Chapter 11

THE ROLE OF GLOBAL FOOD AND OIL PRICES ON THAILAND'S INFLATION AND MONETARY POLICY

By

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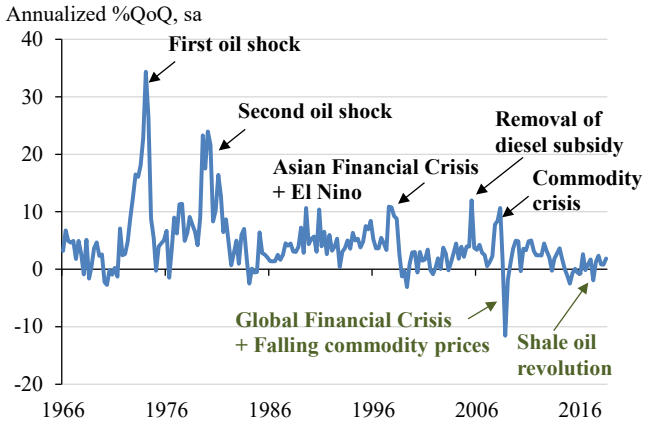
1. Introduction

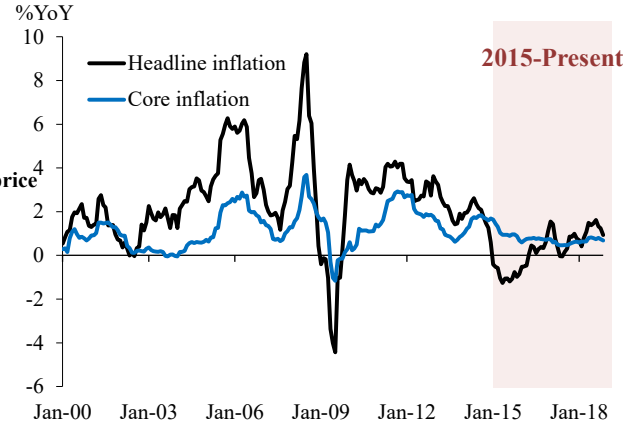
Commodity price dynamics have been important sources of macroeconomic fluctuations for over decades. In retrospect, two oil crises emerged during 1970s and triggered global economic stagflation, characterised by high inflation and unemployment rates. Although commodity prices were less volatile since then, they were once again on a constantly rising trend during 2000s. Both global oil and food prices peaked in 2008, causing high inflation worldwide amidst global economic downturn. The situation has, however, reversed over the past decade, with both commodity prices in the down-cycle. Global inflation has, thus, declined and stood at a low level, posing concern over monetary policy normalisation. Thailand's inflation is without exception. Commodity price developments have played a crucial role in Thailand's inflation dynamics. Figure 1 depicts quarter-on-quarter changes in the consumer price index, where many extreme inflation movements are found to be associated with periods of high volatility in commodity prices. In response to recent declines in global oil prices, headline inflation fell sharply at the end of 2014 and has been low since then (Figure 2). Thai fresh food inflation over the past 4-5 years is also lower than its historical average, raising doubts over the extent such a decline is induced by falling global food prices.

Figure 1
Thailand's Headline Inflation (1966-2561Q3)



Source: IMF

Figure 2
Thailand's Headline and Core Inflation



Source: Ministry of Commerce and calculated by BoT

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Since price stability is the overriding objective of monetary policy, inflation volatility triggered by commodity price changes has posed challenges to policymakers. In particular, to the extent that such changes have persistent effects on inflation and hence have a second-round impact on inflation expectations, monetary policy may have to respond to anchor inflation expectations and avoid any wage-price spiral that once occurred in 1970s. The Bank of Thailand (BoT), therefore, constantly monitors developments and dynamics of commodity prices, among various macroeconomic indicators, in order to cater appropriate policy decisions. This paper aims to benefit monetary policymaking by studying the roles of global food and oil prices in driving Thailand's inflation. The authors focus on three main research questions: First, what is the impact of changes in global food and oil prices on Thailand's inflation? Second, do those changes matter for underlying (trend) inflation pressure? Last, what are their implications on monetary policy?

The analysis on the impact of commodity prices on domestic inflation has garnered more attention after the global commodity crisis during late 2000s. Most researches were conducted in a multi-country setting including a large number of advanced and emerging economies. Furceri et al. (2015), for example, studied the effects of global food prices and found that, for advanced countries, 10-percentage-point increases in global food inflation raised domestic inflation by 0.5 percentage points. However, they reported that the impact could be much larger for emerging economies, partly owing to the higher food share in the CPI basket and less-anchored inflation expectations. Meanwhile, Choi et al. (2017) found that domestic inflation rose by 0.4% following 1% increases in global oil prices. The authors also documented that positive oil price shocks had a larger effect on inflation than negative ones. Such an impact asymmetry is another area to be explored in this study of Thailand.

