to reduce the effects of supply shocks on inflation, and to confine them to the short term.

The strong relative food price trend over time creates not only more substantive uncertainties but also a communications problem. If it continues, core inflation would turn out to be a systematically downward-biased indicator of headline inflation. The communication becomes challenging following a food price shock, because the authorities cannot point to core inflation to reassure the public that policy is on the right track. The challenge for monetary policy communication during a period of trending relative prices, therefore, lies in providing an assessment of the likely size and duration of the relative price trend, and a medium-term forecast in which headline inflation eventually returns to target.

No Track Record: The Challenge of Building Credibility

Before the official inflation target was introduced, the RBI did not have an explicit price stability mandate as its overarching objective. Therefore, the public had no historical record from which to judge either the central bank's commitment to the announced long-term inflation target or whether its actions to this end would prove effective. Despite the regime change, the history of high and unstable inflation has doubtless weighed heavily in the public mind. The RBI has therefore been mindful of the need to get inflation in line with the 4 percent long-term target and to be transparent in explaining how its policy actions are designed to return inflation to target following any deviation. While the RBI was building credibility, policy actions not consistent with stated objectives were liable to damage confidence in the target and thereby to unsettle the nominal anchor. As discussed in Chapter 3, expectations may then amplify the effects of shocks to the economy.

A QUARTERLY PROJECTION MODEL FOR INDIA

The RBI's forecasting and policy analysis system uses a quarterly projection model (QPM) which follows the broad outlines of the generic macroeconomic model sketched out in Chapter 4. Two variants of QPM exist. Production-QPM is the workhorse for deriving the forecasts. It contains significant structural detail to enable explicit forecasts of certain variables that are of particular interest to policymakers, including a linear policy rule for the short-term interest rate.[7] Core-QPM is a stripped-down version, which can be equipped with nonlinearities in the policy reaction function, the Phillips curve, and in a credibility-building process, along with other technical modifications. These enable the exploration of more complex problems and policy options than Production-QPM can examine. Here, the focus is on Core-QPM to show model properties and to illustrate policy options for returning inflation to target following various types of shocks.

As discussed in Chapter 2, flexible inflation targeting may be made operational through the concept of inflation-forecast targeting. Since the central bank forecast

[7]See Benes, Clinton, George, Gupta, and others (2016).

embodies all available information, including the policymakers' own preferences about short-term trade-offs, it provides an ideal target over any time horizon. That is, the forecast medium-term path to target includes the effects of current and expected disturbances and an appropriate policy reaction. The idea of inflation-forecast targeting underlies the policy reaction functions in the RBI's QPM. These reinforce the nominal anchor by ensuring that inflation returns to the 4 percent target over the medium term in the event of any deviation of actual inflation from the target. When policy consistently achieves this result, long-term expectations eventually solidify at the target rate.

Overview of Equations

Below is a list of the behavioral equations for Core-QPM.[8] It contains a quadratic policymaker loss function, which embodies a more realistic view of policymaking under flexible inflation targeting than a linear policy rule—whereas small deviations from desired outcomes may be tolerable, very large deviations can lead to dark corners (for example, inflation spirals or deflation traps) that should be avoided (Blanchard 2014).

Output gap:

$$\hat{y}_t = \alpha_1 E_t[\hat{y}_{t+1}] + \alpha_2 \hat{y}_{t-1} - \alpha_3 \hat{r}_t^m + \alpha_4 \hat{z}_t + \varepsilon_t^{\hat{y}} \tag{11.1}$$

$$\alpha_1 = 0.07; \alpha_2 = 0.60; \alpha_3 = 0.08; \alpha_4 = 0.05$$

Definition of the real interest rate gap:

$$\hat{r}_t^m = i_t - E_t[\pi_{t+1}] \tag{11.2}$$

Definition of the real exchange rate gap:

$$\hat{z}_t = s_t + p_t^f - p_t \tag{11.3}$$

Inflation:

$$\pi_t = \beta_1 E_t[\pi 4_{t+1}] + (1 - \beta_1)\pi_{t-1} + \beta_2\left(e^{\beta_3 \hat{y}_t} - 1\right)/\beta_3 + \beta_4 \hat{z}_t + \varepsilon_t^{\pi} \tag{11.4}$$

$$\beta_1 = 0.33; \beta_2 = 0.06; \beta_3 = 0.40; \beta_4 = 0.005$$

Monetary policy loss function:

$$L_t = \sum_{i=0}^{\infty} \beta^i \left[\lambda_1 (\pi_{t+i} - \pi^*)^2 + \lambda_2 \hat{y}_{t+i}^2 + \lambda_3 (i_{t+i} - i_{t+i-1})^2\right] \tag{11.5}$$

$$\beta = 0.98; \lambda_1 = 1; \lambda_2 = 1; \lambda_3 = 0.5$$

Uncovered interest parity with risk premium:

$$i_t = i_t^f + \sigma_t + (E_t S_{t+1} - S_t)4 + \varepsilon_t^S \tag{11.6}$$

[8]The model follows the format depicted in Figure 2.1, Chapter 2.

