Administered Price and Inflation Targeting in Thailand

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Abstract

A consistently high proportion of government price control since 2002 could be considered as a special challenge for inflation targeting framework in Thailand. Among inflation targeting countries, Thailand has the largest degree of price subsidies with 38% of its consumer basket. This paper aims to provide a comprehensive examination on how administered price effects monetary policy in Thailand, which recently shifted to point targeting using headline inflation (from band targeting using core inflation).

Our empirical results suggest three major findings. First, the presence of price controls raises question about controllability of monetary policy. Sizable share of price control associated with headline inflation generate higher volatility. Cross correlation analysis (between administered price and market-determined price) shows that, when control is unwounded, drastic price rises generate inflationary shock to overall basket. There is a risk of breaking the point target and, therefore, the use of annual average of headline inflation would be a practical way to lessen the impact.

Secondly, evidence from a simple vector autoregression (VAR) reveals that the transmission mechanism of the policy interest rate to market-determined consumer prices appears to take longer time than to aggregate inflation. This implies that monetary policy should even be more forward looking.

Lastly, analysis of the Taylor rule, using data from 2003Q1 to 2014Q4, indicates that the optimality of monetary policy depends crucially on the measures of inflation. Specifically, when aggregate core and headline inflations are used to estimate the Taylor Rule, the coefficients of inflation gap are greater than 1, implying that the Taylor Principle holds. Interestingly, however, this is not the case when inflation is measured by only market determined items (i.e. excluding administered prices). In addition, it is found that the central bank reaction function seems to exhibit higher degree of response to deviation in administered price sector than free price sector. Given higher variability of administered price inflation, policy rate response would be more volatile. Without coordination between the Ministry of Commerce and the Bank of Thailand, it would be difficult for monetary authority to anticipate the discretionary nature of government control measures.
1 Introduction

“Administered prices also set a special challenge for the inflation targeting framework. The extra measures introduced in 2009 were the main reason for the inflation target being missed in that year. Administered prices also make it harder for the BoT to assess the current state of demand. By keeping prices down, pressures on the index may be suppressed, but at the same time holding prices down gives the public more to spend on other things.”

Grenville and Ito (2010, p.44)

Maintaining price stability is always a key objective of Bank of Thailand in conducting monetary policy. After Thailand has adopted inflation targeting as its primary monetary framework in May 2000, inflation level has declined substantially as illustrated in Table1. The five-year average inflation rate from 2000-2004 is around 1.7 percent compared with the average of 5.1 percent in 1995-1999 prior to inflation targeting periods.¹ The average inflation rate has decreased continuously to only 2.1 percent in the recent year, which is relatively lower than our ASEAN neighbors or other developing nations with average of more than 5 percent. It is one of many countries that have achieved a remarkable record of low inflation and have enjoyed a subtle economic environment over the past decade.

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<td>1.70</td>
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Source: World Economic Outlook (2014)

In the beginning of 2015, the central bank decided to shift from quarterly average of core inflation targeting to annual average of headline inflation targeting.² It stirred from a band target of 0.5-3% toward a point target at 2.5% with a tolerance band of ± 1.5%. As headline inflation is perceived to be a better indicator which accurately reflects the real market price level of an economy, the number becomes more attentive by the general public. Additionally, the core inflation has lost its ability to track underlying inflationary pressure as it has diverged out from headline inflation. (BOT, 2015) The change in framework is therefore believed to improve the ability to communicate with the public as well as to better anchor long-term inflation expectation. Based on IMF statistical data, around 31% of 152 central banks around the world have adopted inflation targeting as their monetary policy framework. Unfortunately, Thailand was the last country to use core inflation as a policy target since all other countries had already changed to headline inflation targeting framework.

¹ Based on author computation by using World Economic Outlook data 2014
² On 6 January 2015, the BOT Cabinet approved annual average headline inflation of 2.5 ± 1.5 percent as the monetary policy target for 2015. It became effective after the publication in Royal Gazette.
Although, Buddhari and Chensavardjai (2003) suggested that good macroeconomic management, suitable monetary policy, supportive economics environment have been the major factors nurturing the underlying price movement, large part of the success might be due to the effort of Ministry of Commerce in controlling prices.

As depicted in Figure 1, among 29 economies that have directly targeted inflation, Thailand currently has the highest degree of price controls. Even though Brazil, where a lot of researches and studies on administered price controls have been made, has a considerably high level of government price subsidies, it relative share of administered prices sector is still substantially lower than Thailand. It seems that the normal appearance of price controls have become very important for inflation targeting countries as the average proportion of administered items in CPI basket is approximately 17%. With a closer look on Thailand administered prices development, Figure 2 shows that the share of administered prices in the Thai CPI basket has been consistently high with over 30% since 1998 until the present time. Currently, 135 regulated items accounted for 34.6% of the headline basket and 27.2% of core basket.

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Ministry of Commerce (MPC) as well as other government entities implements subsidy program and price control program as an active tool in maintaining the people cost of living. When there is a negative supply-side shock, producers would likely raise the price in response. But the converse is different. As shock disappears, producers do not lower back their prices. Such an event limiting prices fluctuation may provide a short term relief. Thus, price controls make sense in coping with temporary shock and is proved to be beneficial in the short run when monetary policy cannot accommodate. Yet, as controls are altered, the surprising shock would drive up inflation greatly. For example, after the oil price subsidy was lifted in 2008, inflation sprung up dramatically as seen in Figure 3. Under the circumstance, with the evolution in administered prices, monetary policy maker encounters with one of the most challenging issues on its ability to control price volatility and attains its inflation target. This uncontrollable factor underlying the behavior of the price indicator must be well understood as it is relevant for monetary policy making.

The introduction of an administered price could potentially leads to a limitation on the effectiveness of monetary policy and likely becomes major challenge on central bank inflation controllability. While experiencing a fairly low inflation, a close inspection of the inflation pattern appears to show larger variations. (see Figure 4) Additionally, core inflation and headline inflation started to diverge out from each other since 2002 and these particularly generated skepticism about the effects from price controls implementation. (Mallikamas, 2005) Accordingly, understanding the impact of price control is crucial for monetary policy designing. Central bank should utilize all information in order to make the most optimal policy response.

The aim of this research paper is to analyze the impact of administered prices on monetary policy under inflation targeting framework and hope to provide useful implications for monetary policy operation. The study attempts to investigate and examine the inflation dynamics, monetary policy response, and transmission mechanism under Thai economy context, where there is high proportion of government price controls.
2 Literature Reviews

Price control is usually seen as an instrument in preserving the cost of living. The aim of the government in controlling the prices of goods and services is basically to optimize the social welfare and to protect the domestic consumers’ purchasing power from the exogenous price volatility. In the short run, costs of production are subjected to controls and are apparently stable. Hence, overall price level remains subtle. In addition, with prices constraints, the demand within the country remains unaffected by exogenous shocks. This perhaps results in a declining trend of inflation worldwide after the 1990s.

Nevertheless, the international experience has shown that this government intervention do not offer long term relief from inflation and do inflict costs on the economy by distorting the pricing system. (Daniel, 1975) In other word, this policy turns out to obstruct monetary policy operation. Price is expected to rise radically when the controlling measure is lifted and there is large variability from external factors. In consequence, overall price level or inflation level would predictably ascend. To prevent the rapid rise in price level, central bank has to design a monetary policy responding this price adjustment.