A few articles hypothesised that structural characteristics of each country mattered for the magnitude of the impact. Choi et al. (2017) found that the share of transport in the CPI basket and energy subsidies could help explain cross-country variations in the effects of oil price shocks. Meanwhile, Gelos and Ustyugova (2012) explicitly studied the factors influencing dispersion in inflation responses to commodity price shocks. They found that food shares in the CPI basket, fuel intensities, and pre-existing inflation levels were behind such dispersion. This has, therefore, raised a question of where Thailand stands in terms of the commodity price pass-through. Most studies including Blanchard and Gali (2007), nevertheless, documented the decline in the pass-through over time, due in part to a better conduct of monetary policy.

To the knowledge of the authors, Jongwanich and Park (2011) is the only paper that focuses exclusively on the role of global oil and food price shocks on inflation in the case of "developing Asia". They, however, concluded that the magnitude of the pass-through is small, citing a role played by subsidies and price controls in alleviating the impact.[3] In the case of Thailand alone, Manopimoke and Direkudomsak (2015) examined how the process of globalisation has altered Thai inflation dynamics since 1990s. They found that, since 2001, Thai inflation has become increasingly dependent on the global factors, particularly world oil prices. Furthermore, the recent paper by Limjaroenrat et al. (2018) showed that food and energy prices combined could explain approximately 70 percent of relative price changes at business cycle frequencies.

3. The pass-through estimated in this paper is indeed comparable to that from Jongwanich and Park (2011). However, the authors view that they are economically important, given high volatility of global commodity prices.

To shed light on the three research questions outlined above, the authors rely on two approaches. First, they adopt the local projection method following Jorda (2005) to quantify the sensitivity of Thailand's headline and core inflation to global oil and food price changes. The method was previously employed by Choi et al. (2017) and Furceri et al. (2015) to study the role of commodity prices in a panel comprising a large number of countries. As in the literature, the authors are also interested in whether the impact is asymmetric and non-linear, and whether the pass-through has changed over time. Their findings suggest that both oil and food price changes have statistically significant and economically important, though short-lived, effects on headline inflation. Food price changes, in particular, seem to have a larger and more long-lasting impact, perhaps due to a high share of food in the CPI basket. However, core inflation is barely affected, suggesting limited second-round effects on inflation expectations and labour wages. With regard to impact asymmetry and non-linearity, they find that negative changes tend to have a larger impact on headline inflation than positive changes. The result underscores the importance of government measures as well as firms' price-setting behaviour in a high-competition environment. Large changes, meanwhile, are found to have bigger consequences on inflation than small changes, highlighting the existence of adjustment costs. Additionally, compared to the past, the impact of both commodity price changes is smaller and less persistent. This may be partly attributed to greater commitment of monetary policy towards price stability.

Second, the authors follow the trend-cycle approach of Forbes et al. (2017), by disentangling trend and cyclical components from headline inflation, and then examining whether changes in global food and oil price matter to any of them. To extent that these movements affect trend inflation, there will be important implications on monetary policy. In order to extract trend inflation, they rely on a Multivariate Unobserved Component Stochastic Volatility model following Stock and Watson (2016) and Manopimoke and Limjaroenrat (2017). They find that oil and food price growth are a significant driver of both permanent and transient components of Thailand's headline inflation. In other words, their changes may affect trend inflation or have persistent effects on actual inflation. Their changes are also found to explain larger variation in inflation, compared to other standard macroeconomic variables. A puzzle arises, since the earlier finding from the local projection method points out that changes in commodity prices do have merely short-lived effects on Thailand's inflation. The authors explain this discrepancy by arguing that changes in commodity inflation may themselves persist, thus inducing a persistent impact on inflation. Trend growth of commodity prices is indeed time-varying and can be shown to coincide well with Thailand's trend inflation. As stated above, this finding poses important challenges to monetary policymakers. This is not limited to interest rate decisions that may need to take into account potential long-lasting effects from commodity price developments, but to the setting of the inflation target.

The rest of the paper is organised as follows. Second 2 estimates the local projections in order to quantify the sensitivity of inflation to commodity price changes. The roles of fiscal and monetary policy in alleviating the pass-through are also discussed. The trend-cycle approach is adopted in Section 3 to examine whether commodity prices can persistently affect trend inflation. It is shown how the result can be useful in understanding Thailand's low inflation dynamics. Section 4 reports policy implications, while section five concludes.

