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Abstract

This paper examines the relationship between inflation expectations and monetary policy in Thailand. The forward-looking Taylor rule is applied to measure monetary policy actions. Inflation expectations extracted from the yield curves are used. Our results provide two key findings. First, we find econometric evidence that inflation expectations react to monetary policy actions. A tighter monetary policy can curb expected inflation not only for short-term expectations but also for long-term expectations. These results are valid for both the reduced-form single-equation and the structural-form system-of-equations estimation. Second, the monetary policy stance as measured by the residuals from the forward-looking Taylor rule is able to capture the relationship between monetary policy and inflation expectations better than the outcome-based policy rule. These results may explain the weak evidence in previous studies of the relationship between inflation expectation and monetary policy.

Keywords: monetary policy in Thailand; inflation expectations; yield curve; Taylor rule

JEL classifications: C36, E43, E52, E58

Highlights:

- We study the role of monetary policy on inflation expectations in Thailand.
- Forward-looking Taylor rule links monetary policy and inflation expectation well.
- Outcome-based rule links monetary policy and inflation expectation less well.
- A tighter monetary policy curbs short- as well as long-term inflation expectations.

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1. Introduction

Inflation expectations, or public perceptions regarding the future rate of inflation, are a key component in the conduct of monetary policy. In theory, well-anchored inflation expectations can cause less persistent inflation deviation from its long-run target (Macallan & Taylor, 2011). In addition, with controlled expected inflation, there is less need for large fluctuation in output, implying lower output costs of disinflation or the sacrifice ratio, in particular during periods of large adverse supply shock (Mishkin, 2007).

In the case of Thailand, maintaining price stability has become the overriding objective of monetary policy, particularly since the implementation of inflation targeting in 2000. In an independent review commissioned by the Bank of Thailand, Grenville and Ito (2010) found that core inflation during the first 10 years of adoption had impressively been maintained within the targeting band 90% of the time.

Despite the past success of the inflation-targeting regime, there has been public debate about whether the inflation-targeting framework is generally appropriate for the Thai economy. For example, Saicheua et al. (2012) questioned the sustainability of Thailand's inflation targeting over the long term.

> If Thailand is a small open economy (which we argue it is, or is increasingly becoming one), then it stands to reason that Thailand can neither set its own inflation rate nor, for that matter, its own independent interest rate. Just as a small open economy is a "price-taker", it must also be an interest-rate taker and an inflation-taker as well. (p.3)

In response to this argument, Sitthichaivisade et al. (2012) provided empirical evidence that inflation expectations do indeed play the most important part in explaining inflation dynamics and monetary policy under the inflation-targeting regime and can influence inflation expectations. This work is essentially an updated version of Khemangkorn et al. (2008). Note that in Khemangkorn et al. (2008), the relationship between the inflation expectations and monetary policy stance (as measured by deviation from Taylor's (1993) rule) has the correct sign, but is not statistically significant. Although Sitthichaivisade et al. (2012), with more recent data, did find significant evidence, the focus is on only short-term inflation expectations (one-year horizon) as measured by a survey of professional economists.

There is other supporting empirical evidence that managing inflation expectations has been the focus of monetary policy in Thailand, particularly during the turbulent period of 2008 (Siregar & Goo, 2010). Nevertheless, to the best of our knowledge, a systematic linkage between monetary policy action and longer-run inflation expectations has not been well established in Thailand. Therefore, in this paper, we aim to shed light on the issue of whether monetary policy under the inflation-targeting regime is able to anchor longer-term inflation expectations.

Note that, although the role of inflation expectations has been widely recognized, few studies have investigated direct linkages between monetary policy actions and long-run expectations in other countries, as noted in Kiley (2008). He thus proposed such a framework for testing the relationship directly. Using U.S. survey data, he found that long-run inflation expectations are influenced by monetary policy actions. However, his empirical evidence in the case of the U.S.A. is not strong. Therefore, he proposed further investigation of the behavior of long-horizon inflation expectations in other countries, to provide additional information for comparison with the experience from the U.S.A. Although the present paper follows Kiley (2008) as the baseline specification, we modify his methodology to include the forward-looking Taylor rule instead of the outcome-based Taylor rule. We find that this specification not only provides a better description of the actual setting of monetary policy, but also helps to find important evidence that monetary policy in Thailand is able to anchor inflation expectations in both the short run and the longer run.

The remaining sections in this paper are organized as follows. Section 2 discusses the development of the measurement of expected inflation in Thailand. Section 3 outlines the role of monetary action to inflation expectations using the forward-looking Taylor-rule equation. Section 4 presents the empirical results. Finally, Section 5 concludes the paper.

2. Measuring inflation expectations in Thailand

Although inflation expectations are imperative to inflation dynamics, data for inflation expectations is not directly observable. In general, expected inflation can be extracted from two main sources: survey- and market-based measures. In the survey approach, various types of survey are conducted by central banks or researchers on households, businesses, investors, or private-sector economists who reflect different economic backgrounds, available information, and methods, to approximate inflation expectations.[1] The market-based method is usually inferred from asset prices, that is, nominal and real yield curves that reflect the financial market views of future inflation perspectives. In Thailand, however, the data on inflation expectations is limited, and only some types are freely accessible.

2.1 Survey-based inflation expectations

Currently, surveys on the economics perceptions of households or businesses are limited. Unfortunately, the Consumer Sentiment Survey[2] does not include questions about household perceptions of price stability. In the business sector, since 2000, the Bank of Thailand has been conducting the Business Sentiment Survey using data from over 1000 business firms nationwide. Entrepreneurs are asked to provide information about their perceptions of economic conditions. However, the early surveys did not include questions on inflation perceptions. Since December 2005, the Business Sentiment Survey has included the expected value of inflation for the current calendar year and for the following year. The question has been changed to one-year-ahead inflation to reflect expected inflations since March 2007. However, longer-term expected inflations are still not included in the Business Sentiment Survey.