The empirical results of Masson et al. (1998) and Debelle (2001) show that price controls in emerging economies, account for large part of the market basket of goods used to calculate consumer price index, have substantial impact on inflation volatility in the short term. The researches emphasized that proper inflation forecast should include the effect of price controls into the calculation and central banks should be cautious in handling the rapid rise in price of goods that are exempted from controls. Furthermore, the paper of Safouane and Rebei (2012), found that sizable controls in majority of the countries have exceeded their optimal thresholds share of subsidized goods for most favorable inflation targeting policy that they have calculated. The paper proposed policy recommendations to reduce the extent of government intervention as they find welfare losses in responding to large market distortions.

Much of the empirical literature related to the field of administered prices and monetary policy are founded in Brazil, one of the countries with highest degree of prices controls. In one of the studies by Freitas (2005), the author created a simulation model, a small open economy dynamic New-Keynesian general equilibrium model, including sector of free-goods and administered-goods to evaluate the impact on the performance of the Brazilian monetary policy. The results suggest that the rigidity of the administered pricing is important to explain the movement of unregulated-goods prices or what we called free prices. Majority of the controlled goods and services are commodity products necessary for consumption as well as are typical production factors. Therefore, administered prices put pressure on the aggregate CPI inflation, leading to a corresponding price adjustment in the free prices sector. As a result, conducting monetary policy can become more complicated. More importantly, the research supports the use of headline inflation as the target, as the welfare loss associated presents to be statistically low.

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4For model derivation details refer to Safouane and Rebei (2012)
Even though, it is certain that understanding the impact of price controls is very important, very little researches on this area are rarely found in Thailand. In reviewing existing inflation targeting literatures, low level of inflation in Thailand is partly attributable to administered price. Inflation has been falling from 5-8% prior to year 2000 to less than 1 percent in the recent year. In Buddhari and Chensavardjai(2003) literature described three main reasons which favor the miraculous inflation performance in Thailand: the appreciation of baht, changing pattern in housing market with falling rental cost, and finally the increase of administered price measures. In the similar way, Mallikamas (2005) highlighted that although Central Bank has managed to achieve price stability over the period; price controls of goods and services do have substantial impact to the inflation level of Thailand and thus, the inflation targeting regime.

The research of Mallikamas (2005) suggests that administered price policy of the government was one of the major factors that affect the inflation adjustment mechanism as reflected in a divergence pattern of the core inflation and headline inflation since the year 2002. This can be clearly seen in Figure 3. Correspondingly, the analyses of Chantanahom et al. (2004), which explored the causation of the divergence between headline CPI and PPI, also proved that the rise in proportion of controlled goods in the baskets of consumer price index has preserved the prices volatility of wide range of commodity products leading to the divergence between the two indices. Most papers have similarly proposed convincing implications that administered prices have significant impact on inflation level.

Considering the impact of administered price on inflation and monetary policy operation therefore become an interesting issue. As can inferred from the information above, previous work has been primarily illustrated the importance of price controls on inflation level, but details on how price controls effect inflation targeting framework are limited. One of the literatures by Sriumpolchan (2006), concluded that government price controls do not affect long run comprehensiveness. While it may improve clarity of price signal in tracking underlying inflation, administered prices increase the variation of inflation and hamper monetary policy process. However, this research was done after Thailand has adopted inflation targeting for only 4 years and it was silent about the concerns of shifting from core inflation targeting toward headline inflation targeting in the recent year.

In the present paper, we try to understand how does the government price control complements or distorts the inflation targeting regime by examining (i) inflation dynamics including; (ii) monetary transmission mechanism, (iii) monetary policy response. In understanding inflation process development and trends, method used in Buddhari and Chensavardjai(2003) and Chantanahom et. al.(2004) are revisited. The research extends further study following the lead of previous literatures specifically on the impact of administered prices and inflation.
3 Data

For this study, we mainly use the existing time-series data of the macroeconomic indicators and pricing data of the goods and services. The research captured the dataset for 21 years horizon since the beginning of 1994 until 2014, which covers the period before and after inflation targeting has been fully adopted in Thailand. This should shed light on the role of administered prices in explaining inflation dynamics more explicitly. These sets of data are upon request from the Bureau of Trade and Economic Indices, Ministry of Commerce database, Bank of Thailand, World Economic Outlook, IMF and past research papers are also useful sources of information. The necessary variables include headline inflation, core inflation, free price inflation, administered price inflation, oil price, and 1-day repurchase rate. Based on BoT processed data series, we then constructed disaggregate model of administered prices index and market-determined index for our analysis (Figure 4), in which the calculation method is further demonstrated in section 3.1.

3.1 Consumer Price Index Construction

Consumer Price Index is regarded as the major price indicator that can be easily understood and has become the best available measure of the consumers’ cost of living. In order to fully understand the evolution of inflation, it is important to be aware of the measurement of Thai CPI and its nature. CPI is typically constructed by summing the products of the weighted average and price of items in basket of goods and services, which then later used for inflation computation. Weight of goods and services reflects the relative importance of each item in household consumption in base period. (IFC, 2006) In which, these weights are based on consumer expenditure surveys conducted every four years by the National Statistical Office of Thailand (NSO). This in other word means that items and weighted are reviewed every four years term. Examples of base year are 2002, 2007, 2011 and 2015.

Collecting data by surveying is done separately in five different regions including Bangkok metropolitan, Central, Northeastern, Southern, and Northern areas. According to the NSO, sample households that qualify for survey must meet certain criteria: (1) residing in one of these five regions, (2) having 2-6 family members, (3) earning income between 6,000 to 43,000 baht per month and (4) receiving benefits and subsidies of no more than 30 percent of total income. (Buddhari, 2003) After obtaining every regional CPI indices, MOC then takes the weight average of all areas based on population to construct the national CPI number for example Bangkok metropolitan received the highest weight due to its largest
Currently, CPI basket comprises of 450 items of goods and services. The changes in prices are monthly tracked by the Bureau of Trade and Economic Indices (BTEI). This CPI is regularly reported and publicized which enhances its transparency and usefulness for monetary purpose. BTEI adopted the Laspeyres formula, as a procedure in constructing the CPI index according to the international standard.

\[
I_t = \left[ \frac{\sum P_t \times Q_0}{\sum P_{t-1} \times Q_0} \right] \times I_{t-1}
\]

\[
\pi_{t, t} = \left[ \frac{I_{t, t} - I_{t, t-1}}{I_{t, t-1}} \right] \times 100
\]

Where \( I_t \) is CPI Index at time \( t \); \( P_t \) : Price level at time \( t \); \( Q_0 \) : Weighted average in base year; and \( \pi_{t, t} \) : Inflation rate in month \( i \) year \( t \)

**Measurement Bias and Limitations**

CPI may be the best representative index reflecting the overall price level; nevertheless, it contains some errors and has certain limitations for usage. First of all, new products are not taken into account and therefore the index cannot fully reflect these additional values. Secondly, the relative weight of goods and services is fixed in each period, but in reality, quality of product may often change. Thirdly, due to substitution bias, people may shift from expensive good to cheaper one or switch to discount outlet. As a result, prices cannot be accurately measured and several assumptions are needed to be made. As indicated by MOC authority, tracking prices is also one of the difficulties for CPI construction. Finally, consumer expenditures survey is conducted for household with income between 6,000 to 43,000 baht, this implies that CPI does not fully capture the whole population range and may not reflect the real cost of living especially for those on the very top and very bottom percentile of the country.

