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Monetary Policy Transmission and Financial
Stability in a LIC: The Case of Bangladesh

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Monetary Policy Transmission and Financial Stability in a LIC: The Case of Bangladesh

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Abstract

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This paper explores how monetary policy affects the real economy and its efficacy in promoting financial stability in a large low income country. This paper shows that monetary policy modestly impacts real economic activity and inflation via the bank lending and financial accelerator channels. Second, money market and treasury rates signal changes in the policy stance, while altering banks' intermediation cost curves due to shifting risk premia. At the same time, evidence points to monetary policy inducing an overshooting in asset prices. These findings suggest that financial stability could be undermined if the calibration of monetary policy is based solely on output and inflation without accounting for the stage of the financial cycle. Finally, the paper discusses policy measures that would enhance the transmission of monetary policy and promote financial stability in Bangladesh.

FIGURES

I. INTRODUCTION

In most developing countries (LICs), arguments both for and against restricting the objectives of monetary policy are linked to policy concerns beyond simple price stability. First, countries with more rudimentary financial systems and a concentration of output in a narrower range of products tend to suffer from a greater vulnerability to destabilizing shocks, both internal and external, suggesting a greater need for countercyclical policy. Second, an increased probability of excess risk-taking and asset price bubbles as a result of weak price discovery due to shallow financial markets implies monetary policy should be interventionist to help preserve financial stability. Finally, monetary policy could help control external imbalances, which LICs are more susceptible given limited access to international capital markets.

This paper examines to what extent monetary policy can be directed at financial and real stabilization in Bangladesh. The country is an example where such policy questions are highly relevant, and where policy insights may be equally useful for other LICs.[2] This paper finds:

- Easier monetary policy reduces financial market frictions by altering the shape of banks' intermediation cost curve via the risk-taking channel, while lowering the effective amount of financial risk agents face through reduced risk premiums. Lower discount factors help boost asset prices by increasing present value returns. Taken together, the findings for Bangladesh imply that the calibration of monetary policy for output and inflation objectives should account for the stage of the financial cycle. Monetary policy and policies toward financial stability should be viewed as complementing one another.

- The bank lending, working through changes in price and quantity, and financial channels are key in transmitting the effects of policy to real economic activity and inflation. However, low levels of financial development means any change in asset prices and the external finance premium on real activity work with long lags and are small in magnitude.

- As the impact of the credit and financial channels on economic activity and inflation is limited, policies to strengthen the effectiveness of monetary transmission channels should concentrate on improving access to financial services, diversifying sources of financing for firms by deepening capital markets and cleaning up non-performing loans in the banking sector.

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[2] See Box 1.

This paper is organized as follows. Section 3 lays out a simple data-rich macro-econometric framework. Section 4 discusses the results, with Section 5 concluding and summarizing a number of policy initiatives.

II. MONETARY POLICY FRAMEWORK IN BANGLADESH

Since 2003 monetary management in Bangladesh has centered on a monetary targeting framework. A reserve money target is formulated to achieve the desired level of broad money (M2). Reserve money and M2 are linked through the money multiplier. The final targets, price stability and growth, are achieved by influencing changes in broad money supply.

If the policy instrument – reserve money – reflects the actions of the policy stance of Bangladesh Bank then it should be systematically related to important target variables like inflation and economic activity.[3] This is explored by estimating a monetary policy reaction function based on a hybrid McCallum-Mankiw-Taylor rule that embeds a backward- and forward-looking component of inflation, expressed as:[4]

$$m_t = a_0 + \beta_1 \pi_{t-1} + \beta_2 y_{t-1} + \beta_3 E_t(\pi_{t+1}) + \beta_4 e_{t-1} + u_t \tag{1}$$

The dependent variable is reserve money (m_t), which acts as the policy instrument. As explanatory variables equation (1) contains realized inflation (π_{t-1}), the output gap (y_{t-1}), the nominal effective exchange rate (e_t) and a one year forward measure of inflation expectations based on Consensus Forecast survey data ($E_t(\pi_{t+1})$). Economic activity (y_t) is measured as industrial production.[5]

To capture changes in policy objectives across time the regression coefficients are assumed to evolve according to the following law of motion equation

$$\beta_t = \beta_{t-1} + v_t \quad \text{where} \quad v_t \sim N(0, \Xi) \tag{2}$$

This random walk specification assumes that the monetary authorities update their information at each point in time. The model also allows for time-varying variance, which is assumed to follow a first-order Markov process

$$\varepsilon_t \sim N(0, h_t) \qquad h_t = \sigma_0^2 + (\sigma_1^2 - \sigma_0^2) S_t \quad \text{where } S_t \in \{0,1\} \tag{3}$$

with $\sigma_1^2 > \sigma_0^2$ and probability

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[3] See Bernanke and Blinder (1992).
[4] A similar rule was estimated for India in Patra and Kapur (2012).
[5] Industrial production may be viewed as a more homogenous measure of the data generating process for economic activity, since some of the segments of GDP (such as agriculture and allied products) are driven by factors that are relatively exogenous to the monetary policy stance.

$$prob(S_t = 1|S_{t-1} = 1) = p \quad \text{and} \quad prob(S_t = 0|S_{t-1} = 0) = q$$

The model is estimated using Markov Chain Monte Carlo (MCMC) methods based on Gibbs sampling estimation (see Appendix A).

The estimates are illustrated in Figure 1. Allowing for a few caveats, the time-varying estimates show monetary policy has become increasingly counter-cyclical. Since 2011 a rise in economic activity has precipitated a tightening in reserve money. The median coefficient between reserve money and inflation has also been negative, implying monetary policy has tended to lean against the wind. The relationship between inflation and reserve money was at its height during the peak of the commodity price boom in 2007-08. The term for the exchange rate enters with the correct sign. The result implies monetary policy adjusts to large movements in the exchange rate through smoothing interventions that affect net foreign assets (NFA) and thereby reserve money.

Figure 1: McCallum-Mankiw-Taylor monetary policy reaction function
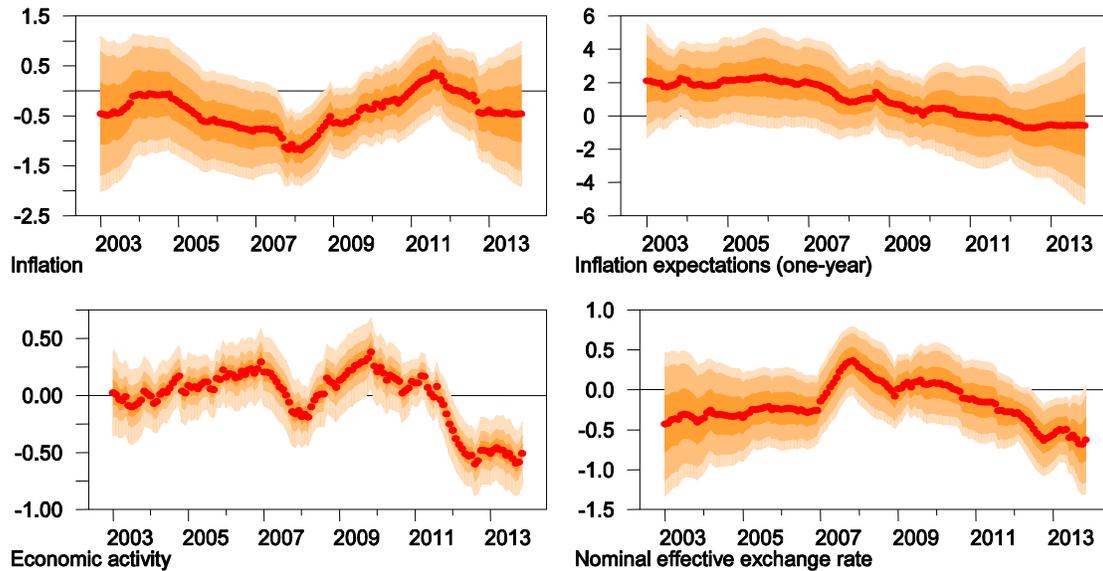
Source: Author calculations

The results show that reserve money has been adjusted to shifting macroeconomic conditions. With reserve money the primary instrument through which changes in monetary policy are enacted, the paper moves on to explore whether innovations in the reserve money help predict movements in the economy because they measure policy induced shocks.

III. A DATA RICH MACROECONOMIC MODEL FOR BANGLADESH

Greater measurement error in macroeconomic time-series in countries with less developed policy institutions often results in economic measures that are less than perfect proxies. These problems are amplified in small econometric models, which imply that the information set spanned by the model differs from that exploited by policymakers. This section sets out a structural model, which synthesizes information from a large dataset, helping limit omitted variable bias and improve accuracy by reducing the probability of the observed variables failing to perfectly reveal the state variables of the model (the non-invertability problem).