Another economic survey in Thailand that has provided continued information about future inflation perceptions in Thailand is the Reuters' survey of professional forecasters, conducted on a quarterly basis. In Reuters' survey, approximately 10 main research houses from the private corporate sector are asked to provide the expected averaged headline inflation for the current year and for the following year in Thailand. Thus, the survey can be viewed as a gauge of inflation expectations of economists or professional forecasters. However, the sample size when compared with equivalent surveys conducted in major economies such as the U.S.A. or the U.K. is small, which raises the question of whether it

[1] See details of the most referenced surveys in the U.S.A. related to inflation expectations in Table 1 of Cunningham et al. (2010).
[2] The Consumer Sentiment Survey in Thailand has been conducted by the University of Thailand Chamber of Commerce on a monthly basis since 1998.

may be a good measure of inflation expectations. Currently, the data collected is available in the Bank of Thailand inflation report[3] published every quarter.

2.2 Market-based inflation expectations

Another well-known approach to obtaining inflation expectations is through extracting inflation expectations embedded in the yield curve from bonds or interest rate swaps markets.

Applying the basic concept of the Fisher equation, inflation compensation, a combination of expected and unexpected components of future inflation, is the difference between the nominal interest rate and the real rate of return. This type of inflation expectation has the benefit of high-frequency data with a relatively long forecast horizon, but it suffers from various specific technical factors such as liquidity premium and inflation risk, which cannot be easily removed.

Following the standard technique widely used by central banks,[4] we calculate the market-based expectation derived from the zero-coupon government bond yield curves (Soderlind & Svensson, 1997). This method uses the break-even inflation estimated by the nominal and real forward rates. Because of the limitations of explicit forward rates, the implied forward rates can be computed using the data from the existing yield curve. The finance literature provides two approaches to computing the implied forward rates. First, by separating the current longer-term bonds into a portfolio of shorter-term bonds with future reinvestment, we can obtain the forward rate for the contract concluded at time t, for an investment that starts at time t', where $t' > t$. This method is called "bootstrapping." Second, the forward rates can be estimated by fitting the spot curves using the function forms of Nelson and Siegel (1987) and Svensson (1994).[5] Inflation compensation is then calculated from the "implied forward rate" or the rate of return that investors required "today" to lend a certain amount of money during a specified period in the future.

Because the survey-based data is limited, we focus on the market-based expected inflations derived from the zero-coupon government bond yield curves[6] using the framework of Soderlind and Svensson (1997). The instantaneous forward curves are calculated for nominal and real yield curves using the Nelson–Siegel method.

We use the Nelson–Siegel function form[7] to compute the implied forward rate. The spot ($y_{s,t}$) and forward rates ($y_{f,t}$) functions are shown in Eqs (1) and (2), respectively:

$$y_{s,t}(\tau) = \beta_{0t} + \beta_{1t}\frac{1-\exp\left(-\frac{\tau}{\lambda}\right)}{\frac{\tau}{\lambda}} + \beta_{2t}\left(\frac{1-\exp\left(-\frac{\tau}{\lambda}\right)}{\frac{\tau}{\lambda}} - \exp\left(-\frac{\tau}{\lambda}\right)\right) \qquad (1)$$

[3] Source: Reuters.

[4] See the discussion on the calculation of market-based inflation expectation in Breedon (1995) and Sangmanee (2001).

[5] For details of estimating the implied forward rate for market-based inflation expectation, see Svensson (1994).

[6] See Cunningham et al. (2010) for a discussion of the advantages and disadvantages of survey- and market-based measures.

[7] In addition to the one-hump shape function of the Nelson–Siegel function, we also estimate the two-hump shape function of Svensson (1994). However, the spot curves of Nelson–Siegel are more similar to the spot curves of the Thai Bond Market Association than those of Svensson. Therefore, the results in this paper will be based on the Nelson–Siegel function form.

$$y_{f,t}(\tau) = \beta_{0t} + \beta_{1t} \exp\left(-\frac{\tau}{\lambda}\right) + \beta_{2t} \frac{\tau}{\lambda} \exp\left(-\frac{\tau}{\lambda}\right) \quad (2)$$

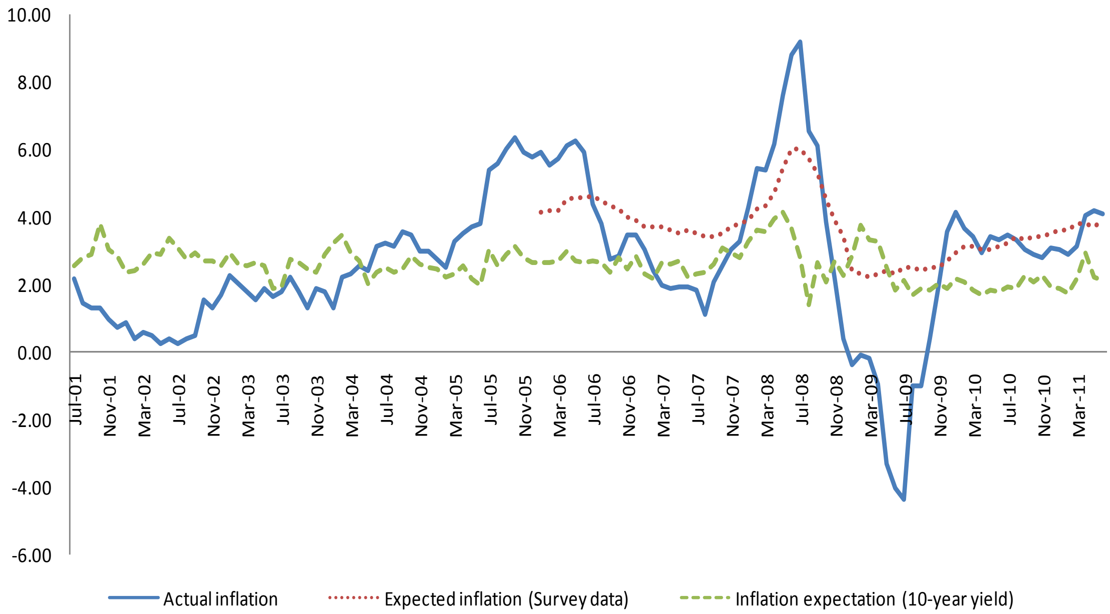
where τ is time-to-maturity, each parameter, β_{0t}, β_{1t}, β_{2t}, and λ can be estimated using Maximum Likelihood.