<table>
<thead>
<tr>
<th>Sectors (% Weights in CPI)</th>
<th>2002</th>
<th>2007</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Food and Beverages</td>
<td>36.06</td>
<td>33.01</td>
<td>33.48</td>
</tr>
<tr>
<td>2 Clothing and footwear</td>
<td>3.40</td>
<td>2.96</td>
<td>3.06</td>
</tr>
<tr>
<td>3 Housing</td>
<td>23.86</td>
<td>23.47</td>
<td>24.14</td>
</tr>
<tr>
<td>4 Personal and medical care</td>
<td>6.03</td>
<td>6.87</td>
<td>6.54</td>
</tr>
<tr>
<td>5 Transportation and communication</td>
<td>21.98</td>
<td>26.80</td>
<td>25.54</td>
</tr>
<tr>
<td>6 Recreation and education</td>
<td>5.82</td>
<td>5.21</td>
<td>6.03</td>
</tr>
<tr>
<td>7 Tobacco and alcoholic beverages</td>
<td>2.82</td>
<td>1.66</td>
<td>1.20</td>
</tr>
<tr>
<td>8 Others</td>
<td>63.93</td>
<td>66.98</td>
<td>66.52</td>
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5 The process of BTEI operation written in this paper was gathered from informational interview with the director of the entity.
Although weight of goods and services is reviewed once every four years, CPI basket compositions have remain in the same shape with partial changes between periods. The number of items continuously increased from only 232 items in 1962 up to 450 items today. Based on Table 2, food and beverage sector has always had the highest weight proportion following by transportation and communication sector. The choice of products and spending patterns adjusted the most in IT sector as technology is advancing at a very face pace. For example, floppy disk was included in 1997 basket, but no longer existed in 2002 module.

3.2 Administered Prices Operation

In 2011 base year, there are 143 administered price items accounted for around 35% of the basket. Approximately 15.6% is controlled by DTF, Ministry of Commerce and 19.3% from other government entities. Regulated prices are highly influenced by public policies which are not driven by market mechanism. Share of administered items is significantly large and appear in various sectors. Exclusively, most of these items are concentrated in transportation and communication sector for example, oil, gas, public transportation. Referring to Figure 5, within administered price items, 12.40% are in energy, 4.32% in raw food, and the rest 20.88% in diverse sectors. While the controls are rigid and generally consistent over the time, observations reveal that oil and fuel prices induce inflation fluctuation significantly. An explicit example shown in Figure 6 is the period of oil crisis around 2008. After the oil subsidy program was altered, surprising price shock brought up the whole CPI index noticeably.

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6 Thanks to the BOT research department for the processed data.
**Measures of controlling and monitoring prices of goods and services by the Department of Internal Trade, Ministry of Commerce**

**Prices of goods and services act, B.E. 2542 (1999)**

The cabinet authorized Central Commission on Prices of Goods and Services the power to investigate, revise, and specify the list of administered goods and services. The controlling period shall not exceed a period of one year, unless new announcement has been made. The commission shall have the power to prescribe the purchase price or the selling price of administered goods and services as well as to regulate standard measures and conditions of production, distribution process, supply storing and other characteristics of the controlled goods and services in order to prevent speculation hoarding. Producers are prohibited to stop or refuse to perform normal services without reasonable grounds. Any person who refuses to comply with the rule shall be liable to punishments.

Department of Internal Trade, Ministry of Commerce direct and monitor consumption goods on standard, price, size, volume, as well as quality in order to optimize the social welfare and ensure fairness for consumers. Upon the Prices of goods and services act, B.E.2542, goods and services monitoring is divided into 3 following cases:

1. In a normal circumstance, when major costs of production are fairly low meaning the aggregate increase does not exceed 5 percent, and supply of goods sufficiently meet the growing demand, Ministry of Commerce shall have powers and duties as follows:
   - Carry out study, analysis, and research with respect to goods or services, and business operations to make sure the prices reasonably reflect real costs of production, and that supply is suffice with demand and is adequately distributed to all consumers.
   - Monitor movements in prices and business operation, to prevent from unfair conditions or trade practices, including inspection of producers at the sources of production, fresh-food markets, and other distributing areas to assure they follow the rule strictly and if not, they should be penalized. The commission shall have the right of enforcement according to section 29 and section 30 of the Prices of goods and services act, B.E.2542.
   - Regulate selling prices by asking for producers’ cooperation to notify any price adjustment and the reason before it is put on the market.
   - Maintain empowerment of administered goods and services, preserving the 18 items as prescribed in the Prices of goods and services act, B.E.2542 as well as strictly direct control on administered price items as described in section 25 and section 26.

2. In an unusual circumstance, when major costs of production increase at a rate of 5-20 percent, and supply of goods is adequately provided in the market, Ministry of Commerce shall have powers and duties as follows:

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7 Consisting of the Minister of Commerce as Chairman, Permanent Secretary for Commerce and Secretary-General of the Central Commission on Prices of Goods and Services as Vice Chairman, and not less than four but not more than eight qualified persons appointed by the Council of Ministers at least one-half of whom should be appointed from qualified persons in the private sector as members.
Prescribe additional list of administered goods and services as necessary regarding the economic environment as well as the situation of each individual goods. Exercise measures such as determining selling price, determine the maximum rate of profit per unit or determine the proportional difference between the purchase price and sale price of controlled goods or services in each trading period in order to minimize consumer risk of burden high price variation.

Direct a business operator to improve the efficiency of production, purchase, distribution as well as other production factors.

Prevent the stockpiling of goods under section 25. Additionally, require producers, distributors to declare quantity, storing area, production and operation plan; or prescribe the amount of storing reserve of goods.

Link a retailer directly to a producer in order to reduce cost of production as consumers can purchase at a cheaper price.

3. In a critical circumstance, when costs of production increase over 20 percent, and a shortage of goods occur, Ministry of Commerce shall have powers and duties as follows:

- Prescribe additional list of administered goods and services that are necessary consumption goods and essential production factors.
- Strictly regulate selling price by determining appropriate price or prohibiting operator from selling above the setting price.
- Control usage, distribution or transformation of goods as well as manage transportation system to ensure fair allocation and distribution of goods and services.
- Arrange for the rationing of purchase and distribution of goods including prescribing rules and procedures for such rationing.
- Procure necessary consumption goods, manage distribution system to meet people demand.