The model can be expressed through a measurement equation, which relates the observed variables to the state vector Λ:

$$
\begin{bmatrix} X_t^e \\ X_t^\pi \\ X_t^y \\ X_t^m \\ X_t^c \\ m_t \\ X_t^f \end{bmatrix} = \begin{bmatrix} \Lambda^e & 0 & \cdots & \cdots & \cdots & \cdots & 0 \\ 0 & \Lambda^\pi & \cdots & \cdots & \cdots & \cdots & \vdots \\ \vdots & \vdots & \Lambda^y & \cdots & \cdots & \cdots & \vdots \\ \vdots & \vdots & \vdots & \Lambda^m & \cdots & \cdots & \vdots \\ \vdots & \vdots & \vdots & \vdots & \Lambda^c & \cdots & \vdots \\ \vdots & \cdots & \cdots & \cdots & \cdots & \Psi & \vdots \\ 0 & \cdots & \cdots & \cdots & \cdots & \cdots & \Lambda^f \end{bmatrix} \begin{bmatrix} F_t^e \\ F_t^\pi \\ F_t^y \\ F_t^m \\ F_t^c \\ m_t \\ F_t^f \end{bmatrix} + e_t \tag{4}
$$

where $X_{i,t}$ is a large panel of 85 macroeconomic time-series ($i = 1,2, \ldots, N$) and e_t are errors such that $E\left(e_t \middle| F_t^e, \ldots, F_t^f\right) = 0$ for all factors (F_t^i). To attain structural inference, the panel of macroeconomic time-series ($X_{i,t}$) is broken down into subsets (or blocks) of variables, which are loaded onto specific factors to allow a structural interpretation to factors.[6] The model attempts to capture a number of key monetary transmission channels:

- ***Macro expectations channel*** (X_t^e): This block captures forward-looking expectations regarding real GDP growth and inflation, as well as external variables including the Bangladesh taka/U.S. dollar exchange rate and the current account balance.

- ***Inflation channel*** (X_t^π): The block incorporates data regarding a variety of producer, consumer, and wage price inflation indices.

- ***Economic activity channel*** (X_t^y): The block incorporates coincidental indicators of economic activity, including employment and production.

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[6] The choice of variables was limited primarily by data availability. The data used are listed in Appendix C.

- ***Liquidity channel*** (X_t^m): The block includes a number of narrow and broad money stock variables to reflect shifts in liquidity. In a bank-based economy like Bangladesh, changes in the pace of broad money growth implicitly convey the degree of risk-taking in the economy, by approximating changes in the size of the aggregate balance sheet of the banking sector.

- ***Credit channel*** (X_t^c): The block incorporates data relevant for an empirical analysis of the credit channel of monetary transmission, including credit to non-bank private and financial sectors from deposit money banks. The credit channel captures the change in the supply of aggregate bank credit to the economy.

- ***Financial and asset price channel*** (X_t^f): The final block of panel data is motivated by the financial market channel of monetary policy transmission. If an easing in monetary conditions is reflected in various financial market instruments, changes in the external finance premium (the balance sheet channel) will affect the terms on which bank customers have access to loans (the bank lending channel) and raise private investment through higher Tobin's q.

The matrix m_t in equation (4) represents the monetary policy instrument, which in this case is reserve money. The effect of each channel on the economy is measured by $\Lambda_{k,i}$, which denotes the common factor restriction of the k-th factor on the i-th variable, and summarizes the contemporaneous relationships amongst the different variables.

Finally, inference concerning the properties of the model cannot be undertaken unless a behavioral system is identified. The identification scheme is based on the information available to policymakers, with the implicit assumption that the central bank can respond to the state of the economy. This assumption has been used widely in low-income country applications.[7] The expectations block (X_t^e) is ranked first given that expectations will have been based on economic data from the previous month or quarter, at best. Only the financial sector (X_t^f) is allowed to have a contemporaneous relationship with the monetary policy instrument. This specification is consistent with the idea that financial markets are forward-looking and less sticky than standard macroeconomic time-series.[8]

In some cases, the number of variables $(X_{i,t})$ in each sub-category is small and, therefore, standard asymptotic properties may no longer hold, since latent factors give consistent estimates only for T_i and X_i both limiting to $\to \infty$. The dynamic factors (F_t^i) in observation equation (1) are, therefore, extracted using the two-step Kalman filter approach in Doz,

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[7] See Mishra and Montiel (2012).
[8] Preventing the monetary policy variable from reacting contemporaneously to financial market developments helps prevent indeterminacy. See Sims, Leeper and Zha (1996).

Giannone and Reichlin (2011), which allows for more consistent factor estimates in the case of small n. Finally, the dynamics of the observation equation (4) is specified via a transition equation of the following form:

$$F_t^i = \sum_{i=1}^{p} \beta_i F_{t-i}^i + v_t \qquad (5)$$

where β_i are coefficients for each structural factor i. The model is estimated using monthly data running from 2002:11 to 2013:11. Data, which are converted to be stationary and standardized, enter the system contemporaneously (see Appendix B and C for a description of the priors used to estimate the model via Gibbs sampling and for data definitions).

IV. THE EFFECTS OF MONETARY POLICY ON THE MACROECONOMY

Before proceeding to the main results, the aggregate responses from each channel is illustrated (Figure 2). Conventional liquidity effects predict that an unanticipated expansionary monetary policy shock causes a transient but persistent decrease in real and nominal interest rates, raising output and employment.

Figure 2: Aggregate response of factors to a monetary policy innovation
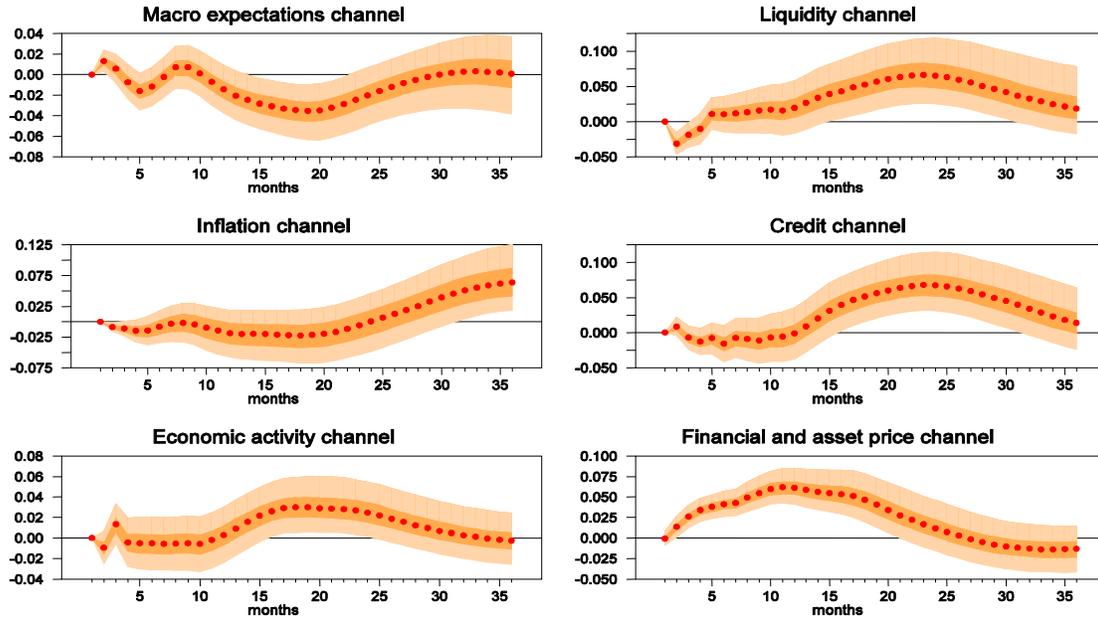
Source: Author calculations

The estimates show that, while there are significant lags, a monetary impulse has broad economic effects on the real and financial sectors. The financial market factor reacts

contemporaneously, while peak impact on economic activity occurs after 15 months, with inflation dynamics cresting a little afterwards.

Monetary policy and the credit and liquidity channels

In response to a monetary policy shock, the purchase of securities, demand for other non-private sector components of credit and use of cross-bank lending increase in the first six months (Figure 3). After this period, the transmission of a monetary impulse begins to diffuse from the money market, while private sector credit growth starts to rise. In total, a one percentage point increase in reserve money leads to an increase in private sector credit by 0.25-to-0.3 percentage points (over a 20-month period).