The expected inflations will be calculated as the difference between nominal and real forward rates.

2.3 Inflation expectations in Thailand

We collected data on one-year expected inflations from the monthly Business Sentiment Survey and compute the market-based inflation expectations using the yield curves data outlined in Section 2.2. Fig. 1 shows the results.

Figure 1 Actual headline inflation, survey-based and market-based inflation expectations in Thailand



Source: Figure 20 in Luangaram and Sethapramote (2012). Survey-based inflation expectation is collected from Bank of Thailand's monthly business sentiment survey reports. Market-based inflation expectation is calculated from 10-years yields using Soderlind and Svensson (1997)'s method

The results in Fig. 1 show the nature of inflation expectations in Thailand. Business Sentiment Survey data is available from 2006.[8] However, the questionnaire is still limited to one-year-ahead inflation outlook. The long-run (10-year) expectations are extracted by a market-based approach. We can see that the long-term expectations move together with short-term expectations and actual inflations. However, fluctuations in long-term expectations are lower than those in short-term expectations.

Next, we consider the lead–lag relationship between actual and expected inflations. As can be seen from Fig. 1, long-term market-based inflation expectations usually lead actual

[8] During 1999 to 2005, the Business Sentiment Survey asked participants to answer questions about inflation outlook in current and subsequent calendar years. Since 2006, the questions have been changed to inflation outlook one year from now, which represents one-year expected inflation.

inflation, particularly during the periods when inflation picked up quickly from the effect of world crude oil price in 2004–2005 and 2007–2008. However, short-term survey-based inflation expectations currently appear to move in the same period as those of actual inflations.

Therefore, in this paper, we use the data extracted from the nominal and real yield curves as the main reference of expected inflations for different time horizons.

3. Inflation expectations and monetary policy actions

In this section, we discuss the methodology used to investigate the effectiveness of monetary policy in anchoring inflation expectations. Previous literature, for example Demertzis et al. (2008) and Gürkaynak et al. (2010), usually focuses on the change in the degree of persistence in actual inflation over time as an indicator of whether or not expected inflation is better anchored.

Therefore, because there is limited evidence on how monetary action influences inflation expectation in both the short term and the long term, we further investigate this issue by applying the methodology suggested by Kiley (2008). The forward-looking form of Taylor-rule equations will be used. Kiley's methodology is briefly discussed as follows.

First, we consider the estimation of central bank reactions, to two main objectives of monetary policy: stability in price and long-run output growth. In the literature, the Taylor-style interest rate rule is applied for this purpose. We follow the same specification as in Kiley (2008), which takes the form:

$$i_t = \sum_{j=i}^{N} a_j i_{t-j} + \left[1 - \sum_{j=1}^{N} a_j\right]\left[r^* + \pi_t^* + \gamma^\pi(\pi_t - \pi_t^*) + \gamma^y y_t\right] + e_t . \tag{3}$$

In Eq. (3), the nominal interest rate (i) is a linear function of its own lags, the long-run real interest rate (r*), the difference between actual inflation and time-varying inflation goal ($\pi_t - \pi_t^*$), and output gap (y_t).

Next, the long-run goal of inflation (π_t^*) is assumed to follow a random walk, $\pi_t^* = \pi_{t-1}^* + v_t$. Based on Kiley (2008), the public's beliefs about long-run inflation goal ($E(\pi_t^*)$) can be formed as the difference between the true long-run goal of inflation and the shock to monetary policy rules from Eq. (3), which can be expressed as

$$\pi_t^* = \pi_{t-1}^* + \kappa \begin{pmatrix} i_{t-1} - \{\sum_{j=1}^{N} a_j i_{t-1-j} + \left[1 - \sum_{j-1}^{N} a_j\right][r^* + \pi_t^* + \\ \gamma^\pi(\pi_{t-1} - \pi_{t-1}^*) + \gamma^y y_{t-1}]\} \end{pmatrix} \tag{4}$$

Eq. (4) shows the relationship between monetary policy action and long-run inflation goal where tighter than expected policy leads to a downward updated value of the inflation goal. Then, by subtracting the long-run goal for inflation with the data for long-term inflation expectation (π_t^{LR}), the estimated equation is written as

$$\pi_t^{LR} - \left\{\pi_{t-1}^{LR} - \kappa\left(i_{t-1} - \left[r^* + \pi_t^* + \gamma^\pi(\pi_{t-1} - \pi_{t-1}^{LR}) + \gamma^y y_{t-1}\right]\right)\right\} = w(t) \tag{5}$$

Next, the role of smoothing interest rate decision[9] is included by adding the lagged value of interest rates (i_{t-2}) into the equation. The equation is then written as

$$\pi_t^{LR} - \left\{\pi_{t-1}^{LR} - \kappa\left(i_{t-1} - \{a_1 i_{t-2} + [1-a_1]\left[r^* + \pi_t^* + \gamma^\pi(\pi_{t-1} - \pi_{t-1}^{LR}) + \gamma^y y_{t-1}\right]\right)\right\} = w(t). \tag{6}$$

Finally, we modify the methodology used in Kiley (2008) by using the forward-looking monetary policy rule instead of the outcome-based rule. In this framework, monetary policy actions react to the forecast value of inflation and output gap rather than the actual outcome of these variables. Orphanides and Wieland (2008) note that the Federal Open Market Committee's economic forecasts play an important role in influencing policy rate decisions. In the case of Thailand, Luangaram and Sethapramote (2015) found that this forecast-based monetary policy rule provides a better description of monetary policy in Thailand.

Using the forward-looking policy-rule approach, the updating expected inflations equations are written as

$$\pi_t^{LR} - \left\{\pi_{t-1}^{LR} - \kappa\left(i_{t-1} - \{a_1 i_{t-2} + [1-a_1]\left[r^* + \pi_t^* + \gamma^\pi(\pi_{t-1}^F - \pi_{t-1}^{LR}) + \gamma^y y_{t-1}^F\right]\right)\right\} = w(t). \tag{7}$$

The results from Luangaram and Sethapramote (2015) show that the forward-looking Taylor-type equation of monetary policy rule outperformed the standard outcome-based Taylor-rule model in explaining the monetary policy reaction function in Thailand. Therefore, we use Eq. (7) as the main estimated equation. As in Sitthichaivisade et al. (2012), we assume $r^* = 0.5\%$ and $\pi^* = 1.75\%$ and 3%[10] for core and headline inflations, respectively.