Department of Internal Trade, Ministry of Commerce has classified the importance of goods and services into 3 main categories as followings:

| 1. Sensitive List | Good or service that is highly volatile. The commission closely tracks the price movement and condition of these items both domestically and internationally on day to day basis. Moreover, authorities are sent out to examine the market price in Bangkok Metropolitan area. In a critical case, commission shall prescribe additional measures as follows:
|                 | i. Prescribe additional administered price of goods and services
|                 | ii. Determine the purchase prices or distribution prices
|                 | iii. Arrange of the rationing of purchase of goods and services
|                 | iv. Supply and distribute goods necessary for living and ensure it is suffice with the demand. |
| 2. Priority Watch List | This category is inferior to the one above as goods and services in this group are followed up twice a week with a close inspection on their prices. In a critical case, commission shall prescribe additional measures as follows: |
i. Links distributors directly to producers
ii. Direct a business operator to improve the efficiency of production, purchase, distribution as well as other production factors
iii. Prescribe measures to prevent the stockpiling

3. Watch List
A least sensitive set of items, which the prices are highly stable. In a normal situation, commission shall prescribe measures as follows:
   i. Monitor price of goods and services every two weeks as well as inspect for any act of unfair trade practices
   ii. Open a 24-hour Hotline 1569 to receive consumer complaints of unfair conditions

4 Research Methodology

To assess the impact of price subsidies on inflation targeting regime, multiple models are applied. In order to capture the effects of administered prices, we reasonably use quarterly data of CPI index with decompositions of each core and headline inflation into administered price inflation and free price inflation. Based on MOC data of CPI index from year 1994-2015, we break the model construction into administered prices index and free prices index. Administered prices index only includes subsidized items for example sugar, oil, student uniform, etc. In the similar way, free prices index was created from index of market-determined items. With these components, tests and models can be estimated more resiliently. The disaggregate indices would allow us to clearly distinguish the effects between variables and perform econometric analyses. Our analyses are divided into 3 main sections: (i) inflation dynamics, (ii) monetary transmission mechanism, and (iii) monetary policy response.

4.1 Inflation Dynamics
In order to understand the evolving process of inflation in Thailand as well as its nature, we perform 5 types of investigation:
   a. Disaggregate sectors regression

The regression analysis of disaggregate sector of CPI basket on overall inflation allow us to trace the importance of inflation determinants over time and to see which category of goods and services is the most dominant indicator. Also, this explores the degree of influential power each individual component has in prescribing inflation level. In other word, it reveals the effect each component has on inflation as described in the equation below:

\[
\log(CPI) = -0.074 + \gamma_1\text{Cloth_Footwear} + \gamma_2\text{Food_Bev} + \gamma_3\text{Housing} + \\
\gamma_4\text{Personal_Medical} + \gamma_5\text{Recrea_Educ} + \gamma_6\text{Tobac_Alch} + \gamma_7\text{Trans_Comm} + \\
\gamma_8\text{Others} + \epsilon_t
\]

b. Correlation Coefficient
The parameter represents the co-movement of variables in the short run as well as specifies how strong the relationships between variables are. A coefficient that is close to 1 can be interpreted as a very tight relationship of between two variables.
In this specific case, the associations between different variables can be perceived through the estimation of correlation. The formula of correlation coefficient is 
\[ r = \frac{cov(x, y)}{\sqrt{s_x^2 \times s_y^2}} \]
Where \( cov(x, y) \) is a covariance of \( x \) and \( y \) defined as 
\[ cov(x, y) = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{n-1} \]
\( s_x^2 \) and \( s_y^2 \) denote sample variances of \( x \) and \( y \) measuring variability around its mean value, 
\[ s_x^2 = \frac{\sum(x_i - \bar{x})^2}{n-1} \quad \text{and} \quad s_y^2 = \frac{\sum(y_i - \bar{y})^2}{n-1} \]

C. Cross Correlation

We next investigate the lead and lag correlations between variables. Cross correlation is one statistical measurement that determines the timing movement between any two series as a function of the lag of one another or in other word; it measures similarity between two series of data at two different time-lag position. By observing correlogram, we will be able to clearly seen when do variables have the maximum correlation. For instance, when does administered price inflation has the strongest correlation with the headline inflation. This can point out the signal of administered price pattern on the overall price. Thus the highest coefficient is associated to the period with the highest correlation.

d. Johansen Co-Integration Test

To identify the long-term nature of connection of two time-series, we applied Johansen Co-Integration Test. Correlation coefficient may be able specify the short run relationship between two variables; however, it cannot adequately indicate any long run association. Co-integrating relationship describe the long-run equilibrium relationship of the co-integrated pairs. Although each path individually can be unpredictable, two variables could possibly move in the same direction overtime. Consistently, given the location of one series, we can fairly estimate position of another as well as the distance between them.

e. Persistency of Inflation

Reviewing existing literatures, general findings from Batani (2002), Levin and Piger (2004), and O’Reilly and Whelan (2005) all suggest that inflation in many countries tends to be highly persistent. In contrast, research by Chantanahom et al. (2004) which employed similar AR(1) and AR(12) analyses for Thailand case with data from 1995 to 2004, concluded that degree of inflation persistence in Thailand was fairly low. Persistence parameter was found to be less than 0.5 for headline inflation.\\n
We adopt the similar autoregressive model AR(1) as in Khemangkorn (2008) as our measures of inflation persistence. Autoregressive help us to be aware of how persistent or how sticky inflation is. Persistency intuitively means that once hit by a shock, how adaptive inflation would be. The regression model provides evidence of degree of inflation persistence as well as reveals how inflation expectation play role in explaining inflation

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8 Method of calculation is similar to correlation coefficient model.
dynamics. High persistency does not favor monetary policy because this means inflation is not likely to response to shock instantly. This quantitative analysis therefore offers important implications for monetary policy in shaping price setting behavior.

The model for AR(1):

\[ \pi_t = \mu + \rho \pi_{t-1} + \epsilon_t \]

where \( \mu \) is the constant term, \( \pi_t \) is the quarter-on-quarter inflation rate at time \( t \), \( \pi_{t-1} \) is the quarter-on-quarter inflation rate of the previous period, and \( \epsilon_t \) is an exogenous shock or external noise.

4.2 Monetary Transmission Mechanism

In understanding the transmission mechanism of monetary policy, we develop a Vector Autoregressive model (VAR). Considering the equation below, the model describes progress of a set of \( k \) endogenous variables including GDP, inflation, and policy rate over the period \( t, \ldots, T \) as linear function of their past value. In our model, \( y_{t-1} \) denotes 1-period lag of \( y_t \), \( A_i \) is \( k \times k \) matrix, \( c \) is a constant term, and \( e_t \) is a vector of error term. Extending from normal autoregressive model, VAR captures the linear interdependencies among multiple time series variables with more than one evolving variable. In this case, the estimate would report the response of all variables to exogenous impulses shock of the policy rate. Applying this model, we would be able to observe how long it takes for monetary policy to become fully effective.

\[ y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + e_t \]

4.3 Monetary Policy Response

a. Taylor Rule

In this section, we proceed to evaluate the Bank of Thailand monetary policy performance by adopting Taylor rule equation. We try to identify whether the MPC used the optimal policy rule for decision-making or not. In other word, how responsive the central bank is to deviation in inflation rate and output gap. The relative weight provides us information on how decision of policy is made as well as explains the act of central bank in different period. On top of that, we explore another aspect of this issue by looking at policy response on administered price inflation and free price inflation. But first, we should notice that estimating using normal Taylor rule may not well reflect the central bank practice as in reality policy rate does not adjust at one time. It instead is done in respective periods. According to Ito and Grenville (2010), conventional estimation response should include lagged dependent variable into the Taylor model to best capture the tendency of interest rate smoothing. This analysis of Taylor equation however is used as a benchmark because real policy setting involves much more complicated model.

Following the literature of Ito and Grenville (2010), we adopt the modified Taylor-type equation of this form:

\[ i_t = r_f + \pi_t + \beta_\pi (\pi_t - \pi^*) + \beta_y (y_t - y^*) + \epsilon_t \]
Where \( i_t \) denotes policy rate (1day repo rate); \( r^f \) is the natural rate of interest; \( \pi^* \) is the target rate \(^{10}\); \( \pi_t \) is the actual inflation; \( y_t - y^* \) is the output gap; and \( \varepsilon_t \) is an error term.