Exchange rate expectation:

$$E_t S_{t+1} = \delta_1 S_{t+1} + (1-\delta_1)\left\{ S_{t-1} + 2\left[\Delta\bar{Z}_t + \frac{\pi 4_{t-1} - \pi 4^f_{t-1}}{4}\right] + \delta_2 \hat{z}_t \right\} \quad (11.7)$$

$$\delta_1 = 0.6; \delta_2 = 0.3$$

Weakened uncovered interest parity with risk premium:

$$\gamma_1\left[i_t - \left(i^f_t + \sigma_t\right)\right] + (1-\gamma_1)\left[\Delta\bar{Z}_t \times 4 + \left(\pi 4_{t-1} - \pi 4^f_{t-1}\right)\right] = \left(E_t S_{t+1} - S_t\right) \times 4 + \varepsilon^S_t \quad (11.8)$$

$$\gamma_1 = 0.7$$

Inflation expectation:

$$E_t\left[\pi 4_{t+1}\right] = c_{t-1}\pi 4_{t+4} + (1-c_{t-1})\pi 4_{t-1} + (1-c_{t-1})b^\pi + \kappa\sum_{i=1}^{5}(1-c_{t-1})^i \varepsilon^\pi_{t-i+1} \quad (11.9)$$

$$b^\pi = 0.25; \kappa = 1$$

Change in real exchange rate trend:

$$\Delta\bar{Z}_t = 0 \quad (11.10)$$

Notations: output gap ($\hat{y}_t$), real interest rate gap ($\hat{r}^m_t$), real exchange rate gap ($\hat{z}_t$), shocks to aggregate demand ($\varepsilon^{\hat{y}}_t$), domestic prices (p_t), foreign price (p^f_t), annualized quarterly changes in the seasonally adjusted logarithm of CPI (π_t), inflation expectation ($E_t[\pi 4_{t+1}]$), shocks to inflation (ε^π_t), interest rate (i_t), nominal exchange rate (S_t), expected exchange rate ($E_t S_{t+1}$), foreign nominal interest rate (i^f_t), time-varying country risk premium (σ_t), change in real exchange rate trend ($\Delta\bar{Z}_t$), year-over-year inflation ($\pi 4_t$), foreign inflation ($\pi 4^f_t$), shocks to the exchange rate (ε^S_t), credibility stock (c_t).

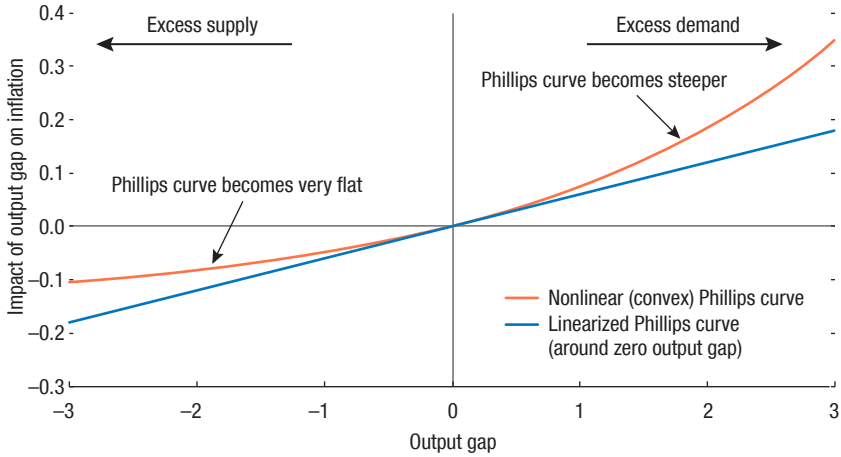
Calibration of the model reflects India-specific features. The uncovered interest parity condition is modified to reduce the sensitivity of the rupee exchange rate to interest rate differentials. This captures frictions from capital controls and from incomplete financial markets. Expectations include a backward-looking component and a forward-looking, model-consistent component (also known as rational expectations).

Some Specific Features

The Phillips curve contains a nonlinear output gap. The term $(\beta_2(e^{\beta_3\hat{y}_t} - 1)/\beta_3)$ implies an increasing marginal effect on the inflation rate as the gap increases. At wide negative output gaps, the curve becomes quite flat (Figure 11.4).