From Eq. (7), the reaction between expected inflation and monetary policy rules is estimated by using a reduced-form equation. Kiley (2008) suggests that Eqs (3) and (7) could be jointly estimated in the updating inflation expectations and policy-rule system of equations. The joint estimation of this system can be written as

$$\pi_t^{LR} - \left\{\pi_{t-1}^{LR} - \kappa\left(i_{t-1} - \{a_1 i_{t-2} + [1-a_1]\left[r^* + \pi_t^* + \gamma^\pi(\pi_{t-1}^F - \pi_{t-1}^{LR}) + \gamma^y y_{t-1}^F\right]\right)\right\} = w(t) \tag{8.1}$$

$$i_t - i_{t-1} = (1-a_1)\left[\gamma^\pi(\pi_t^F - \pi_{t-1}^F) + \gamma^y(y_t^F - y_{t-1}^F)\right] + a_1(i_{t-1} - i_{t-2}) + e_t. \tag{8.2}$$

Empirical results from Kiley (2008) indicate an efficiency gain from using this structural form in estimations with the generalized method of moments (GMM).

Lastly, to compare the results in our study with those of previous papers, we also consider the outcome-based Taylor-rule equation in estimating the structural equation system. In this case, the estimated system of equations is based on the expectation equation (6) and the outcome-based Taylor-rule model, which are expressed as

$$\pi_t^{LR} - \left\{\pi_{t-1}^{LR} - \kappa\left(i_{t-1} - \{a_1 i_{t-02} + [1-a_1]\left[r^* + \pi_t^* + \gamma^\pi(\pi_{t-1} - \pi_{t-1}^{LR}) + \gamma^y y_{t-1}\right]\right)\right\} = w(t) \tag{9.1}$$

$$i_t - i_{t-1} = (1-a_1)\left[\gamma^\pi(\pi_t - \pi_{t-1}) + \gamma^y(y_t - y_{t-1})\right] + a_1(i_{t-1} - i_{t-2}) + e_t. \tag{9.2}$$

The empirical results of estimating the equations are shown in Section 4.2.

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[9] See Luangaram and Sethapramote (2015) for a discussion of interest rate smoothing in Thailand.

[10] These numbers represent the mid-point of the inflation-targeting band for core and headline inflation, respectively.

4. Empirical results

4.1 Data

Data from this study was collected from publicly available data sources. Gross domestic product, core and headline inflation, and yield curves were collected from the Reuters database. The real yield curves were obtained from the "multi-factor affine arbitrage-free model" based on Apaitan (2014). Inflation-linked bonds were first issued in Thailand in July 2011 with 10 years to maturity and returns linked to headline consumer price index. Until the newly issued inflation-linked bond has become more actively traded and sufficiently liquid for long periods, directly observing real yield from inflation-linked bonds may not be suitable for research analysis.

Output and inflation forecasts (core and headline inflations) are taken from Bank of Thailand's quarterly Monetary Policy Report, which has been publicly released since 2000 Q2. Therefore, our data is in the range of t = 2002Q2, …., 2011Q2 (T = 44). We consider inflations and output forecasts four and eight quarters ahead.

We focus on the actual and expected inflation data. Tables 1 and 2 show the descriptive statistics. Fig. 2 shows the time-series plot of the actual and expected inflations data against the one-day repurchase rate, used as the monetary policy interest rate in Thailand.

As can be seen from Table 1, the means and medians for expected inflation range from 3.01 (for 10-years-ahead expectations) to 3.65 (for 1-year-ahead expectations). These numbers are slightly higher than that of the actual headline (2.57). However, headline inflation moved below 2% during the period 2000–2003, when the Thai economy was still struggling in the aftermath of the Asian Financial Crisis. Therefore, we consider the subsample data from 2003 Q1 to 2011 Q1. The results from Table 2 indicate that the average values of both actual expectations and inflation expectations are close to each other. The average of actual inflation is 2.99, and that of expected inflation ranges from 3.59 (1 year ahead) to 2.92 (10 years ahead). For standard deviation, the actual inflations are more volatile than the inflation expectations measured by both range (maximum–minimum) and standard deviation. The expected inflations appear to become more stable for long-term expectations (more than 5 years ahead) than for short-term expectations and actual outcome. These results indicate that long-term expectations could be anchored during the period of the inflation-targeting framework because of the relative stability in longer-term expectations.

Subsequently, we consider the relationship between the policy interest rate and inflations. In Fig. 2, we can observe the co-movement pattern between actual inflation and repurchase rate in Thailand. Additionally, in both the upward and downward cycles, actual inflation tends to move before policy interest rate. For example, during 2004 to 2006 when the inflation pressure increased from the rising energy price in 2004 Q2, the policy interest rate started to follow this upward trend later in 2004 Q2. Similarly, during 2010 to 2011 when the energy price and domestic demand recovered from the effects of the global financial crisis, an upward cycle in inflation since 2010 Q1 can be observed. The policy interest rate continued to increase from 2010 Q2. In the downward period of inflation, the inflation rate moved back toward the long-run target in 2006 Q3. The repurchase rate started to drop one quarter later.

Next, we discuss the relationship between expected inflations and policy interest rate. In every case, concurrent movements are not directly observed. However, the inflation expectations appear to decrease after the interest rates continued to increase in 2006 and 2010. These pattern is clearly observed for short-term expectations (1- and 3-years ahead expected inflations). However, for longer-term expectations, this relationship cannot be directly observed by using the simple graphical illustration.

Therefore, in Section 4.2, we focus on econometric analysis of the reaction of expected inflations to monetary policy actions by using the framework of Kiley (2008) with a forward-looking version of Taylor-rule equations as outlined in Section 3.