This equation can be rewrite as

\[
i_t = (r^f + \pi^*) + (1 + \beta_\pi)(\pi_t - \pi^*) + \beta_y(y_t - y^*) + \varepsilon_t
\]

\[
i_t = \alpha + \beta_1(\pi_t - \pi^*) + \beta_2(y_t - y^*) + \rho i_{t-1} + \varepsilon_t
\]

The coefficients are interpreted as,

\[
(r^f + \pi^*) = \alpha; \quad \beta_\pi = (1 - \beta_1); \quad \text{and} \quad \beta_y = \beta_2
\]

Based on Taylor principle, central bank should response to an increase in inflation or a positive output gap with a greater increase in interest rate. This means \( \beta_\pi > 0; \beta_y > 0 \)

However, as what we mentioned earlier, to better reflect the interest rate smoothing, we add the lagged variable of policy rate, \( i_{t-1} \) on the right hand side of the equation.

\[
i_t = (1 - \rho)[(r^f + \pi^*) + (1 + \beta_\pi)(\pi_t - \pi^*) + \beta_y(y_t - y^*)] + \rho i_{t-1} + \varepsilon_t
\]

Where

\[
\alpha = (1 - \rho)(r^f + \pi^*); \quad \beta_1 = (1 - \rho)(1 + \beta_\pi); \quad \beta_2 = (1 - \rho)\beta_y
\]

These parameters can be retrieved and the sign condition should be satisfied as followed:

\[
(r^f + \pi^*) = \frac{\alpha}{(1 - \rho)}; \quad \beta_\pi = \frac{\beta_1}{(1 - \rho)} - 1 > 0; \quad \beta_y = \frac{\beta_2}{(1 - \rho)} > 0
\]

On the last part, we derive another specification figure to look on monetary response to administered price inflation and free price inflation by disaggregating the inflation deviation into two component parts.

\[
i_t = \alpha + \beta_1(\pi^{admin} - \pi^*) + \beta_2(\pi^{free} - \pi^*) + \beta_3(y_t - y^*) + \rho i_{t-1} + \varepsilon_t
\]

Estimation of the equation employs data set from 2003q1 to 2014q4.

5 Empirical Results

5.1 Inflation Dynamics

Although central bank has successfully managed to achieve price stability over the past decade, controlling core inflation within a range of 0.5-3%, price control of goods and services seems to have substantial impact to the overall volatility of inflation. We then proceed to look at the impact of administered price on the recent development in different aspects.

We first provide an analysis of descriptive statistics. Headline inflation maybe a better indicator to explain the true cost of living with its high comprehensiveness, but it also contains high transitory noise. We found that headline inflation was highly volatile and this eventually explained by the presence of administered price. Among all variables, headline administered price inflation has the largest mean with 3.14 and a standard deviation of 4.22. Since administered price items accounted for 38% of the total CPI basket, this suggests that the movement of this price certainly influence the general headline figure.

\(^{10}\)In our model, interest rate target is assumed to be 1.75% for core inflation and 3% for headline inflation
If we take a closer look on Figure 7, since the year 2002 when there was a large increase in administered price control, it can be obviously seen that core and headline inflations started to diverge out from each other. Moreover, the spikes in price level are likely caused by administered prices. Two extreme episodes of price control were during 2006 and 2008, where there are large deviations between free price inflation and aggregate price level. During the time there was large fuel and transportation subsidies as well as public services price aiding program. These controls made it harder for Bank of Thailand to assess the real demand and to judge the underlying price movement.

Table 3 Descriptive Statistics
Sample: 1996Q1 2014Q4

<table>
<thead>
<tr>
<th></th>
<th>Core Inflation</th>
<th>Core Admin Inflation</th>
<th>Core Free Inflation</th>
<th>Headline Inflation</th>
<th>Headline Admin Inflation</th>
<th>Headline Free Inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.976</td>
<td>1.829</td>
<td>2.012</td>
<td>3.129</td>
<td>3.140</td>
<td>3.081</td>
</tr>
<tr>
<td>Median</td>
<td>1.477</td>
<td>1.166</td>
<td>1.284</td>
<td>2.828</td>
<td>2.634</td>
<td>2.448</td>
</tr>
<tr>
<td>Minimum</td>
<td>-0.570</td>
<td>-5.223</td>
<td>-0.183</td>
<td>-2.638</td>
<td>-12.968</td>
<td>-0.974</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>1.839</td>
<td>2.480</td>
<td>2.010</td>
<td>2.425</td>
<td>4.227</td>
<td>2.292</td>
</tr>
<tr>
<td>Skewness</td>
<td>1.465</td>
<td>0.113</td>
<td>1.314</td>
<td>0.540</td>
<td>-1.026</td>
<td>0.975</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>36.561</td>
<td>4.805</td>
<td>24.689</td>
<td>4.836</td>
<td>45.246</td>
<td>15.119</td>
</tr>
<tr>
<td>Probability</td>
<td>0.000</td>
<td>0.090</td>
<td>0.000</td>
<td>0.089</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Subsample: 2000Q3 2014Q4

<table>
<thead>
<tr>
<th></th>
<th>Core Inflation</th>
<th>Core Admin Inflation</th>
<th>Core Free Inflation</th>
<th>Headline Inflation</th>
<th>Headline Admin Inflation</th>
<th>Headline Free Inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.286</td>
<td>1.083</td>
<td>1.323</td>
<td>2.686</td>
<td>2.690</td>
<td>2.612</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>0.894</td>
<td>1.957</td>
<td>1.185</td>
<td>1.884</td>
<td>4.383</td>
<td>1.593</td>
</tr>
</tbody>
</table>

It is undeniable that the restrictions of prices help to maintain price stability of goods and services as well as protect welfare of consumers in the short run; however, the rapid price rise after the control is unwound drives up inflation greatly. This explains why administered price inflation has relatively higher standard deviation in both core and headline inflation. However, core inflation is comparably more stable. Its low variation can be explained by the exclusion of energy and raw food from the composite of inflation. Removing large portion of administered items allows core inflation to move freely, driven by market mechanism, and better reflect the current state of demand as well as true pace of inflation.
Figure 7: Development of Inflation Process in Thailand

Core Inflation

Core administered prices inflation

Core free prices inflation

Headline Inflation

Headline administered prices inflation

Headline free prices inflation

Core target band: 0.5-3%
Disaggregate Sectors Regression

In this section, we take a closer look at the relationship between inflation and disaggregate components. The total CPI is broken down into eight different sectors conforming to the categories proposed by the Bureau of Trade and Economic Indices.