Why might financial intermediaries respond over the short-to-medium term to increased liquidity by purchasing securities rather than expanding private sector credit? First, the lagged effect of monetary policy on credit is reflective of the idea that private sector loans are quasi-contractual commitments whose stock is difficult to change quickly, while also containing a countercyclical component arising from the desire of agents and firms to smooth the impact of cyclical variation in income. Second, short-term securities and loans may be close substitutes if bank lending is not 'special' in the usual sense, with returns on private sector credit and market securities being similar.[9] The strength of this arbitrage usually depends on the degree of competition between banks.

With money being the counterpart to bank lending, expansionary monetary policy also leads to a rise in bank liabilities, namely in the form of demand deposits (Figure 4).[10] Finally, moving in tandem with the credit growth response, the gradual increase in broad monetary aggregates (M2 and M3) to a monetary policy shock suggest they approximate changes in liquidity, and therefore provide useful signals of changes in the size of the aggregate balance sheet of the banking sector. This implies broad money growth implicitly conveys the degree of risk-taking in the economy and information on the vulnerability of the financial system to a reversal of funds.

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[9] See Diamond and Rajan (2011).
[10] See Mishkin (1996).

Figure 3: Response of credit to a monetary policy innovation

Deposit Money Banks Credit: Private sector

Deposit Money Banks Credit: To Banks

Deposit Money Banks Credit: Advances

Deposit Money Banks Credit: Claims on Other Sectors

Deposit Money Banks Credit: Assets Purchased

Deposit Money Banks Credit: Domestic Claims
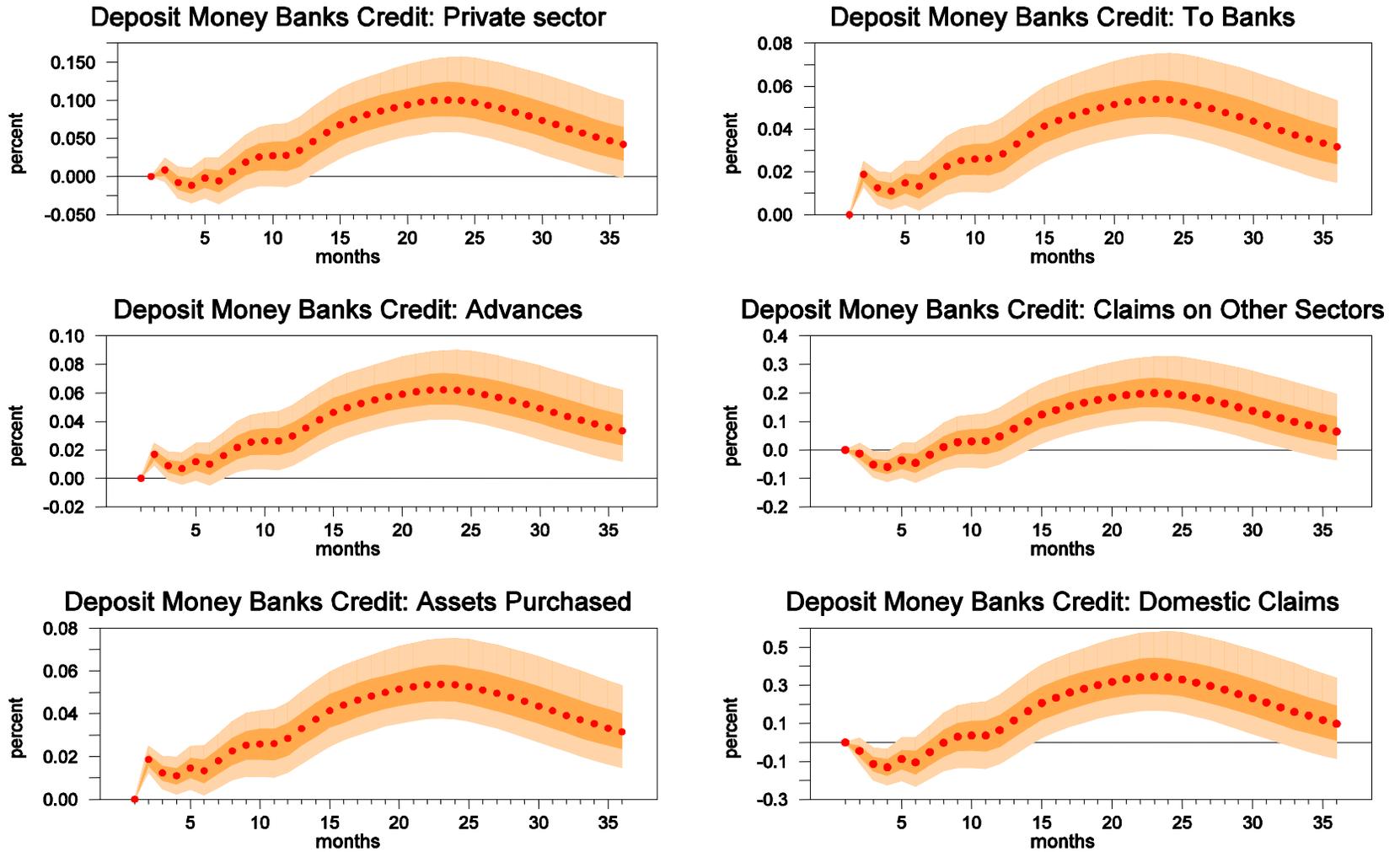
Source: Author calculations

Figure 4: Response of narrow, broad monetary aggregates and bank liabilities to a monetary policy innovation
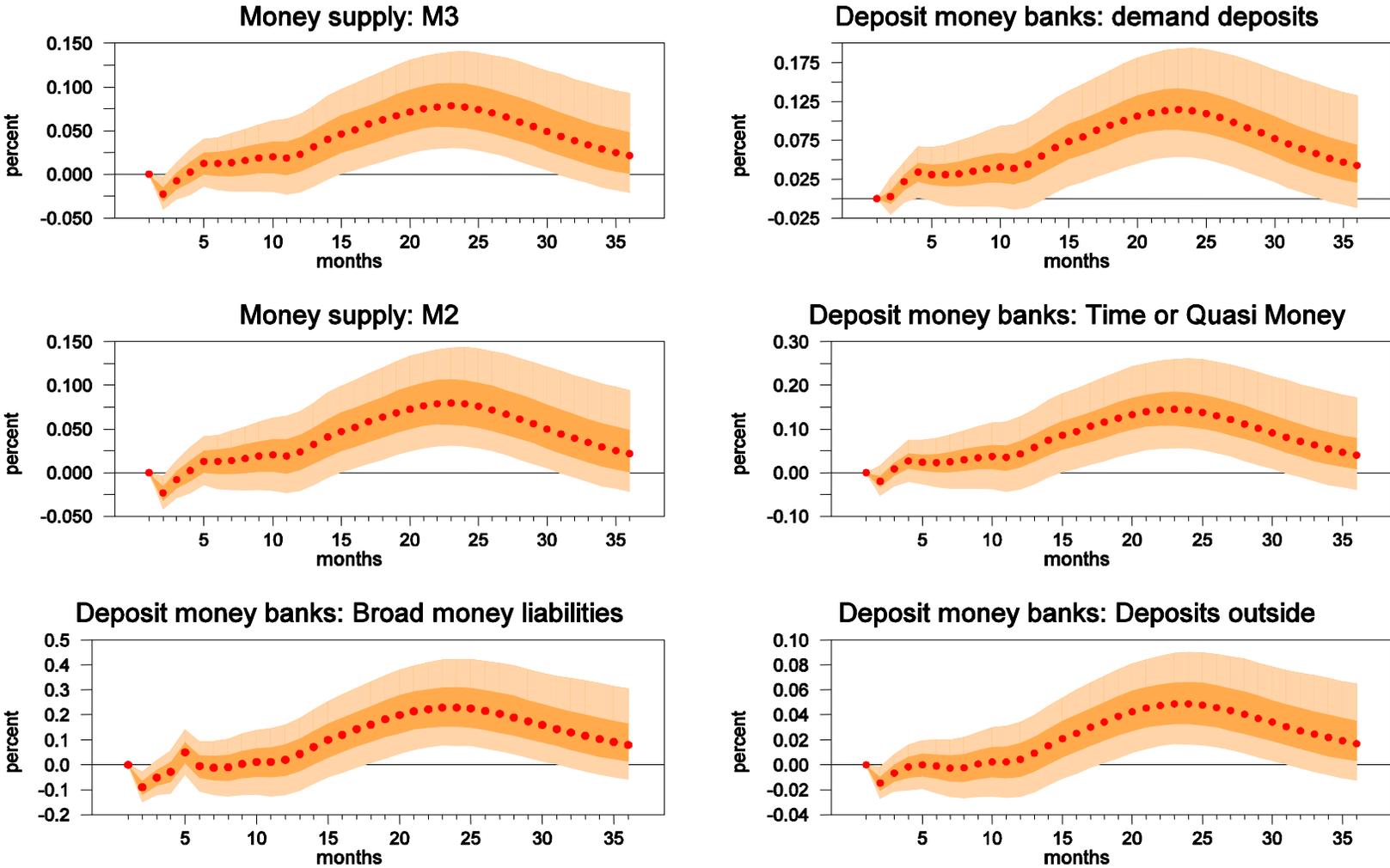
Source: Author calculations