Table 1 Descriptive statistics for actual headline inflation, and 1-, 3-, 5-, 7- and 10-years ahead expected inflations during 2000, quarter 2 to 2011, quarter 1

	Mean	Median	Maximum	Minimum	Std. Dev.	Period
Actual Inflation	2.572	2.283	7.500	-2.791	2.098	2000q2-2011q1(T=44)
Inflation Expectations						
1-Year-ahead	3.650	3.560	5.140	2.302	0.783	2001q3-2011q1 (T=39)
2-Year-ahead	3.450	3.181	5.044	1.917	0.877	2001q3-2011q1 (T=39)
3-Year-ahead	3.210	3.092	4.742	1.752	0.767	2001q3-2011q1 (T=39)
4-Year-ahead	3.049	2.966	4.257	1.497	0.655	2001q3-2011q1 (T=39)
5-Year-ahead	2.967	2.944	3.962	1.486	0.577	2001q3-2011q1 (T=39)
6-Year-ahead	2.938	2.892	3.914	1.628	0.529	2001q3-2011q1 (T=39)
7-Year-ahead	2.941	2.873	3.919	1.852	0.508	2001q3-2011q1 (T=39)
8-Year-ahead	2.960	2.862	3.943	2.104	0.508	2001q3-2011q1 (T=39)
9-Year-ahead	2.986	2.936	4.008	2.043	0.521	2001q3-2011q1 (T=39)
10-Year-ahead	3.013	2.944	4.124	2.007	0.542	2001q3-2011q1 (T=39)

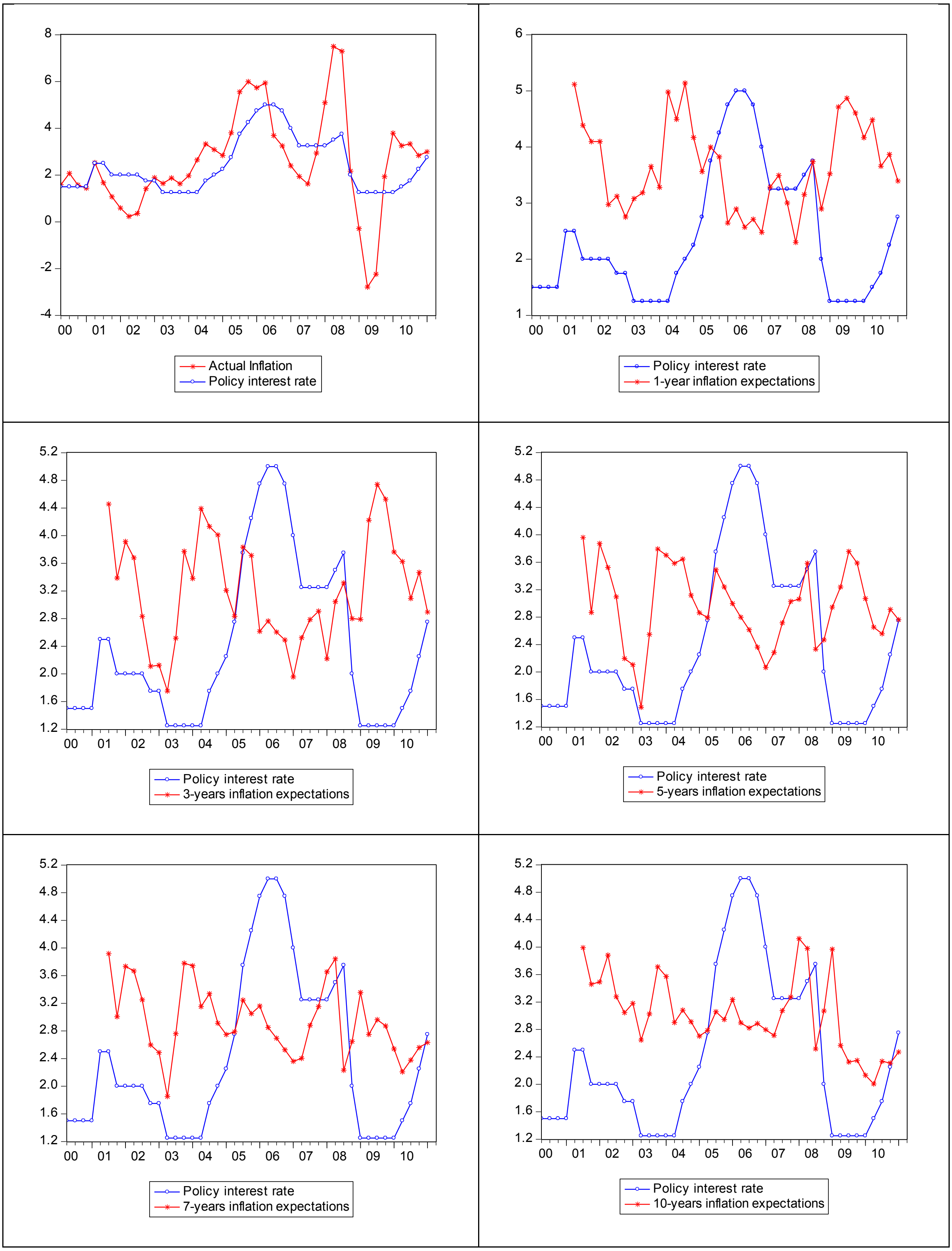
Source: Actual headline inflation collected from the Datastream. Inflation expectations are calculated from the market-based approach using data from nominal and real yield curves.

Table 2 Descriptive statistics for actual headline inflation, and 1-, 3-, 5-, 7- and 10-years ahead expected inflations during 2003, quarter 1 to 2011, quarter 1

	Mean	Median	Maximum	Minimum	Std. Dev.	Period
Actual Inflation	2.989	2.941	7.500	-2.791	2.245	2003q1-2011q1 (T=33)
Inflation Expectations						
1-Year-ahead	3.593	3.522	5.137	2.302	0.777	2003q1-2011q1 (T=33)
2-Year-ahead	3.409	3.172	5.044	1.917	0.878	2003q1-2011q1 (T=33)
3-Year-ahead	3.177	3.045	4.742	1.752	0.763	2003q1-2011q1 (T=33)
4-Year-ahead	3.010	2.839	4.257	1.497	0.642	2003q1-2011q1 (T=33)
5-Year-ahead	2.914	2.911	3.794	1.486	0.554	2003q1-2011q1 (T=33)
6-Year-ahead	2.872	2.793	3.790	1.628	0.500	2003q1-2011q1 (T=33)
7-Year-ahead	2.864	2.786	3.842	1.852	0.477	2003q1-2011q1 (T=33)
8-Year-ahead	2.875	2.785	3.908	2.104	0.478	2003q1-2011q1 (T=33)
9-Year-ahead	2.896	2.884	4.008	2.043	0.495	2003q1-2011q1 (T=33)
10-Year-ahead	2.920	2.895	4.124	2.007	0.521	2003q1-2011q1 (T=33)

Source: Actual headline inflation collected from the Datastream. Inflation expectations are calculated from the market-based approach using data from nominal and real yield curves.