Table 4 Disaggregate CPI Components Regression – Headline Inflation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Food and Beverages</td>
<td>0.405</td>
<td>0.004</td>
<td>0.000</td>
</tr>
<tr>
<td>2 Transportation and Communication</td>
<td>0.139</td>
<td>0.022</td>
<td>0.000</td>
</tr>
<tr>
<td>3 Clothing and Footwear</td>
<td>-0.129</td>
<td>0.024</td>
<td>0.000</td>
</tr>
<tr>
<td>4 Recreational and Education</td>
<td>0.074</td>
<td>0.009</td>
<td>0.000</td>
</tr>
<tr>
<td>5 Tobacco and Alcoholic Beverages</td>
<td>0.029</td>
<td>0.003</td>
<td>0.000</td>
</tr>
<tr>
<td>6 Personal and Medical care</td>
<td>0.002</td>
<td>0.021</td>
<td>0.091</td>
</tr>
<tr>
<td>7 Housing</td>
<td>0.132</td>
<td>0.023</td>
<td>0.000</td>
</tr>
<tr>
<td>8 Others</td>
<td>0.236</td>
<td>0.058</td>
<td>0.000</td>
</tr>
</tbody>
</table>

From analysis above, using monthly data from 2003 to present, food and beverage sector has the highest impact on headline inflation as it has the strongest coefficient with 0.405. Given that the majority of items in this category are necessity consumption goods as well as inputs for other goods, a change in headline inflation process is largely influenced by the movement of this sectoral index. Correspondingly, transportation and communication which heavily composed of oil and fuels, is also an important determinant of headline volatility. A change in these prices would produce a pass-through effect or passing cost over on other items. Evidence from Mallikamas (2004) demonstrates that pass-through effect or second-round effect has diminished. The author stated that “The change in the degree of pass-through is most likely a result of lower inflation expectation, intense competition in retail sector, and price administration by the government.”

Table 5 Disaggregate CPI Components Regression – Core Inflation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Food and Beverages</td>
<td>0.257</td>
<td>0.018</td>
<td>0.000</td>
</tr>
<tr>
<td>2 Transportation and Communication</td>
<td>-0.024</td>
<td>0.090</td>
<td>0.784</td>
</tr>
<tr>
<td>3 Clothing and Footwear</td>
<td>0.485</td>
<td>0.097</td>
<td>0.000</td>
</tr>
<tr>
<td>4 Recreational and Education</td>
<td>-0.025</td>
<td>0.039</td>
<td>0.516</td>
</tr>
<tr>
<td>5 Tobacco and Alcoholic Beverages</td>
<td>0.076</td>
<td>0.015</td>
<td>0.000</td>
</tr>
<tr>
<td>6 Personal and Medical care</td>
<td>0.201</td>
<td>0.084</td>
<td>0.019</td>
</tr>
<tr>
<td>7 Housing</td>
<td>0.084</td>
<td>0.095</td>
<td>0.381</td>
</tr>
<tr>
<td>8 Others</td>
<td>0.123</td>
<td>0.233</td>
<td>0.596</td>
</tr>
</tbody>
</table>

The results yet show different story under core inflation model, coefficient of food and beverages as well as transportation and communication sector are substantially lower than what we saw in the previous case. In contrast to headline inflation, the exclusion of raw food and energy items made these categories less dominant in explaining inflation dynamic. At the same time, core inflation has more service proportion in its measure; hence, core CPI basket is vastly driven by movement in service prices. The evidence of 12-years regression analysis illustrates that clothing and footwear has become the major determinant of core inflation process.
**Coefficient Correlation**

Table 6 Correlation of key price measures between 1994 and 2014

<table>
<thead>
<tr>
<th></th>
<th>Core Inflation</th>
<th>Core Admin Inflation</th>
<th>Core Free Inflation</th>
<th>Headline Inflation</th>
<th>Headline Admin Inflation</th>
<th>Headline Free Inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>1.000</td>
<td>0.762</td>
<td>0.946</td>
<td>0.812</td>
<td>0.503</td>
<td>0.842</td>
</tr>
<tr>
<td>Core Admin</td>
<td>0.762</td>
<td>1.000</td>
<td>0.524</td>
<td>0.769</td>
<td>0.782</td>
<td>0.457</td>
</tr>
<tr>
<td>Core Free</td>
<td>0.946</td>
<td>0.524</td>
<td>1.000</td>
<td>0.694</td>
<td>0.276</td>
<td>0.891</td>
</tr>
<tr>
<td>Headline</td>
<td>0.812</td>
<td>0.769</td>
<td>0.694</td>
<td>1.000</td>
<td>0.831</td>
<td>0.784</td>
</tr>
<tr>
<td>Headline Admin</td>
<td>0.503</td>
<td>0.782</td>
<td>0.276</td>
<td>0.831</td>
<td>1.000</td>
<td>0.307</td>
</tr>
<tr>
<td>Headline Free</td>
<td>0.842</td>
<td>0.457</td>
<td>0.891</td>
<td>0.784</td>
<td>0.307</td>
<td>1.000</td>
</tr>
</tbody>
</table>

The table above provides some simple statistics on core inflation, headline inflation in more dimensions with both administered price and free price inflation. According to Mallikamas (2005), the correlation of headline and core inflation has fallen sharply after 2002. One of the factors contributing to this decline is administered price. This proposes a criticism of the use of core inflation as a monetary target. In contrast to Mallikamas’s view, the results of above suggest that shifting to headline inflation targeting can be more challenging. The large share of administered items in CPI basket is eventually concentrated in transportation and communication sector, which are necessity goods for living that largely govern headline inflation process. Hence, headline inflation is strongly correlated with administered price inflation than free price inflation with coefficient correlation of 0.831 and 0.784 respectively. On the other hand, with the exclusion of energy and raw food, core inflation highly associated with free price inflation than the price control sector. As Central Bank has moved toward headline inflation targeting, this fact implies that it might burden great risk of breaking the target since monetary policy does not have the ability to control administered price inflation.

**Cross correlation**

The evidence below shows that free price inflation has the highest correlation with administered price inflation in the leading period. Core inflation process is largely governed by free price inflation. The negative correlation between the lag period of free price and administered price reveals the process of government in regulation price control. Because of the little relationship administered price and free price had in the core inflation, the price controls implemented by government did not have significant effect on free price inflation.
As administered price items accounted for large share in headline CPI basket, the movement of administered price inflation played a prevailing role in determining overall headline inflation. We discovered that strong correlation is exhibited in the instant period between the two. The estimation on free price inflation depicts tighter correlation to headline inflation with its leading period. This perhaps explains pass-through effect of headline inflation on free price. Finally, the most interesting finding is, on the last diagram of Figure 9, administered price and free price inflation had both solid lag and lead correlations. The probable explanation is that as price of goods and services increase, government

---

**Figure 8: Cross Correlation between Core Administered Prices Inflation and Core Free Price Inflation**

Sample: 2000Q3 2014Q4  
Included observations: 58  
Correlations are asymptotically consistent approximations

<table>
<thead>
<tr>
<th></th>
<th>C_ADINF,C_FINF(-i)</th>
<th>C_ADINF,C_FINF(+i)</th>
<th>i</th>
<th>lag</th>
<th>lead</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>-0.275</td>
<td>-0.275</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>-0.433</td>
<td>-0.087</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>2</td>
<td>-0.466</td>
<td>0.072</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>-0.386</td>
<td>0.167</td>
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<td></td>
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<td>4</td>
<td>-0.235</td>
<td>0.187</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>-0.073</td>
<td>0.184</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>0.020</td>
<td>0.177</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td>0.030</td>
<td>0.145</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>-0.029</td>
<td>0.099</td>
</tr>
</tbody>
</table>

---

**Figure 9: Cross Correlation between Headline Administered Prices Inflation and Headline Free Price Inflation**

Sample: 2000Q3 2014Q4  
Included observations: 58  
Correlations are asymptotically consistent approximations

<table>
<thead>
<tr>
<th></th>
<th>H_ADINF,H_FINF(-i)</th>
<th>H_ADINF,H_FINF(+i)</th>
<th>i</th>
<th>lag</th>
<th>lead</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>-0.059</td>
<td>-0.059</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>-0.371</td>
<td>0.315</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>-0.501</td>
<td>0.471</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>-0.384</td>
<td>0.420</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>-0.100</td>
<td>0.217</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>0.074</td>
<td>-0.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>0.134</td>
<td>-0.091</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td>0.037</td>
<td>-0.134</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>-0.065</td>
<td>-0.086</td>
</tr>
</tbody>
</table>
authorities are likely to limit this price changes by suppressing the prices of administered items. However, after a certain period of time, when control is altered, the inflationary shock would pass through to free price inflation in the later periods. The results consistently confirm that headline inflation is largely influenced by the price administration, which cannot be managed by the central bank. As in the early of 2015, cabinet approved annual average headline inflation at 2.5 ± 1.5 percent tolerance zone as primary policy target. As a result, our findings address that achieving the target may apparently become difficult.