Changes in the pace of broad money growth may also signal a build-up in financial vulnerabilities. The ratio of total credit-to-broad money would provide a useful signal on the stage of the financial cycle, with an increase in the level implying a greater dependence on non-core bank liabilities to finance credit expansion.[11]

BOX 1: FINANCIAL MARKET DEVELOPMENT IN BANGLADESH

One of the main constraints of monetary policy transmission is underdeveloped domestic financial markets. In Bangladesh, the primary suppliers of credit to firms and households are domestic banks. While the banking sector has expanded significantly over the past decade, domestic financial markets remain shallow and constrained by structural impediments. Measured by the ratio of broad money to GDP, domestic money markets are shallower and less liquid compared with emerging market economies. Secondary markets for government debt instruments and commercial paper is nascent, and equity markets are shallow. Additionally, much of the population (mainly rural) relies on informal forms of credit and financial services, which monetary policy does not directly influence.

Table 1: Financial development indicators in Bangladesh

Private sector credit (% of GDP)	Credit to private sector provided by banks (%)	Bank deposits (% of GDP)	Broad money (% of GDP)	Market capitalization of listed companies (% of GDP)	Stocks traded: Total Value (% of GDP)	Private bond market (% of GDP)	Deposit accounts per 1000 Adults
49.7	99.2	45.6	69.7	15.2	10.8	0.0	513

Note: Based on 2012 World Bank data.

The underdeveloped state of domestic financial markets in Bangladesh has a bearing not only on interest rate and credit pass-through, but also all other channels of monetary policy transmission.

Financial, interest rate and asset price channel

The effects of a monetary impulse on the financial sector, illustrated in Figure 5, work with shorter lags compared with the real sector, which is consistent with the idea that asset prices are less sticky than conventional macroeconomic indicators. The results show that interest rates in Bangladesh convey information about liquidity conditions and signal changes in the monetary policy stance, while also altering the shape of banks' intermediation cost curve. In response to easier monetary conditions, the average call money market rate declines, while

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[11] See Borio and Lowe (2008).

there is also a compression in the net interest margin and the Ted spread (money market rate minus the one-year treasury bill rate) - both measures of perceived credit risk. It implies that the cost of credit becomes more (less) expensive in times of low (high) liquidity and, together with the credit and liquidity responses in Figures 3 and 4, that the bank lending channel works through both price and quantity channels. Here, the risk-taking channel may help foretell the sequence of events; it predicts that monetary policy can alter the supply of credit from financial intermediaries by shifting banks' perception or tolerance of risk.[12] Declining money market and Treasury bill rates is consistent with lower (short-term) funding costs for banks. Lower funding costs are passed on to lenders, as reflected in the compression in the net interest margin. Although, the modest rise in private credit growth shown in Figure 3 suggests that changes in banks' costs of funds may be reflected more in bank profit margins and less in banks' supply of lending.

Variations in interest rates would also affect discount factors applied to future income streams from equities. First, lower (real) interest rates make equities more attractive. Looser monetary policy lowers the risk-free (real) interest rate (one-year rate), increasing the present discounted value of dividends and lowering the equity premium, which helps push up equity prices.[13] In all, the dynamic responses of interest rates and equity prices imply that a one percent increase in reserve money yields a one year stock price multiplier of between 2.5 and 4.0.[14] Second, the compression in the Ted spread and the equity premium (the extra return that investors demand to hold stocks) is evidence of price-based market risk indicators being procyclical and declining risk aversion, which would help explain the rise in capital raised by firms listed on the Dhaka and Chittagong stock indexes during the sample period. The findings imply that the impact of a loosening in monetary policy on stock prices works through its effects on the equity risk premium rather than dividends. Reduced risk premia via looser monetary policy (the risk-taking channel) increases the probability of asset price bubbles by altering the willingness of market participants to take on risk exposures, and thereby influence financial conditions (see Box 2). Finally, the procyclical nature of spreads suggests caution in using price-based measures as early warning indicators of financial distress.[15]

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[12] The risk taking channel is distinct from credit channels of monetary policy transmission, such as the bank lending channel, which ties credit supply to banks' reserve holdings.

[13] The change in nominal stock returns is an implicit rejection of the efficient market hypothesis.

[14] A ten percent rise in reserve money leads, on average, to a decline in the riskless (Treasury) interest rate by around 0.8 percentage points and a positive movement of stock prices of around two percent.

[15] Also see Gali (2014).

Figure 5: Response of financial sector to a monetary policy innovation
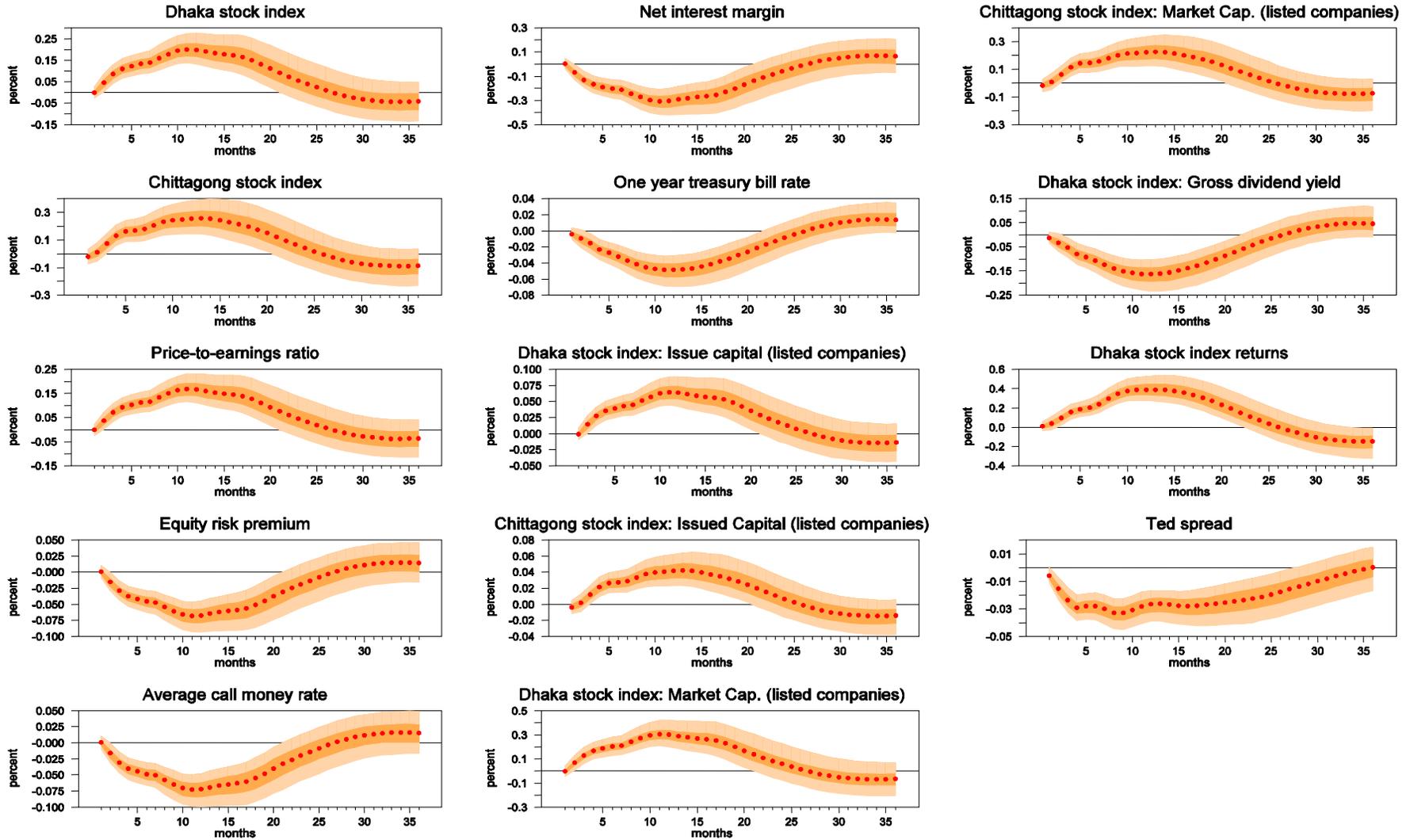
Source: Author calculations