Figure 2 Actual headline inflation, inflation expectations and policy interest rate in Thailand



Source: Inflation expectation is calculated from the market-based approach using Soderlind and Svensson (1997)'s method. The policy interest rate is 1-day repurchase rate.

4.2 Econometric results

The basic results are based on the updating inflation expectation equation (7) with Taylor residuals derived from the forward-looking Taylor-rule equation (3). We follow Kiley's (2008) suggestion to set the real interest rate as a constant rather than estimate it as another parameter. The long-run equilibrium real interest rate (r*) is fixed at 0.5% as suggested by Sitthichaivisade et al. (2012). The long-term inflation target (π_{t-1}^*) is set at 1.75 and 3.0 for core and headline inflation, respectively. Because of the problem of endogeneity between actual inflation, expected inflation, and monetary policy action, the use of GMM is usually suggested in the literature (e.g., Kiley, 2008). We use lagged values of variables in the regression as the instrumental variables. Therefore, the list of used instrumental variables includes the first- and second-period lagged values of change in policy interest rate ($i_{t-1} - i_{t-2}$, $i_{t-2} - i_{t-3}$), the first lagged value of change in the eight-quarters-ahead forecast of headline and core inflation ($\pi_{t-1}^F - \pi_{t-2}^F$), and output growth forecast ($y_{t-1}^F - y_{t-2}^F$). We also perform the J-test to check for over-identification restrictions in GMM estimation. Standard errors of estimated coefficients are corrected for heteroskedasticity and serial correlation. The nonlinear regressions are estimated using GMM. Multiple starting values are applied to check for validity of the results. The minimizing value criterion of the GMM objective function (J-statistics) is applied to select the starting value for estimating the nonlinear relationship between Eqs (7), (8), and (9). Table 3 shows the results of Eq. (7) estimated using GMM.

Table 3 Core inflation forward looking 8-quarters ahead forecast for both inflation and output growth estimated by GMM as a single equation

Parameter	Inflation expectations				
	1-year-ahead	3-year-ahead	5-year-ahead	7-year-ahead	10-year-ahead
κ	1.053***	0.635***	0.605***	0.648***	0.515*
	(0.289)	(0.200)	(0.157)	(0.177)	(0.291)
γ^{π}	1.784***	1.624**	2.087	5.746	17.233
	(0.409)	(0.608)	(1.282)	(4.508)	(50.636)
γ^{y}	0.730***	0.582***	0.619***	1.338	4.159
	(0.126)	(0.146)	(0.218)	(0.868)	(11.449)
a_1	0.707***	0.718***	0.829***	0.907***	0.968***
	(0.072)	(0.095)	(0.071)	(0.061)	(0.088)
Adj R^2	0.417	0.450	0.308	0.088	0.181
J-test: p-value	0.413	0.461	0.618	0.406	0.345
Obs.	37	37	37	37	37

Note: - The results are based on estimation of the following equation.

$$\pi_t^{LR} - \{\pi_{t-1}^{LR} - \kappa(i_{t-1} - \{a_1 i_{t-2} + [1-a_1][r^* + \pi_t^* + \gamma^{\pi}(\pi_{t-1}^F - \pi_{t-1}^{LR}) + \gamma^y y_{t-1}^F]\})\} = w(t) \quad (7)$$

- The numbers in parentheses are standard errors of the estimated coefficients.
  ***, **, * denotes statistically signficant at the 1, 5 and 10 percent levels, respectively.

The main focus of this inflation expectation equation is the κ coefficient, which indicates the responses of expected inflations to the changes in monetary policy stance shown in Eq. (4). Kiley (2008) calls this parameter the "updating coefficient."[11] As can been seen from Table 3, the estimated results show that the updating coefficients are highly significant

[11] The term "updating coefficient (κ)" is used to represent the degree to which an agent's inflation perceptions are updated (Kiley, 2008).

at the 1% significance level for the equations using inflation expectations data ranging from 1, 3, 5, to 7 years ahead. However, in the case of 10-year expected inflations, which are regarded as long-term expectations in many studies (e.g., Gürkaynak et al., 2006), this updating coefficient is statistically significant only at the 10% significance level. The sign of updating coefficients are positive, as suggested by Kiley (2008). These coefficients imply that a tighter monetary policy causes inflation expectations to decline. Moreover, when we compare the size of updating coefficients between each equation, the reactions of the short-term inflation expectation equations are larger than those of the long-term expectation equations, implying that the long-term expectations are less likely to react than the short-term expectations. Therefore, empirical evidence of the response of inflation expectations to monetary policy action is more likely to be detected in the shorter-term expectation data. The results from the J-test support the validity of instrumental variables in this study. The null hypothesis is not rejected in every case.

We next consider the other estimated parameters in the equation. The estimated coefficients in the monetary policy rule function show positive values for both the reaction to inflation deviation from the target (γ^{π}) and the reaction to output gap (γ^{y}). These results demonstrate the reasonable response of monetary policy when the central bank raises policy interest rate to counter a high inflation and output growth outlook. The parameter of the policy reaction to inflation pressure is stronger, which is similar to the finding of Luangaram and Sethapramote (2015). Overall, the results provide evidence of the reaction of expected inflation in the long run based on 5- and 7-year equations. However, we still cannot find significant evidence for the case of 10-year inflation expectations. When we consider the goodness of fit of the equation, the 1-, 3-, and 5-year inflation expectations equations show adjusted R-squared values that are above 30%. However, the R-squared value drops considerably to 0.04 and 0.12 for the 7- and 10-year equations, respectively.