In the model, persistent food and fuel price shocks in a context of low monetary policy credibility can result in upward ratcheting in inflation expectations and can contribute to higher levels of inflation persistence. Specifically, inflation expectations are modeled as a linear combination of backward-looking (lags) and forward-looking, model-consistent (leads) components, with the weight on the former decreasing with the stock of credibility. In addition, when credibility is imperfect, inflation expectations are biased upward relative to the linear combination of backward-looking and forward-looking components. This strengthens the propagation mechanism from supply shocks, and therefore requires a more

Figure 11.4. Convex Phillips Curve
(Percentage point)



Source: Authors' calculations.

aggressive tightening in monetary conditions to contain inflationary pressures and anchor long-term inflation expectations. Over time, an established inflation-forecast-targeting regime provides an effective strategy for dealing with the second-round effects of supply shocks.

Credibility is earned, over time, by achieving announced objectives, and by effective, transparent communications. On the other side, it can be lost through policy actions inconsistent with stated objectives. There are two types of expectation-building processes. The first is optimistic yet watchful: it attaches a positive weight $(1 - \rho)$ to the central bank's intermediate target for inflation (that is, the inflation target π^*), but also some weight (ρ) to past inflation. The second type, conditioned by history, is skeptical, informed by the belief that inflation is likely to wander off back to some historical high level. This belief puts some weight on high inflation (π^H), as well as on past inflation, but ignores the central bank's inflation target. The credibility signal, as defined by the relative squared forecast errors under the two types, provides a measure of the extent to which an inflation outcome is consistent with the central bank's promise, where inflation falls to the target rate over time. High values of the credibility signals increase the credibility stock. However, it takes repeated good signals to improve credibility significantly.

Credibility stock building:

$$c_t = \rho^c \times c_{t-1} + (1 - \rho^c) \times \xi_t \qquad (11.11)$$

$$\rho^c = 0.8$$

Signal for revision of credibility based on squared forecast errors:

$$\xi_t = \frac{(\varepsilon_t^H)^2}{(\varepsilon_t^H)^2 + (\varepsilon_t^L)^2} \tag{11.12}$$

Forecast errors:
Forecast error expected by optimists

$$\varepsilon_t^L = \pi 4_t - \left[\rho \times \pi 4_{t-1} + (1-\rho) \times \pi^*\right] \tag{11.13}$$

Forecast error expected by skeptics

$$\varepsilon_t^H = \pi 4_t - \left[\rho \times \pi 4_{t-1} + (1-\rho) \times \pi^H\right]$$

$$\rho = 0.5; \pi^* = 4; \pi^H = 8$$

Boundary conditions:

$$\text{If } \pi 4_t - \left[\rho \times \pi 4_{t-1} + (1-\rho) \times \pi^*\right] < 0, \text{ then } \xi_t = 1. \tag{11.14}$$

$$\text{If } \pi 4_t - \left[\rho \times \pi 4_{t-1} + (1-\rho) \times \pi^H\right] > 0, \text{ then } \xi_t = 0.$$

Monetary policy in the model minimizes a quadratic loss function, which penalizes squared deviations from output and inflation objectives and large short-term interest rate changes. It is common to use a linear (Taylor-type) rule to characterize monetary policy under inflation targeting. Such an approach may be adequate for situations in which there is no nearby risk to the credibility of the official inflation target. For India, however, long-term expectations of inflation are not yet firmly attached to the 4 percent target. Any substantial excess of actual inflation over target would likely cause expectations of inflation to ratchet up. To return inflation to target would then involve large losses to output and employment. Central bank policymakers would therefore react increasingly strongly to deviations above target as they grow—in effect, as if they had a quadratic loss function.

But policymakers avoid sharp interest rate changes. The penalty in the loss function for steep policy rate changes reflects the well-known preference of policymakers for gradual rate movements. This has the economic rationale that policymakers uncertain about the source or the duration of a shock will proceed cautiously. In addition, more variable changes in rates are liable to convey less information to the public about the stance of monetary policy. A given policy rate change has more effect on longer-term interest rates and the exchange rate if there is less noise in its movements.

ILLUSTRATIVE CORE-QPM MONETARY POLICY EXPERIMENTS

The most important function of a forecasting and policy analysis system model is as a tool for policymakers to assess the implications of alternate policy options under periods of uncertainty. A few plausible scenarios can be traced in the Indian context, which illustrate policy options and their likely implications using Core-QPM simulations.