Cointegration Test

Johansen Co-integration test is performed to derive the long-run coefficient of the relationship between administered price and overall inflation. Based on empirical results above, Johansen co-integration hypothesis between the two variables are rejected at 0.05 level for both core and headline inflation.\textsuperscript{11} The rejection suggests that administered prices do not have significant effect on comprehensiveness and does not reflect the underlying cost of living in the long term. In other word, because the restriction period is temporary, administered price inflation has no long run integration with both core and headline inflation. Even though in the short run administered price directly determine the dynamics of free price and overall inflation, there is no significant co-integrating relationship in the long run.

Autoregression

Another crucial factor for policy-making analyses is the persistence of inflation. Higher inflation persistence amplifies output and inflation effects of monetary policy shock. (Angeloni, Coenen, and Mets 2003). Thus, inflation persistence could be costly for monetary policy when inflation is highly interacted with expectation. This means that any shock can produce prolong effects and could potentially cause spiral inflation.

In testing inflation persistence with autoregressive model AR(1) to AR(4) as in Khamangkorn (2008), we find that administered price inflation is reasonably less persistence than free price inflation for core inflation case whereas in headline inflation is shown to be insignificant.\textsuperscript{12} Although, there are lower frequencies of price adjustment due to the stickiness in price of a large number of administered price components, once they are allowed to adjust, prices are likely to rise significantly. The time-frame of price control is also considered temporary; making administered price inflation became relatively less persistence.

The effect of shock on price level is persisted if the length of wage contract is long and price cannot be changed instantaneously. Similarly, process of setting price and extracting the signal of price changes are slow. As administered price items are strictly regulated by government entities, price do not freely driven by market mechanism. Price can therefore adjust more swiftly than market-determined items.

\textsuperscript{11} The empirical results are illustrated in Appendix A
\textsuperscript{12} In this section, we employed quarter-on-quarter dataset on autoregression analysis as it better explain persistency of inflation.
Table 7 Estimates of persistence in disaggregate inflation

<table>
<thead>
<tr>
<th></th>
<th>$\rho$ coefficient</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Inflation</td>
<td>0.490</td>
<td>0.001</td>
</tr>
<tr>
<td>Core Admin Inflation</td>
<td>0.523</td>
<td>0.000</td>
</tr>
<tr>
<td>Core Free Inflation</td>
<td>0.771</td>
<td>0.000</td>
</tr>
<tr>
<td>Headline Inflation</td>
<td>0.297</td>
<td>0.021</td>
</tr>
<tr>
<td>Headline Admin Inflation</td>
<td>0.352</td>
<td>0.006</td>
</tr>
<tr>
<td>Headline Free Inflation</td>
<td>0.041</td>
<td>0.767</td>
</tr>
</tbody>
</table>

Another important finding can be drawn from Table 7 is that the persistence parameter ($\rho$ coefficient) of inflation process for headline inflation is proportionately less than core inflation. This result is consistent with what we discussed earlier. Given that administered prices have low persistency, headline inflation, which contains high proportion of price controls, is therefore less persistent. It can be seen from column 2 that the estimated degree of persistence for headline inflation is somewhat lower in every inflation series and model specifications.

$$\pi_t = \pi^e + aX_t + v_t$$

$$\pi_{t-1} \rightarrow \text{Backward Looking}$$

$$E_t(\pi_{t+1}) \rightarrow \text{Forward Looking}$$

$$\pi_t = (1 - \gamma)\pi_{t-1} + \gamma E_t(\pi_{t+1}) + v_t$$

Referring to New Keynesian Phillips Curve, the model implies that current inflation is determined by inflation expectation and output gap. Given the low persistence in headline inflation, we can infered from the equation above that when $(1 - \gamma)$ is low $\gamma$ will then be assumably high as they are alternatives. One essential point can be derived from the results is that by shifting to headline targeting framework, central bank noticeably has higher ability to anchor inflation expectation.

5.2 Monetay Transmission Mechanism

Vector Autoregression model

In the last section, we then take investigation on the effectiveness of monetary policy. Through testing length of transmission mechanism of monetary policy, we discovered that free prices inflation response slower to interest rate changes relative than overall inflation. As in Figure 10, given impulse shock on policy rate, headline inflation as well as core inflation tend to adjust faster to interest rate shock than the market-determined price inflation does. The VAR charts above demonstrate that for headline inflation, it takes approximately 8 quarters for monetary to have full impact, whereas it takes almost 10 quarters for free price. This is consistent with core inflation where monetary policy becomes effective in 9 quarters and 10 quarters on free price.

This suggests that the transmission process of monetary policy of take more than 2 years for it to have full effect on the inflation. More importantly, because free prices sector, which central bank has direct control and should strongly focus on, response significantly lower. The implies that Bank of Thailand should even be more forward looking as monetary policy likely takes longer horizon than expect. Due to price stickiness, free prices inflation
requires certain amount of time to completely adjust. It is noteworthy that we have already taken into account of exogenous oil price, price puzzle still exist. Explicit analysis indicates that normal framework of VAR might not be suitable as VAR model in general is symmetric. Hence, a modified model of VAR, extending the conventional analysis to capture the asymmetric response is necessary required for further study.

Figure 10: VAR with impulse shock on policy rate

Response of headline inflation to policy rate

Response of headline free prices inflation to policy rate

Response of core inflation to policy rate

Response of core free prices inflation to policy rate
5.3 Monetary Policy Response

Taylor Rule

Table 8 Taylor Equation Estimation Results

<table>
<thead>
<tr>
<th></th>
<th>Sample period (2003Q1-2014Q4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal Equation Estimated by GMM</td>
</tr>
<tr>
<td></td>
<td>Regression</td>
</tr>
<tr>
<td>constant</td>
<td>$\alpha = r_f + \pi^*$</td>
</tr>
<tr>
<td>output gap</td>
<td>$\beta_2 = \beta_y$</td>
</tr>
<tr>
<td>inflation gap</td>
<td>$\beta_1$</td>
</tr>
<tr>
<td>lagged policy</td>
<td>$\rho$</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.555</td>
</tr>
</tbody>
</table>

Notes: Brackets are standard errors. "**" denotes significance level at 5%

After performing regression tests, we found that the coefficient of inflation deviation in both the normal equation and smoothing equation seems reasonable with $\beta_\pi > 1$, although the magnitude of response to output gap is statistically insignificant. Using aggregate core inflation, monetary policy has been optimal, judging by the coefficient of inflation gap is greater than 1. Additionally, smoothing coefficient suggests certain degree of policy rate stickiness with $\rho = 0.682$.