Next, we consider estimation of the system of equations that represent interaction between monetary policy actions and inflation expectation. Kiley (2008) notes that there is a low-power problem in estimating the updating equation in a single-equation framework. To achieve efficiency gain, we consider the results from the joint estimation of the system of Eqs (8.1) and (8.2). Tables 4 and 5 show the empirical results of system estimation with the least-squares (LS) and the GMM estimations, respectively. We first consider the results from the LS estimators. The results remain similar to those of the single equation where the updating coefficients (κ) are statistically significant in every case except the 10-year equation. The R-squared statistics are also close to those of the single-equation counterparts. Next, we consider the case of the GMM estimation. The results from the J-statistics confirm the validity of the GMM estimations. The null hypothesis cannot be rejected. Next, the results from Table 5 indicate that the standard errors of estimated coefficients decrease from those of the estimation of a single equation in Table 3 and those of the system of equations with the ordinary LS estimates in Table 4. Therefore, the updating coefficient (κ) becomes statistically significant at the 10% level for the 10-year expected inflations. However, the R-squared of the 10-year equation remains approximately the same as that of the single-equation system (around 10%).

Overall, we can conclude that evidence of interaction between monetary policy action and inflation expectations in Thailand is significant. The results are strong in the case of the inflation expectations extracted from real and nominal yields for maturities up to 5 years. The R-squared values and significance of the updating coefficient confirm this relationship and are not sensitive to use of the single-equation or system-of-equations approaches. Moreover, the results are also valid for both GMM and LS estimators. However, for the longer-term expectations (7 years and 10 years ahead), the R-squared values decrease significantly. In addition, the results of 10-year expected inflations are significant only in the case of joint estimation of the updating equation and the policy rule when using the GMM estimators.

Table 4 Core inflation Forward looking 8-quarters ahead forecast for both inflation & output growth estimated in a system by LS

Parameter	Inflation expectations				
	1-year-ahead	3-year-ahead	5-year-ahead	7-year-ahead	10-year-ahead
κ	0.882***	0.726***	0.616***	0.511***	0.024
	(0.188)	(0.174)	(0.168)	(0.175)	(0.100)
γ^{π}	1.525***	1.429***	1.515**	1.744**	0.532
	(0.407)	(0.437)	(0.590)	(0.856)	(0.423)
γ^{y}	0.640***	0.501***	0.474***	0.524**	0.494
	(0.147)	(0.129)	(0.151)	(0.215)	(0.300)
a_1	0.732***	0.703***	0.739***	0.767***	0.592***
	(0.065)	(0.077)	(0.080)	(0.090)	(0.154)
Adj R^2 (8.1)	0.465	0.430	0.229	0.005	0.032
Adj R^2(8.2)	0.300	0.292	0.280	0.266	0.363
Obs. (8.1)	38	38	38	38	38
Obs. (8.2)	42	42	42	42	42

Note: - The results are based on estimation of the following system of equation.

$$\pi_t^{LR} - \left\{\pi_{t-1}^{LR} - \kappa\left(i_{t-1} - \{a_1 i_{t-2} + [1-a_1]\left[r^* + \pi_t^* + \gamma^{\pi}(\pi_{t-1}^{F} - \pi_{t-1}^{LR}) + \gamma^{y} y_{t-1}^{F}\right]\right)\right\} = w(t) \qquad (8.1)$$

$$i_t - i_{t-1} = (1-a_1)\left[\gamma^{\pi}(\pi_t^{F} - \pi_{t-1}^{F}) + \gamma^{y}(y_t^{F} - y_{t-1}^{F})\right] + a_1(i_{t-1} - i_{t-2}) + e_t \qquad (8.2)$$

- The numbers in parentheses are standard errors of the estimated coefficients.
  ***, **, * denotes statistically signficant at the 1, 5 and 10 percent levels, respectively.

Table 5 Core inflation forward looking 8-quarters ahead forecast for both inflation and output growth estimated by GMM as a system

Parameter	Inflation expectations				
	1-year-ahead	3-year-ahead	5-year-ahead	7-year-ahead	10-year-ahead
κ	0.630***	0.583***	0.476***	0.372***	0.197*
	(0.115)	(0.087)	(0.069)	(0.086)	(0.103)
γ^{π}	1.684***	1.404***	1.962**	2.768*	2.124
	(0.544)	(0.448)	(0.763)	(1.649)	(1.529)
γ^{y}	0.657***	0.499***	0.596***	0.760**	0.703
	(0.182)	(0.080)	(0.145)	(0.347)	(0.444)
a_1	0.783***	0.734***	0.792***	0.841***	0.811***
	(0.058)	(0.059)	(0.056)	(0.070)	(0.093)
Adj R^2(8.1)	0.436	0.412	0.221	0.009	0.098
Adj R^2(8.2)	0.310	0.321	0.287	0.256	0.286
j-test: p-value	0.826	0.828	0.778	0.724	0.750
Obs. (8.1)	38	38	38	38	38
Obs. (8.2)	41	41	41	41	41

Note: - The results are based on estimation of the following system of equation.

$$\pi_t^{LR} - \left\{\pi_{t-1}^{LR} - \kappa\left(i_{t-1} - \{a_1 i_{t-2} + [1-a_1]\left[r^* + \pi_t^* + \gamma^\pi(\pi_{t-1}^F - \pi_{t-1}^{LR}) + \gamma^y y_{t-1}^F\right]\right)\right\} = w(t) \qquad (8.1)$$
$$i_t - i_{t-1} = (1-a_1)\left[\gamma^\pi(\pi_t^F - \pi_{t-1}^F) + \gamma^y(y_t^F - y_{t-1}^F)\right] + a_1(i_{t-1} - i_{t-2}) + e_t \qquad (8.2)$$

- The numbers in parentheses are standard errors of the estimated coefficients.
  ***, **, * denotes statistically signficant at the 1, 5 and 10 percent levels, respectively.