Disinflation

This experiment derives paths for endogenous variables in a disinflation goal that would take inflation from 5 percent to 4 percent. Minimizing the loss function ensures that the latter is achieved at the lowest cost in loss in output, deviation of inflation from the target, and interest rate variability. An initial equilibrium with 5 percent inflation is assumed, and hence the nominal interest rate is 7 percent (or a real rate of 2 percent). With initial credibility not very high, the central bank should hike the policy rate in the baseline (Figure 11.5). The uncovered interest parity condition warrants a drop in the exchange rate (that is, appreciation of the rupee) when there are no further shocks to the system. The combination of interest rate increase and exchange rate appreciation reduces demand and opens a negative output gap. Inflation declines first by the impact of the stronger rupee, and then, increasingly over time, by the negative output gap. The cost in cumulative forgone output is 2 percent of annual GDP (that is, a sacrifice ratio of 2).

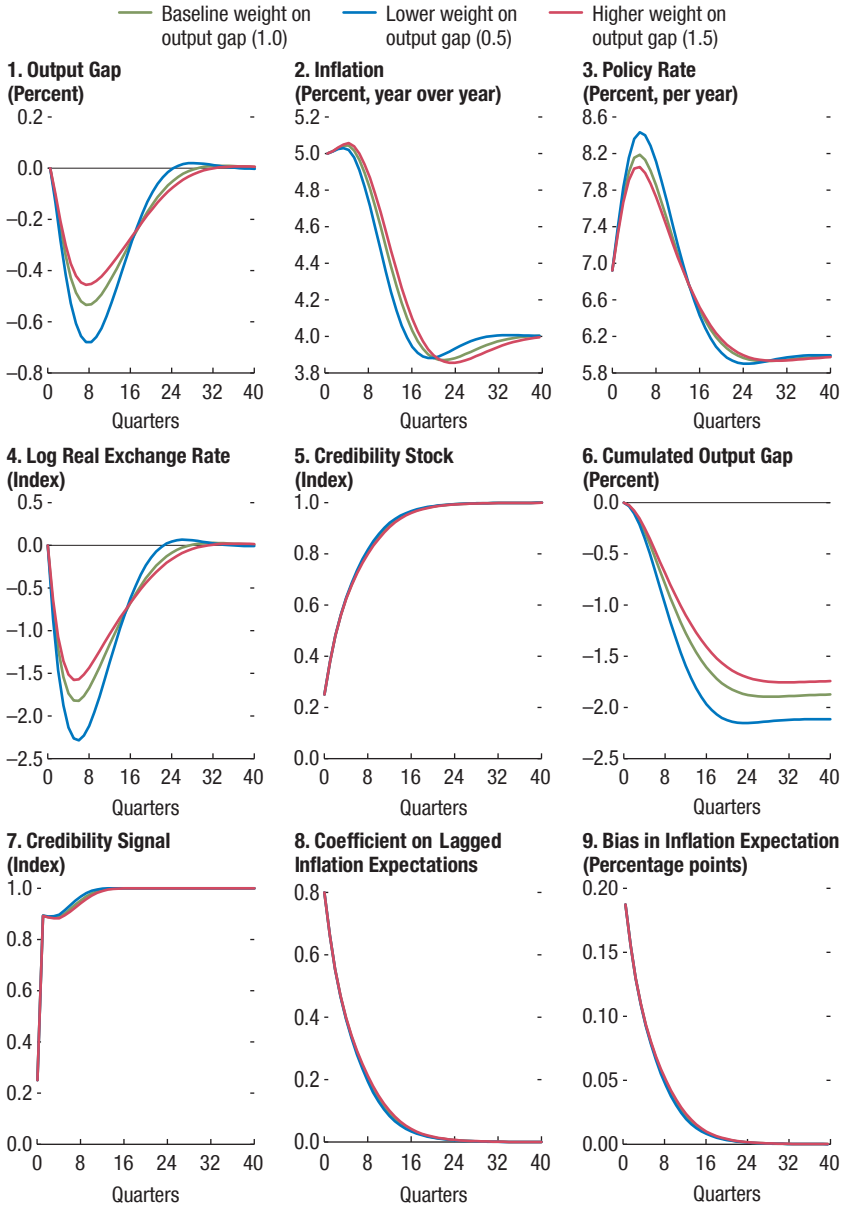
The credibility stock starts low initially, but as inflation declines toward the target, the central bank receives repeated high credibility signals, and as a result, it builds up the credibility stock over time. Eventually, as the credibility stock goes to one, the lagged term in inflation expectations and the bias term both disappear, which implies a much-improved short-term trade-off between output and inflation. Hawkish policymakers would achieve the long-term target slightly faster than the baseline. But they would raise the policy rate more, triggering a sharper appreciation, a wider medium-term negative output gap, and hence a larger sacrifice ratio. Dovish policymakers, in turn, with a higher weight on the output gap, would tighten monetary conditions less than the baseline and hence the sacrifice ratio would be lower.