Table 9: Modified Taylor Rule with Administered Price

<table>
<thead>
<tr>
<th></th>
<th>Smoothing Equation Estimated by GMM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>core inflation</td>
</tr>
<tr>
<td>Constant</td>
<td>$r_f + \pi^*$</td>
</tr>
<tr>
<td>output gap</td>
<td>$\beta_y$</td>
</tr>
<tr>
<td>administered price inflation gap</td>
<td>$\beta_{\pi \text{admin}}$</td>
</tr>
<tr>
<td>free price inflation gap</td>
<td>$\beta_{\pi \text{free}}$</td>
</tr>
<tr>
<td>lagged policy</td>
<td>$\rho$</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.938</td>
</tr>
</tbody>
</table>

It is interesting to look on the details of monetary policy setting under the presence of administered price (see Table 9). The evidence suggests that the coefficients of both administered price inflation gap and free price inflation gap are highly significant. Moreover, the central bank seems to be slightly more responsive to administered price deviation. Based on this criteria, monetary policy does not appear to be optimal given that it also responses to jump in administered price. To confirm this, we adopt another measure using headline inflation. In this case, the coefficient of administered price gap is statistically significant at 0.92, whereas coefficient of free price variable is insignificant. This specification proved to provide similar result.
One important finding emerged from this outcome-based Taylor rule specification is that operational policy setting is not optimal when looking at market-determined inflation alone. Different specifications might be needed for robustness check.

6 Conclusions

To the most recent period, inevitably, Thailand inflation process has largely been influenced by the price aiding programs of the government. Specifically, the low level of inflation in the past decades is partly attributable to price administrations. However, it has also been responsible for the divergence between core and headline inflation. The issue regarding the effect of administered price on inflation targeting brought us motivation in conducting this research study. On the one side, arguments suggest that government price controls complement central bank’s price stability goal and hence support monetary policy under inflation targeting framework. In contrast, the opposite side views that the price restrictions rather distort market mechanism and do not provide long term alleviation of price pressure. Instead, performing monetary policy becomes more complicated and its effectiveness is hindered.

We analyze the impact of administered price on inflation process and the conduct of monetary policy covering three different dimensions (i) inflation dynamics; (ii) monetary transmission mechanism; (iii) central bank reaction function using the Taylor Rule specification.

The empirical results conclude 3 main findings as follows: First, price controls regulated by the government raise concern on controllability of monetary policy. Headline inflation is highly volatile with relatively larger standard deviation than core inflation. This implies that central bank burdens great risk of breaking the target as well as losing its controllability. In addition, the magnitude of correlation between headline inflation and administered prices sector is significantly high. With more than one third of the CPI basket consisting of administered items, these variations are difficult to be managed and are not within direct control of monetary policy. By investigating cross correlation between inflation measures, complicated lead and lag relationship of headline administered price and free price inflation emerged. Government authority would strictly regulate administered items, which are crucial inputs to other goods and services such as oil, or raw food. The impulse responses would later neutralize relative price changes. After certain time, when control is unwounded, drastic price rises generate inflationary shock to overall basket. The rigidity of administered price obstructs the real underlying price pressure. Therefore, conducting monetary policy becomes even more complex.

The study does not argue that the change in framework toward headline targeting is inappropriate. Even though administered price may propose certain difficulties for monetary policy operation and play important role in explaining inflation dynamics, price controls do not have any long-run relationship with inflation development. More importantly, using the former econometric test, autoregression model with disaggregate components, we found that headline inflation was relatively less persistent than core inflation. Less persistence of inflation implies that once it gets hit by a shock, inflation tend to adjust back quickly. This can be inferred that the central bank has higher ability to anchor inflation expectation and increases monetary policy effectiveness.

Secondly, our research suggests that Bank of Thailand should be even more forward looking in setting appropriate monetary policy. In exploring the transmission mechanism of
policy interest rate by using a simple VAR method, free prices sector apparently has slower transmission process than the overall headline inflation with over 2 years. Since free prices inflation is what the central bank has direct control over, it should be cautious in evaluating time horizon of transmission mechanism. Wage rigidity and price setting behavior is one possible explanation describing price adjustment process. Nevertheless, it is noteworthy that the samples in the test already take into account of exogenous oil price, but price puzzle remains.

Lastly, based on Taylor rule estimation, the optimality of monetary policy seems to depend crucially on how inflation has been measured. Using core inflation, monetary policy has been optimal with the coefficient of inflation deviation significantly greater than 1. However, when core inflation is decomposed into administered items and market-determined items, it appears that the Bank of Thailand was more responsive to variation in administered price sector than the free price inflation gap and both long-run coefficients are less than 1. Given higher variability of administered price inflation, policy rate response would be more volatile.

Important policy implication is that more coordination between Bank of Thailand and Ministry of Commerce is necessary required. Since both organizations have the same objective in preserving social welfare and people cost of living, collaboration would eventually allow them to achieve their goal more effectively rather than interfering each other work. Without communication, it is very difficult for the central bank to know when and how control measures will be changed. As a result, Bank of Thailand cannot anticipate this information into its inflation forecast. Regarding the high volatility of headline inflation due to the large variation in administered prices, government should therefore carefully reconsider the regulated items by performing cost and benefit analyses. Reduction in controls of insignificant goods and services is essentially encouraged. Communication about when to alter the controlling items would also become helpful for the central bank in designing monetary policy as policy maker can incorporate the following information into its forecast. Finally, information sharing is also a relevant factor that built up clearer economics prospect as well as to understand real underlying price movement.

Further extensions of this study could incorporate the welfare analysis determining the most optimal threshold for administered prices for the economy. The evidences of our paper may conclude certain difficulties arises from price subsidies program and does suggest several important findings on inflation development. However, the analyses do not capture economical aspect on how price controls effect economic growth.
References:


**Appendix A**

Sample (adjusted): 1996Q4 2014Q4

Core inflation and Core administered inflation

Unrestricted Cointegration Rank Test (Trace)

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Eigenvalue</th>
<th>Trace Statistic</th>
<th>0.05 Critical Value</th>
<th>Prob.**</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>None *</td>
<td>0.207384</td>
<td>25.84109</td>
<td>15.49471</td>
<td>0.0010</td>
<td>Not cointegrated</td>
</tr>
<tr>
<td>At most 1 *</td>
<td>0.114472</td>
<td>8.874717</td>
<td>3.841466</td>
<td>0.0029</td>
<td>Not cointegrated</td>
</tr>
</tbody>
</table>

Headline inflation and Headline administered inflation

Unrestricted Cointegration Rank Test (Trace)

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Eigenvalue</th>
<th>Trace Statistic</th>
<th>0.05 Critical Value</th>
<th>Prob.**</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>None *</td>
<td>0.223578</td>
<td>30.80466</td>
<td>15.49471</td>
<td>0.0001</td>
<td>Not cointegrated</td>
</tr>
<tr>
<td>At most 1 *</td>
<td>0.155425</td>
<td>12.33130</td>
<td>3.841466</td>
<td>0.0004</td>
<td>Not cointegrated</td>
</tr>
</tbody>
</table>

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values
Appendix B

Core Inflation

Core Administered Price Inflation

Core Free Price Inflation

Headline Inflation