Table 6 Core inflation outcome based Taylor-rule equation for both inflation & output growth estimated by LS as a system

Parameter	Inflation expectations				
	1-year-ahead	3-year-ahead	5-year-ahead	7-year-ahead	10-year-ahead
κ	0.358**	0.406**	0.137	0.069	0.032
	(0.170)	(0.194)	(0.094)	(0.071)	(0.068)
γ^π	0.277	0.340	0.372	0.395*	0.408*
	(0.273)	(0.329)	(0.252)	(0.226)	(0.231)
γ^y	0.393	0.377	0.208	0.187	0.180
	(0.252)	(0.273)	(0.137)	(0.113)	(0.113)
a_1	0.716***	0.729***	0.496***	0.431***	0.407**
	(0.127)	(0.132)	(0.168)	(0.163)	(0.171)
Adj R^2(9.1)	0.412	0.201	0.047	-0.027	0.035
Adj R^2(9.2)	0.262	0.252	0.347	0.355	0.355
Obs. (9.1)	38	38	38	38	38
Obs. (9.2)	41	41	41	41	41

Note: The results are based on estimation of the following system of equation.

$$\pi_t^{LR} - \left\{\pi_{t-1}^{LR} - \kappa\left(i_{t-1} - \{a_1 i_{t-02} + [1-a_1]\left[r^* + \pi_t^* + \gamma^\pi(\pi_{t-1} - \pi_{t-1}^{LR}) + \gamma^y y_{t-1}\right]\right)\right\} = w(t) \qquad (9.1)$$
$$i_t - i_{t-1} = (1-a_1)\left[\gamma^\pi(\pi_t - \pi_{t-1}) + \gamma^y(y_t - y_{t-1})\right] + a_1(i_{t-1} - i_{t-2}) + e_t \qquad (9.2)$$

- The numbers in parentheses are standard errors of the estimated coefficients.
  ***, **, * denotes statistically signficant at the 1, 5 and 10 percent levels, respectively.

Table 7 Core Inflation outcome based Taylor-rule equation for both inflation & output growth estimated by GMM as a system

Parameter	Inflation expectations				
	1-year-ahead	3-year-ahead	5-year-ahead	7-year-ahead	10-year-ahead
κ	0.037	0.044*	0.027	0.039*	0.015
	(0.025)	(0.026)	(0.026)	(0.024)	(0.015)
γ^π	0.759***	0.860***	0.757***	0.738***	0.829***
	(0.168)	(0.214)	(0.266)	(0.219)	(0.180)
γ^y	-0.111	-0.199**	-0.205**	-0.190**	-0.181**
	(0.080)	(0.090)	(0.080)	(0.086)	(0.083)
a_1	0.174	0.233	0.142	0.157	0.185
	(0.172)	(0.176)	(0.176)	(0.172)	(0.142)
Adj R^2(9.1)	0.348	0.215	0.105	-0.053	-0.042
Adj R^2(9.2)	-0.106	-0.380	-0.466	-0.372	-0.361
J-test: p-value	0.669	0.761	0.686	0.751	0.691
Obs. (9.1)	37	37	37	37	37
Obs. (9.2)	40	40	40	40	40

Note: The results are based on estimation of the following system of equation.

$$\pi_t^{LR} - \left\{\pi_{t-1}^{LR} - \kappa\left(i_{t-1} - \{a_1 i_{t-02} + [1-a_1]\left[r^* + \pi_t^* + \gamma^\pi(\pi_{t-1} - \pi_{t-1}^{LR}) + \gamma^y y_{t-1}\right]\right)\right\} = w(t) \qquad (9.1)$$
$$i_t - i_{t-1} = (1-a_1)\left[\gamma^\pi(\pi_t - \pi_{t-1}) + \gamma^y(y_t - y_{t-1})\right] + a_1(i_{t-1} - i_{t-2}) + e_t \qquad (9.2)$$

- The numbers in parentheses are standard errors of the estimated coefficients.

***, **, * denotes statistically signficant at the 1, 5 and 10 percent levels, respectively.

Finally, we apply the outcome-based Taylor rule in the joint estimation of the updating and policy-rule equations. The outcome-based equation has been applied in empirical studies to measure monetary policy stances and their impact on inflation expectations in Thailand. For example, Khemangkorn et al. (2008) originally estimated the simple equation of change in inflation expectations by using the residual from the outcome-based equation as a sole explanatory variable. Sitthichaivisade et al. (2012) applied the methodology in Khemangkorn et al. (2008) with a longer span of data. Therefore, we further estimate the expectation and policy reactions function system by using the outcome-based approach presented in Eqs (9.1) and (9.2). We employ both LS and GMM methods to estimate this system of equations. The results are shown in Tables 6 and 7, respectively.

As can been seen from Tables 6 and 7, the updating coefficients in this case are significant only for one- and three-year expected inflations. Moreover, the R-squared statistics significantly decrease for the over-three-years expectation equations. Overall, we find that evidence of reactions in expected inflations to monetary policy actions in the outcome-based Taylor-rule approach is weaker than that in the forward-looking Taylor-rule model.

This weakness arises because of the nature of monetary policy, which operates with a significant lag, meaning that policy-makers must be forward-looking. As noted in Bernanke (2010), the outcome-based Taylor rule makes no distinction between changes in inflation that are expected to be temporary and those that are expected to be long lasting. Generally, policy-makers would respond less if changes in inflation are expected to be temporary.

5. Conclusion

The relationship between monetary policy actions and long-term inflation expectations has important implications for the conduct of monetary policy. However, empirical studies that directly investigate this reaction are limited. To address this, we applied Kiley's (2008) methodology, in which the reaction of expected inflation to monetary policy actions and the Taylor-rule equation are jointly estimated as a system of equations. In the case of Thailand, Khemangkorn et al. (2008) and Sitthichaivisade et al. (2012) found only weak evidence of a relationship in the case of short-term expectations (one-year-ahead expected inflation). Because the data on survey-based expectations is limited, we applied the inflation expectation computed by the market-based approach.

This paper presents two main findings. First, we find evidence that inflation expectations react to monetary policy actions. A tighter monetary policy can curb expected inflation not only for short-term expectations but also for long-term expectations. These results are valid for both the reduced-form single-equation and the structural-form system-of-equations estimation. Second, our empirical results show that monetary policy stance as measured by the residuals from the forward-looking Taylor rule is able to capture the relationship between monetary policy and inflation expectations better than that measured by the residuals from the outcome-based policy rule.

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