Figure 11.6 shows a path generated under the assumption that the policy stance is fully credible. The 1 percentage point reduction in inflation is achieved within six quarters, at a reduced loss of cumulative output—1/2 percent of annual GDP. In the baseline, the tightening of policy is achieved without any increase in the policy interest rate—in effect, the required increase in the real rate is achieved entirely through the reduced expectations of inflation. If policymakers were to place more weight on deviations of output from the long-term equilibrium, the more gradual approach would further reduce the output cost. Were policymakers to exhibit willingness to tolerate short-term loss of output and employment, and so place less weight on the output gap, the policy rate would indeed increase slightly and the sacrifice ratio would be slightly higher. But clearly, policymakers' preference on the output gap makes little material difference to outcomes in the perfect credibility situation.

Mitigating Demand Shocks: Divine Coincidence

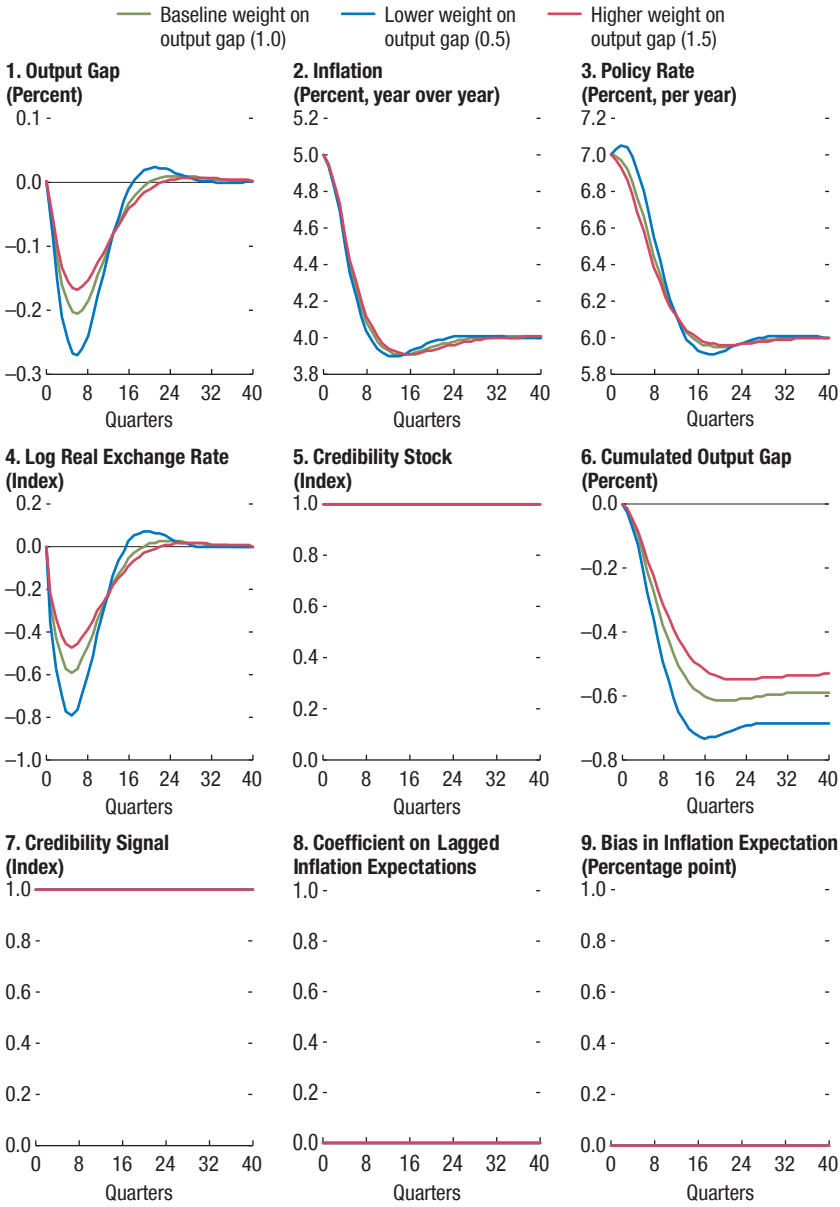
Under optimal policy, the central bank raises (or cuts) the policy rate to deal with positive (or negative) demand shocks (Figure 11.7). Dealing with such shocks does not create a conflict between output and inflation objectives because of the so-called divine coincidence (Blanchard and Galí 2007). With a prompt, active

Figure 11.5. Disinflation with Endogenous Policy Credibility



Source: Authors' calculations.