BOX 2: MONETARY POLICY AND STOCK MARKET BUBBLES IN BANGLADESH

Following the global financial crisis, the view that policymakers should pay close attention and eventually respond to developments in asset markets has generated a renewed interest in the link between monetary policy and asset price bubbles. This link is explored by calibrating a structural equation linking excess equity returns to monetary policy under risk neutrality set out in Gali (2014). The stock price (Q) is decomposed into fundamental (Q^f) and bubble (Q^b) components: $Q = Q^f + Q^b$. In a risk-free environment, the fundamental component (q^f) is defined as the present discounted value of future dividends

$$q^f = const + \sum_{j=0}^{\infty} \Theta^j[(1 - \Theta)E_t\{d_{t+k}\} - E_t\{r_{t+k}\}] \tag{6}$$

In response to a monetary impulse, the fundamental stock price can be traced out using

$$\frac{\partial q_{t+k}^f}{\partial \varepsilon_t^m} = \sum_{j=0}^{\infty} \Theta^j(1 - \Theta)\frac{\partial d_{t+k+j+1}^f}{\partial \varepsilon_t^m} - \frac{\partial r_{t+k+j}}{\partial \varepsilon_t^m} \tag{7}$$

where $\Theta = d/r < 1$ and d_t is the gross dividend yield and r_t is the riskless real rate. Theoretically, the model assumes

$$\frac{\partial r_{t+k+j}}{\partial \varepsilon_t^m} < 0 \quad \text{and} \quad \frac{\partial d_{t+k+j+1}^f}{\partial \varepsilon_t^m} \le 0 \tag{8}$$

Figure 6: Response of equity price and fundamental equity price

Stock price and fundamental component
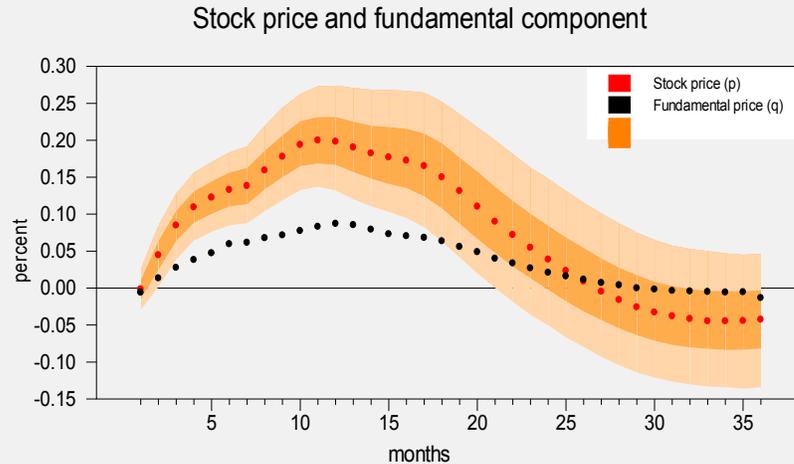
Source: Author calculations

The bubble component can be backed out via the gap between the empirical stock price response and the fundamental stock price from the theoretical model. In response to a loosening in monetary conditions, the response of the gap is positive and, after two periods, increasing, which points to the existence of a non-negligible bubble component. The result implies that movements in excess returns associated with monetary policy easing reflect excess sensitivity or overreaction of stock prices to policy actions. Financial markets in Bangladesh are shallow and, as a result, suffer from weak price discovery. Under these conditions, changes in monetary policy may have unintended spillovers in terms of financial stability, which could be undermined if policy focuses narrowly on conventional output and inflation outcomes.

To isolate the change in risk-taking resulting from a monetary policy shock a Sharpe ratio is calculated to determine risk-adjusted equity returns. This scenario assumes the perspective of a Bayesian investor, who trades contingent on a monetary policy shock. If μ_k and σ_k are the Bayesian posterior mean and standard deviation for excess equity returns derived from the MCMC draws, then the Sharpe ratio can be defined as μ_k/σ_k; the greater the value of the Sharpe ratio, the more attractive the risk-adjusted return on equities.[16] Estimates of the Sharpe ratio are between 0.2 and 3.3. The potentially high value of the Sharpe ratio implies that the risk-adjusted returns to a monetary policy shock on a portfolio comprising high risk investments is likely to yield significant returns. The possible generation of these higher returns and the compression in risk premia could act to encourage investors to raise their leverage in response to a loosening in monetary conditions.
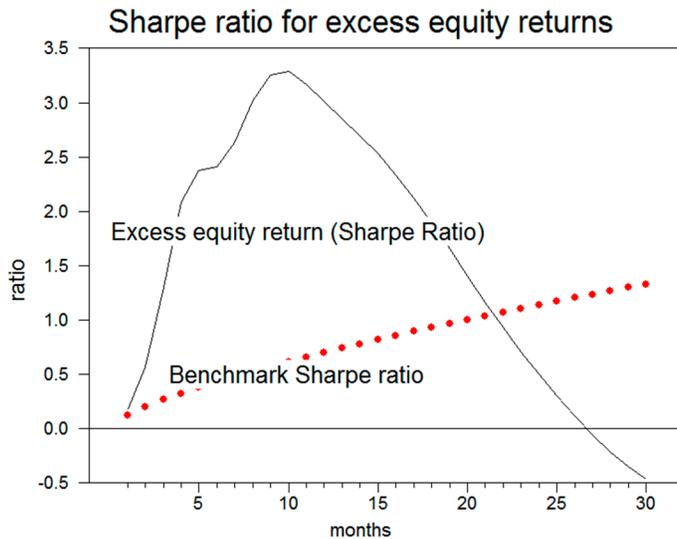
Sharpe ratio for excess equity returns

Excess equity return (Sharpe Ratio)

Benchmark Sharpe ratio

Notwithstanding financial stability issues, the results imply that easier monetary policy in Bangladesh not only results in capital gains, but also reduces the effective degree of financial risk agents may face. These linkages open up the possibility of new channels in which monetary policy may affect real activity, for example, by affecting the level of precautionary saving: (*i*) higher equity prices pushes down the external finance premium and entails a positive balance sheet effect for publicly listed firms; (*ii*) as stocks are claims to real assets, a rising price-to-earnings ratio, as shown in Figure 5, hints at an improved economic outlook.

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[16] The Sharpe ratio calculates the return from investing in equity and its uncertain returns versus the riskless rate. A portfolio engaging in zero risk investment, such as the purchase of Treasury bills (for which the expected return is the risk-free rate), has a Sharpe ratio of zero. To benchmark the findings of excess equity returns to a monetary policy shock a Sharpe ratio of approximately 0.5 over an investment horizon of one year is assumed. This amounts to a benchmark Sharpe ratio (red line) of $0.5\,(k/12)^{0.5}$ for an investment horizon of k months.

BOX 3: MONETARY POLICY AND FINANCIAL RISK APPETITE

Monetary policy appears to alter the willingness of agents' to bear financial risk. This is investigated by illustrating the impact of monetary policy shocks on financial risk appetite, as measured by the equity risk premium, by plotting the forecast error at the 12 month horizon over the last few years.[17]

In the absence of any new shocks, the baseline predicts a moderate rise in the equity risk premia from early 2010 to August 2011. During this period, equity risk premia rose more than predicted (black line). The figure also illustrates the portion of the forecast error at any date attributable to the cumulative shocks in monetary policy between January 2010 and December 2013 (red line). The estimates show that monetary policy shocks can account for much of the gap between predicted and actual risk premia variation over the last couple of years, suggesting a role for monetary policy in equity price valuations and risk premia.