Figure 11.6. Disinflation with Perfect Policy Credibility



Source: Authors' calculations.

response to the shock, inflation is held close to baseline in each case. Given the flat Phillips curve under excess supply conditions, the widening of the output gap must be somewhat greater for the negative than for the positive shock. Because inflation is well controlled, demand shocks have no major impact on credibility.

Mitigating Supply Shocks: Trade-Offs

A nasty supply shock requires an increase in interest rates and a larger negative output gap (relative to baseline) to maintain the path to the 4 percent long-term target (Figure 11.8). The medium-term trade-off is between the speed of the approach to the target and the size of the output gap. A prompt and aggressive approach prevents long-term inflation expectations from ratcheting upward and preserves credibility, but it has higher costs to short-term output. By contrast, a favorable supply shock presents an attractive trade-off: inflation moderates relative to baseline and reaches 4 percent sooner; monetary policy eases; and the output gap closes faster.

Prompt versus Delayed Policy Responses

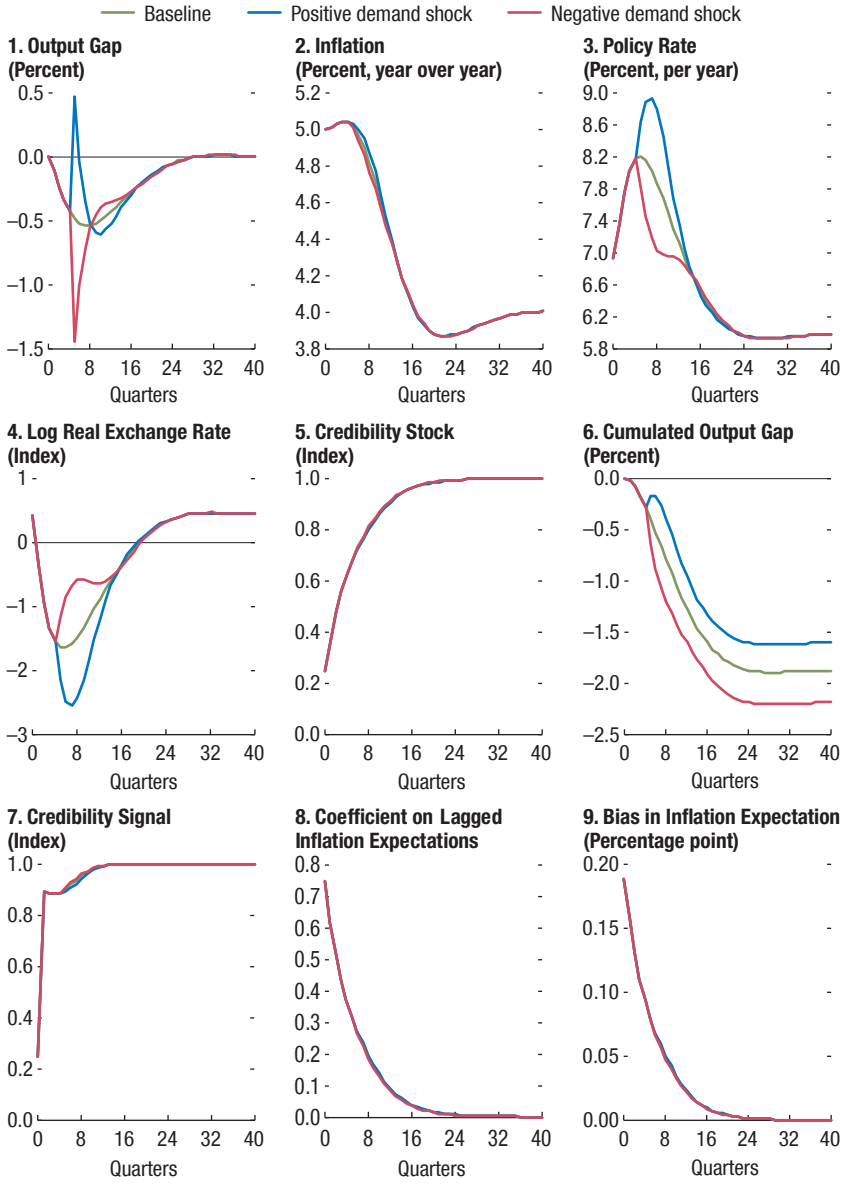
In the previous experiments, losses to both output and monetary policy credibility following supply shocks were reduced by prompt, effective action. The importance of timely policy action when credibility is imperfect can be shown with an experiment in which policymakers wait before responding to a nasty supply shock. If the policy action is delayed, the interest rate hike must be much greater than under a baseline response, and the cumulative output gap is larger, with higher inflation (Figure 11.9). Thus, a delayed policy response causes a substantial deterioration in the medium-term output-inflation trade-off.

CONCLUSIONS

India's experience with inflation targeting contrasts in several ways with that of most advanced economies. Structural factors result in changes in the RBI policy rate being transmitted weakly to output and inflation. Volatile food prices exert a large influence over the short- to medium-term dynamics of inflation. A history of high and variable inflation has left a legacy of skepticism about whether monetary policy will, or even can, achieve the announced inflation-control objective. Features such as these have implications for the conduct of policy, and they create challenges for macroeconomic modeling.

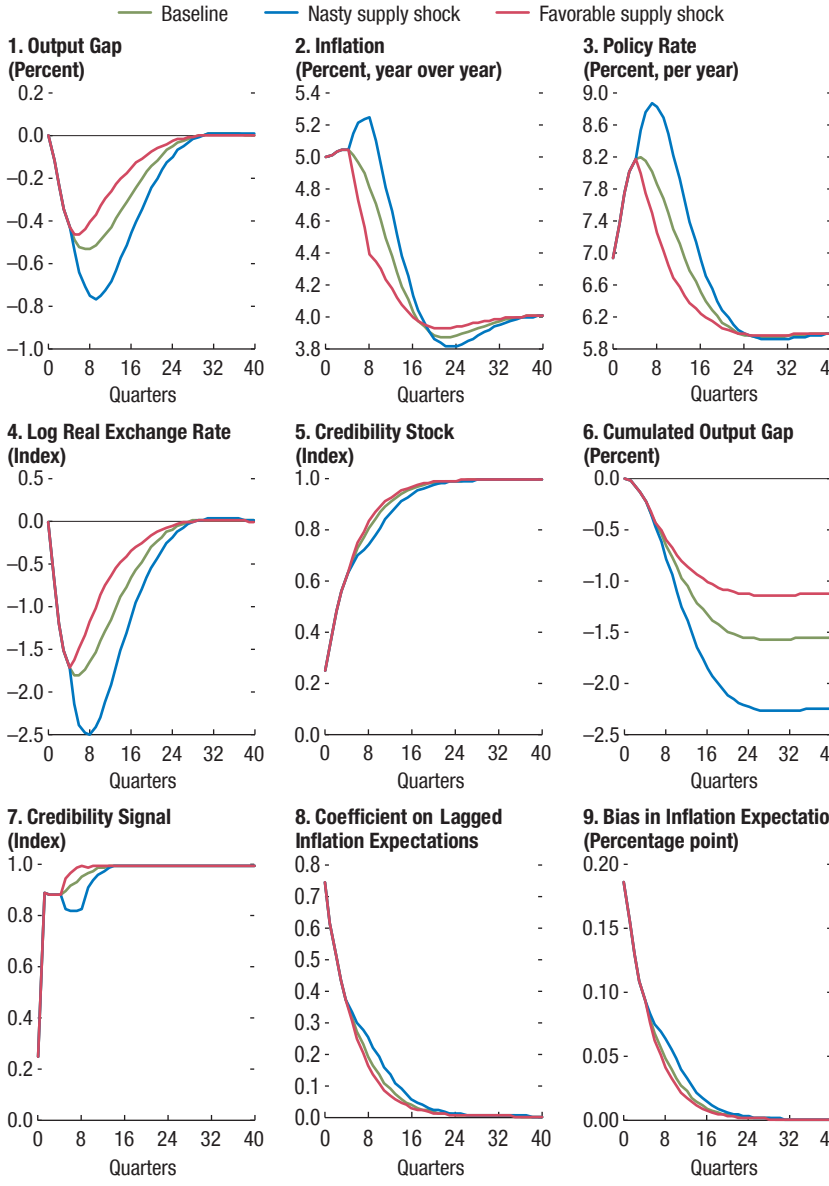
It is too early to judge whether the inflation targeting of the RBI will succeed in establishing a firm nominal anchor. So far, inflation has been brought down in line with the official target range. A strong test to the regime will come with the next major shock to food prices. Previous shocks set off second rounds of price and wage increases and hence a spiral of inflation. Public expectations of long-term inflation drifted with the actual rate. The intent under the new regime is that a bad harvest should have only a transitory effect on inflation, and