Monetary policy, economic activity and prices

How do patterns of portfolio adjustment to a monetary impulse relate to economic activity? It is worth noting that the informal sector is estimated to equivalent to 80-90 percent of total GDP, making it difficult to clearly decipher the effects of policy on activity and employment (Figure 7). An expansionary monetary impulse leads to a small rise in economic activity, as measured by industrial production and formal sector employment, implying the pass-through of monetary policy to economic activity through the credit and financial channels is weak. This finding is not unusual in countries with low levels of financial development (see Box 1), which weaken the transmission of policy shocks via the external finance premium and more general wealth effects (the balance sheet channel). Additionally, contrasting with the idea that small firms, which face more binding credit constraints, are more likely to benefit from an easing, monetary policy has a more pronounced impact on larger firms than smaller ones.[18] Finally, the effects on real activity are with an 18-month lag, which is similar to

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[17] Define the covariance matrix as $\widehat{\Omega} = \hat{P}\hat{P}'$. The h-step-ahead forecast error can then be written $y_{t+h} - \hat{y}_{t+h|t-1} = \hat{\varepsilon}_{t+h} + \hat{\vartheta}_1 \hat{\varepsilon}_{t+h-1} + \cdots + \hat{\vartheta}_h \hat{\varepsilon}_t$. Define the orthogonalized residuals by $\hat{v}_t = \hat{P}^{-1}\hat{\varepsilon}_t$, then the contribution of the forecast error is calculated as $\sum_{k=0}^{h} \hat{\vartheta}_k \hat{P}_1 v_{t+h-k}$, and what y_{t+h} would have been in the absence of the monetary policy shocks is calculated as $y_{t+h} - \sum_{k=0}^{h} \hat{\vartheta}_k \hat{P}_1 v_{t+h-k}$.

[18] See Gertler and Gilchrist (1994).

earlier observations on bank liquidity and private sector credit, suggesting that money/credit aggregates contain useful coincidental information on the economy.

The effects of domestic monetary policy on inflation are even less easy to decipher. A one percentage point increase in reserve money leads to an increase in the headline and core CPI by around 0.7 and 0.5 percentage points, respectively, but with long lags (Figure 8). It could reflect the concentration of administered prices in the CPI basket, which limit pass-though and dilute shocks along the distribution chain (Figure 9). Second, the standard deviation in the responses across price indices demonstrates considerably heterogeneity. This implies that monetary policy can alter relative prices.

V. POLICY DISCUSSION AND SUMMARY

This paper examines the transmission of monetary policy in Bangladesh. A number of conclusions emerge from the findings:

- Monetary policy influences perceived credit risk, which would imply that a monetary easing (tightening) during an economic downturn (upturn) - i.e., precisely when the number of balance-sheet/liquidity constrained agents are on the rise (decline) - could help alleviate (tighten) credit and financial market frictions by lowering banks' intermediation costs. However, the overall impact on economic activity and inflation is limited, implying the economic stabilization properties of these channels are not guaranteed.

- The findings imply that monetary policy could help curb a major overvaluation in equity prices; tighter monetary policy pushes up discount rates and risk premiums and reduces the risk investors are willing to bear while, at the same time, lowering future dividends measured in present value terms and, therefore, broad stock values. Taken together, financial stability could be undermined if counter-cyclical monetary policy focuses *solely* on conventional output and inflation objectives without taking into account the stage of the financial cycle; compared with the traditional business cycle financial cycles operate at a lower frequency.[19]

- The long lags in the effects of monetary policy on real economic activity, inflation, and credit growth implies policy should place a significant weight on forward–looking information and respond to current or expected shocks, instead of only responding to current inflationary effects of past shocks. Responding to past events could contribute to economic volatility.

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[19] See Borio and Zhou (2008).

Figure 7: Response of economic activity to a monetary policy innovation

Chittagong port cargo (imports)

Industrial production (medium and large firms)

Industrial production (small firms)

Average employment growth across sectors

Cement production
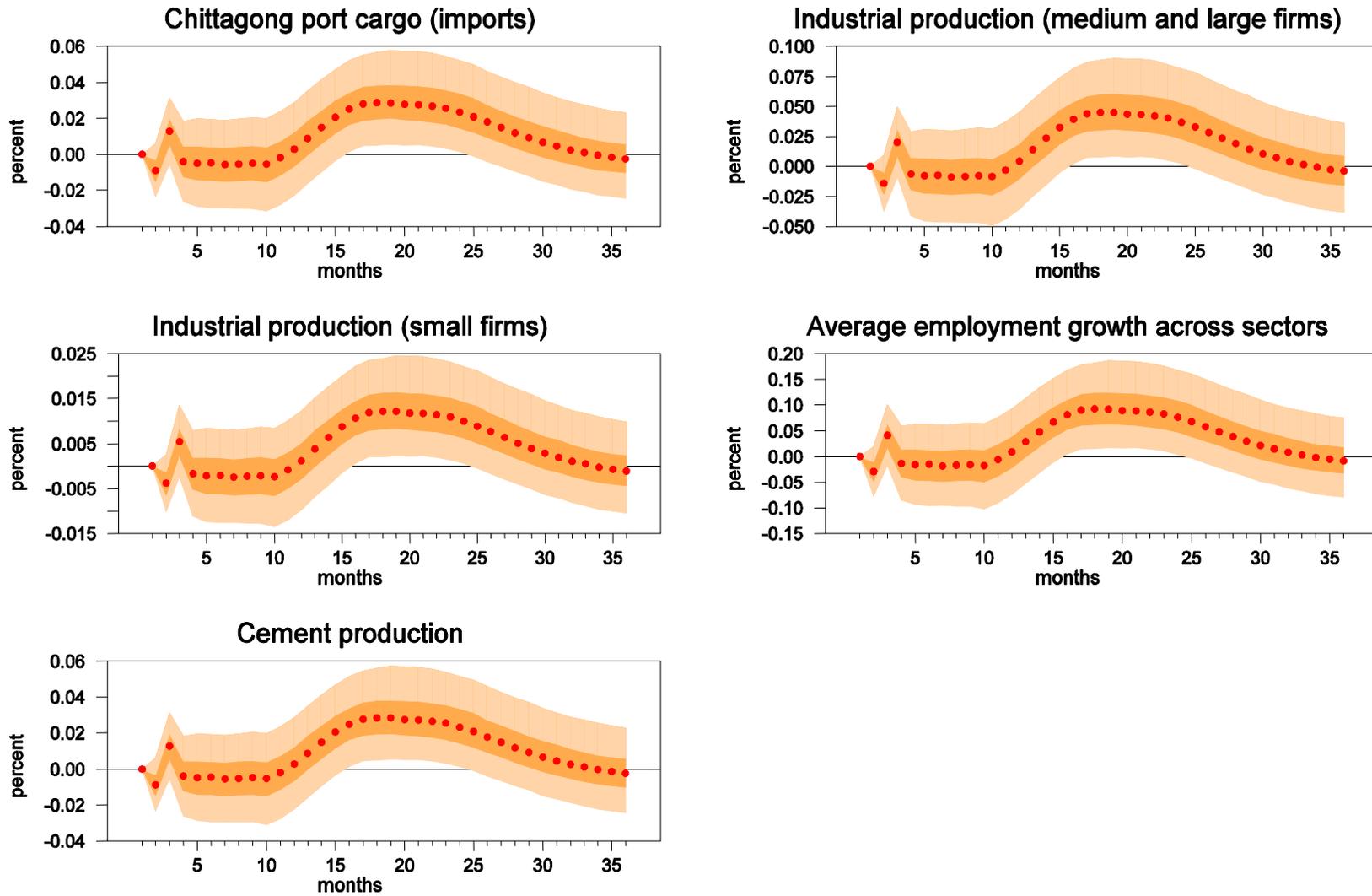
Source: Author calculations

Figure 8: Response of headline and core inflation to a monetary policy innovation

Headline inflation (CPI)

Intermediate goods inflation

Core inflation (CPI)