Figure 11.7. Demand Shocks



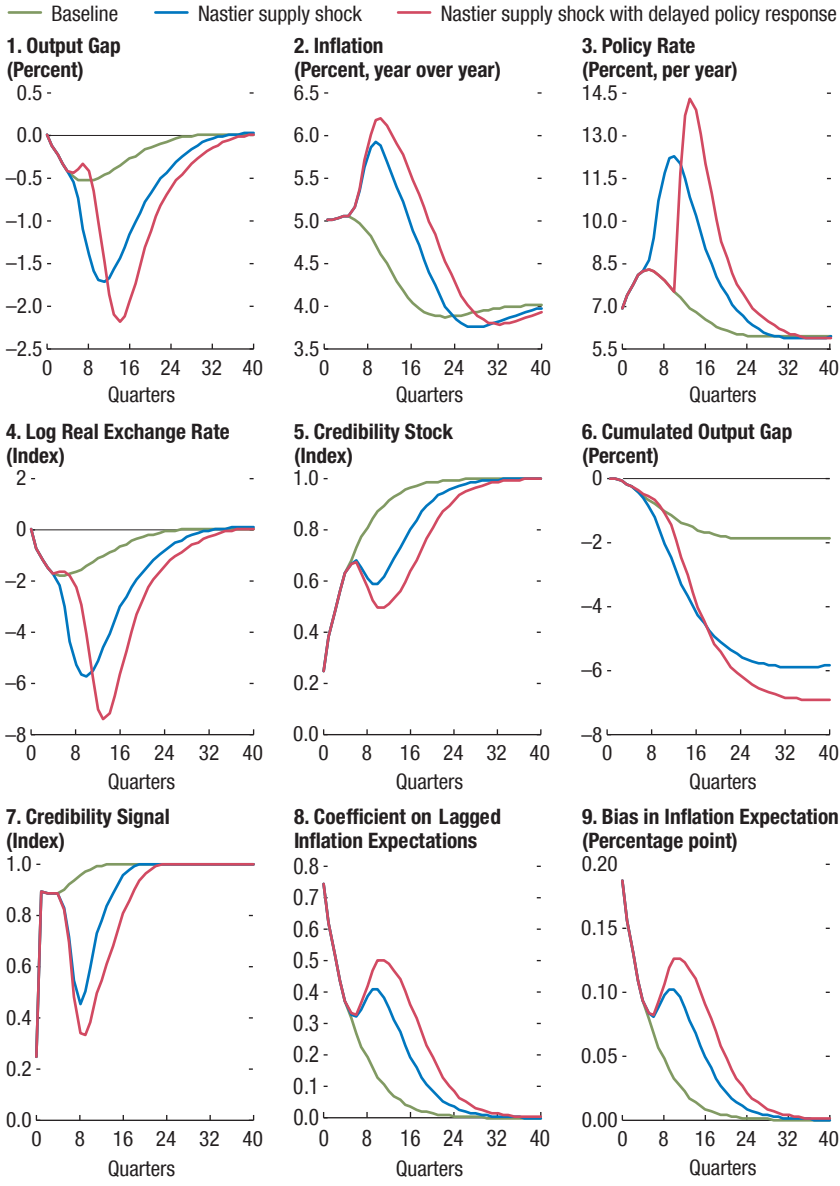
Source: Authors' calculations.

Figure 11.8. Supply Shocks



Source: Authors' calculations.

Figure 11.9. A Delayed Policy Response to Shocks



Source: Authors' calculations.

long-term expectations should hold steady at the official target rate. The change in relative prices, which monetary policy is powerless to affect, can be absorbed without a lasting change in the inflation rate. In other inflation-forecast-targeting countries, long-term inflation expectations have held firm following supply shocks, but the effect of such shocks on consumer prices in India is exceptionally large.

With respect to modeling, the RBI has been experimenting with ways to incorporate the special structural features of the Indian economy into a core macroeconomic forecasting model. A credibility-building process, according to which policy earns credibility over time by consistently returning inflation to target, will be a relevant part of the model during the early years of the new regime. Simulation results from the model indicate that delays in responding to shocks can be quite costly in terms of output losses and inflation, partly because of lost credibility.

There has also been a conjunctural difference with most advanced economies, in that the Indian economy has enjoyed robust growth since the global financial crisis. The relevant danger for India would be that long-term expectations of inflation get derailed on the upside. However, a theme in this book is that policy should respond assertively to disturbances that threaten to push the economy into a bad quasi-equilibrium, and this applies to India too. When there is a risk that inflation expectations may drift from inflation targets, prudent conduct of monetary policy may call for aggressive policy actions.

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