Capital goods inflation

Producer price inflation

Intermediate capital goods inflation

Manufacturing inflation

Rental price index inflation
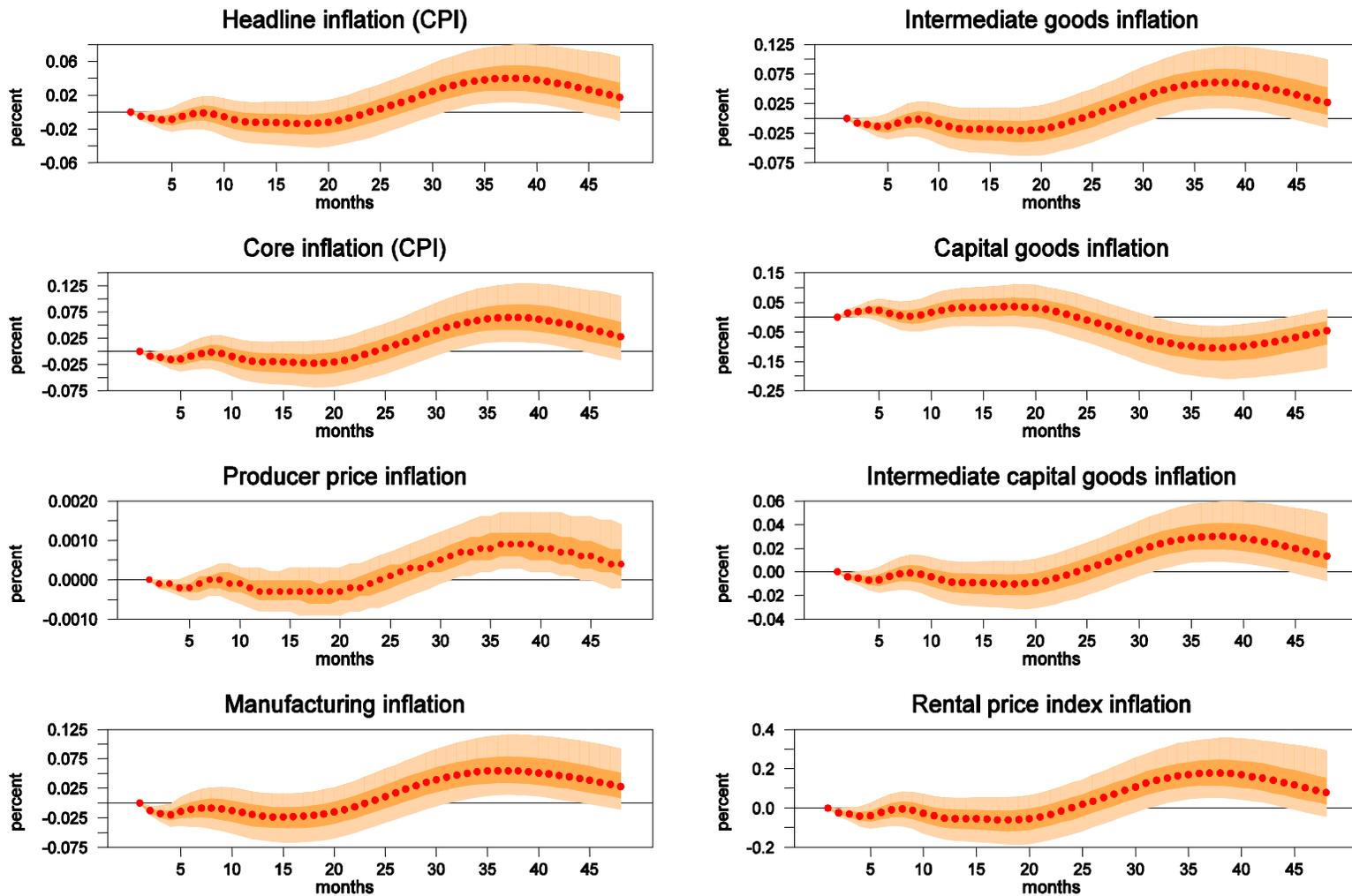
Source: Author calculations

Figure 9: Response of disaggregated CPI and PPI price level to a monetary policy innovation

Components in inflation block (X_t)

Dispersion in price indices

- Headline CPI inflation
- Average inflation
- Core CPI inflation
- Capital goods inflation
- Manufacturing inflation
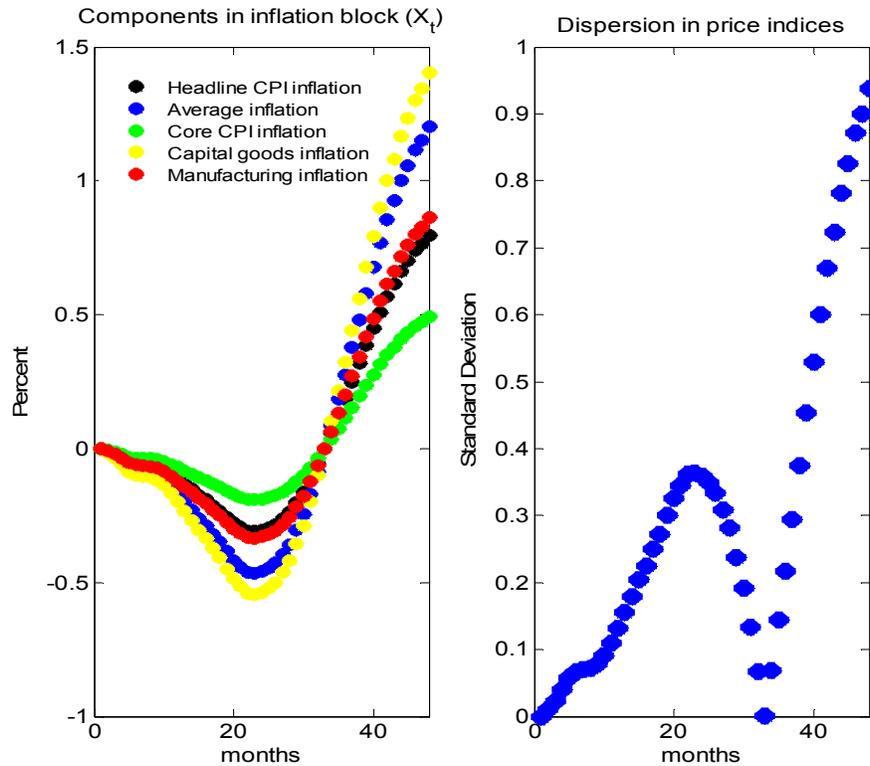
Source: Author calculations

The results are consistent with a multitude of studies on LICs with small and fragile financial sectors.[20] The limited effectiveness of the transmission channels implies monetary policy on its own may be insufficient to completely mitigate the adverse economic effects of destabilizing shocks, but could be used to complement and augment other stabilization policies. Strengthening banks' balance sheets coupled with financial reform will help strengthen monetary transmission channels. In particular:

Bangladesh: Banks' Nonperforming Loans (NPL), Dec. 2007 – Sep. 2014
(In percent of total loans)

- All banks
- SOCBs
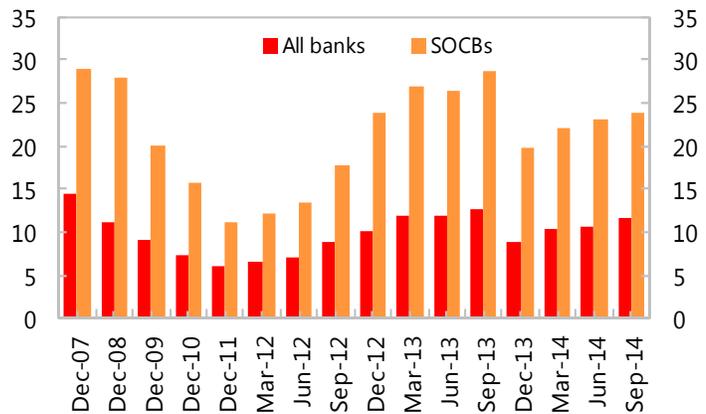
Sources: Bangladesh Bank; and IMF staff estimates.

- Nonperforming loans are

[20] Mishra and Montiel (2012).

high. Banks with weak balance sheets may react to an expansive monetary policy stance by shoring up and hoarding liquidity rather than extending credit at lower rates. Cleaning up non-performing loans in the banking sector would strengthen transmission mechanisms, especially the bank lending channel.

- Strengthening of regulations and oversight to prevent financial institutions from excessive risk-taking is also important. The non-negligible predictive content in broad money aggregate(s) should be utilized as a macroprudential monitoring tool to track potential vulnerabilities in the financial system since they represent a liability measure of the banking sector. Procyclical money growth would reflect incremental bank lending that may reverse abruptly when the cycle turns and financial conditions deteriorate.[21] With bank lending dominant in Bangladesh, liquidity is closely tied to the degree to which the central bank drains excess deposits from the banking system. The perspective in this paper implies that monetary policy and policies toward financial stability are closely related.

- The dominance of banks as the main suppliers of credit implies a bank credit crunch, relative to other forms of credit, would significantly increase the cost of using external finance (that is, funding outside the firm). Policies should, therefore, aim to diversify sources of financing for firms through the development of domestic debt markets in the form of conventional corporate and sovereign as well as Islamic bond issuance, which may help accelerate policy reforms, while increasing the sensitivity of the economy to market interest rate changes. Additionally, improving access to financial services, including credit, will help increase the responsiveness of economic activity to changes in monetary policy.

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[21] The macroprudential role of monetary aggregates relates to the predictive behavioral and stability properties of such aggregates rather than their direct effects on output and inflation (see Shin, 2011). When excessive asset growth is fuelled by loose domestic financial conditions administrative tools on bank lending may include: caps on loan-to-value (LTV) ratios; limits on debt service-to-income (DTI) ratios, which serve to anchor loan growth to the wage level.

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APPENDIX A: STATE SPACE MODEL FOR MONETARY POLICY RULE ESTIMATES

The model allows for forecast errors in the predicting of the reduced form coefficients and the heteroskedastic random disturbance. In the time-varying coefficient equation

$$y_t = X_{t-1}\beta_t + \varepsilon_t \tag{A.1}$$

the one-step ahead prediction errors are expressed as

$$y_{t|t-1} = X_{t-1}\beta_{t|t-1} \tag{A.2}$$

This implies that the forecast errors have two components equaling

$$X_{t-1}(\beta_t - \beta_{t|t-1}) + \varepsilon_t \tag{A.3}$$

Assuming the variance is expressed as

$$(\beta_t - \beta_{t|t-1}) \equiv R_t \quad var(\varepsilon_t) = \sigma_\varepsilon^2 \tag{A.4}$$

then the one-step-ahead forecast error variance is

$$H_t \equiv H_{1t} + H_{2t} = X_{t-1}R_{t|t-1}X'_{t-1} + \sigma_t^2 \tag{A.5}$$

The first component, H_{1t}, is the variance due to time-varying parameters. The second (H_{2t}) is the variance of the random disturbance term (ε_t). Inferences regarding the relative sizes of the two sources of forecast error variance play a role in updating the coefficient values. Using Kalman filtering equations, it can be shown that the forecast $y_{t+1|t}$ can be written as

$$y_{t+1|t} = X_t\beta_{t|t-1} + z_t\tau_{t|t-1} \tag{A.6}$$

where X_t are the explanatory variables, $\tau_{t|t-1}$ is last period's forecast error, thus, representing new information available, and z_t is proportional to

$$\frac{H_{1t}}{H_{1t}+H_{2t}}$$

If H_{2t} is large relative to H_{1t} observers would attribute less of a forecast error to a change in coefficients. A large of H_{2t} would imply that last period's forecast error will play a relatively small role in determining next period's forecast.

APPENDIX B: DYNAMIC FACTOR MODEL ESTIMATION BASED ON GIBBS SAMPLING

To account for uncertainty in the reduced-form parameters the model is estimated using Markov Chain Monte Carlo (MCMC) methods based on the Gibbs sampling. Collecting the reduced form coefficients into a $(N \times (N \times 7 + 1))$ vector, θ, and stacking the data such that $X_t = I_n \otimes [1, y'_{t-1}, \dots, y'_{t-p}]$, following Uhlig (2005) the conditional posterior distribution of the VAR coefficients is given by

$$p(\theta/R) \sim N(\bar{\theta}, R \otimes \bar{V}^{-1}) \tag{B.1}$$

where

$$\bar{\theta} = (N_0 + X'_t X_t)^{-1}(N_0 \theta_0 + X'_t X_t \hat{\theta}) \tag{B.2}$$

$$\bar{V} = N_0 + X'_t X_t \tag{B.3}$$

As in Sims and Zha (1998) θ_0 and N_0 denote the prior mean and variance of the reduced form coefficients. In order to reflect the uncertainty surrounding the choice of starting values, a large prior covariance of the states the hyperparameters are set:

- $\mu_0 = .1$,

- $\mu_1 = 0.5$

- $\mu_2 = \mu_3 = \mu_4 = 1$

- The diagonal elements of N_0 are given by $\frac{\mu_0 \mu_1}{\sigma_j p^{\mu_3}}$, where p denotes the lag length and σ_j is the variance of the residuals from an AR(6) regression on the jth endogenous variable in the VAR.

A stationarity condition is also imposed such that unstable draws of the reduced form VAR coefficients are rejected

$$p(\theta_t | \theta_{t-1}, Q) = I(\theta_t) f(\theta_t | \theta_{t-1}, Q) \tag{B.4}$$

where $f(\theta_t | \theta_{t-1}, Q)$ characterises the conditional density for the VAR coefficients θ_t, $t = 1, \dots, T$. Unstable draws of the reduced form VAR coefficients are rejected according to whether they satisfy the indicator function $I(\theta_t)$, which takes a value of zero when the roots of the associated VAR polynomial are inside the unit circle, and it is equal to one otherwise. The Gibbs sampler is used to approximate the posterior distribution in the model based on 50,000 replications and 10,000 for inference.

APPENDIX C: DATA DEFINITIONS

Macro expectations block

Inflation expectations (one year horizon)	Consensus forecast
Real GDP growth expectations (one year horizon)	Consensus forecast
Current account balance(one year horizon)	Consensus forecast
Taka/USD expectations (one year horizon)	Consensus forecast
Taka/USD expectations (two year horizon)	Consensus forecast

Inflation block

Consumer price index (CPI)	CEIC
CPI: Core inflation	CEIC
CPI: Clothing and footwear	CEIC
CPI: Gross rent, fuel and lighting	CEIC
CPI: Furnishing household equipment and operation	CEIC
CPI: Medical care and health expenses	CEIC
CPI: Transport and communications	CEIC
CPI: Recreation, entertainment and cultural services	CEIC
CPI: Miscellaneous goods and services	CEIC
Average Retail Prices: Bamboo	CEIC
Average Retail Prices: Timber: Mango: Plank	CEIC
Average Retail Prices: Timber: Garjan: Plank	CEIC
Average Retail Prices: Sand	CEIC
Average Retail Prices: Cement: Local	CEIC
Average Retail Prices: Bricks	CEIC
Average Retail Prices: Paints	CEIC
Average Retail Prices: Iron rods	CEIC
Average Retail Prices: Kerosene	CEIC
Average Retail Prices: Rubber Goods	CEIC
Average Retail Prices: Paper	CEIC
Average Retail Prices: Clothing & Footwear: Long cloth	CEIC
Property Rental Index: Residential House	CEIC
Wage Rate Index	CEIC
Producer Price index (PPI)	CEIC
PPI: Manufacturing	CEIC
PPI: Mfg: Consumer Goods	CEIC
PPI: Mfg: Capital Goods	CEIC
PPI: Mfg: Capital Goods: Machinery Excl Electric & Transport	CEIC
PPI: Mfg: Capital Goods: Machinery Electric	CEIC
PPI: Mfg: Capital Goods: Other Capital Goods	CEIC
PPI: Mfg: Intermediate Goods: Intermediate Consumer Goods	CEIC
PPI: Mfg: Intermediate Goods	CEIC
PPI: Mfg: Capital Goods: Transport Equipment	CEIC
PPI: Mfg: Intermediate Goods: Intermediate Capital Goods	CEIC

Economic activity block

Chittagong port cargo index: Imports	CEIC
Industrial production (small scale producers)	CEIC
Cement production	CEIC
Industrial production (medium and large scale producers)	CEIC
Average employment growth across sectors	CEIC

Liquidity block

Money supply: M1	CEIC
Money supply: M2	CEIC
Money supply: M3	CEIC
Deposits: Demand	CEIC
Deposits: Time or Quasi Money	CEIC
DMB deposits: Other Deposits	CEIC
DMB deposits: Currency outside depository corporation	CEIC
DMB deposits: Deposits excluded from broad money	CEIC
Depository Corporations Survey: Broad Money Liabilities	CEIC
NCBs: Deposits	CEIC

Credit block

Deposit Money Banks Credit: Advances	CEIC
Deposit Money Banks Credit: Bills purchased	CEIC
Deposit Money Banks Credit: To banks	CEIC
Deposit Money Banks Credit: Private sector	CEIC
Deposit Money Banks Credit: Claims on other sectors	CEIC
Deposit Money Banks Credit: Domestic Claims	CEIC

Financial and asset price block

Nominal taka/USD exchange rate	CEIC
Nominal effective exchange rate	CEIC
Equity risk premium (earnings yield minus treasury bill rate)	-
Dhaka stock index share price	CEIC
Average call money rate	CEIC
Deposit rate of commercial banks	CEIC
Lending rate of commercial banks	CEIC
One year treasury bill rate	CEIC
Net interest margin (deposit minus lending rate)	-
Ted spread (call money rate minus Treasury bill rate)	-
Dhaka stock market capitalization: Companies shares	CEIC
Dhaka stock market capitalization: Mutual funds	CEIC
Dhaka stock market capitalization: Listed companies	CEIC
Dhaka stock market issued capital: Turnover value	CEIC
Chittagong stock index	CEIC
Chittagong stock market: Market capitalization	CEIC
Chittagong stock market: Issued capital	CEIC
Chittagong stock market: Trade total	CEIC
Chittagong stock market: Turnover value	CEIC
Chittagong stock market value: Shares and debentures	CEIC
Gross dividend yield (Dhaka stock index)	CEIC
Price to earnings ratio (Dhaka stock index)	CEIC
Dhaka stock return index	-