2. The Effects of Global Oil and Food Prices on Thailand's Inflation: A Local Projection Approach

2.1 Model Specification

In this section, the authors attempt to quantify the impact of changes in global oil and food prices on Thailand's inflation, relying on a local projection approach. Like a vector autoregression (VAR) model, the method allows them to trace the dynamic effects of shocks on variables of interest. Nevertheless, as argued by Jorda (2005), it is more robust to model misspecification and accommodates experimentation with non-linear specifications, which are impractical in a multivariate context. To perform local projections, the following specification is estimated:

$$\pi_{t+k} = \alpha^k + \sum_{j=1}^{l} \gamma_j^k \pi_{t-j} + \beta_k \pi_t^c + \sum_{j=1}^{k} \theta_j^k \pi_{t+j}^c + \delta_k y_{t+k} + \varepsilon_t^k, c \in \{oil, food\}. \quad (1)$$

π_t denotes the percentage change in Thailand's headline consumer price index (CPI), while π_t^c is the percentage change in global oil or food prices[4]. For global oil prices, the authors rely on Dubai crude oil prices, since Thailand, or more generally the South East Asian countries, mainly imports crude oil from the Middle East. Dubai prices, hence, serve as a price benchmark for oil from such region. Meanwhile, a food price index compiled by the World Bank is used as a proxy for global food prices. The index covers prices of a wide variety of food commodities, such as vegetable oils, meals, grains, etc. The authors, alternatively, employ a food price index from Food and Agricultural Organisation of the United Nations (FAO) for a robustness check. To capture the persistence of inflation, lagged values of the dependent variable are included, where $l = 4$ is set. Furthermore, as in Choi et al (2017) and Teulings and Zubanov (2010), the forward leads of commodity price changes are also included in the specification to correct the bias in impulse responses inherent in the local projection method. The only controlled variable present in the equation is the output gap. This is to capture the role of domestic economic conditions in determining inflation dynamics.

The coefficient of interest is β_k, which measures the impact of changes in global oil or food prices on Thailand's inflation for each future period k. To obtain dynamic responses of inflation to each commodity price change, the authors plot estimated β_k from $k = 0$ (the date of the commodity price change) to the end of the forecast horizon. Here, $k = 6\ is\ set.$ 95% confidence bands for the impulse responses are computed using the Newey-West standard errors associated with the estimated coefficients. The estimation sample is from January 2000 to September 2018 (monthly frequency). The chosen sample corresponds to periods under the Inflation Targeting regime, which commenced in May 2000 and potentially caused shifts in structural parameters, especially those related to inflation dynamics.

2.2 Baseline Results

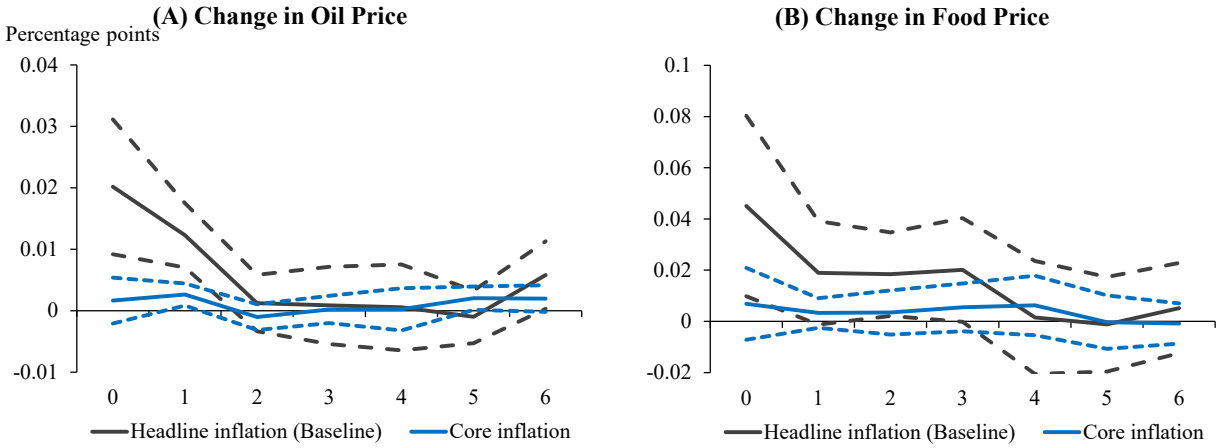
Figure 3 shows the baseline results obtained from estimating Equation (1) above. The results suggest that both global oil and food price changes have significant, but short-lived, effects on Thailand's headline inflation (black lines). For changes in oil prices, the responses of inflation are relatively instantaneous, as the impact dissipates after one month. In particular, they find that a one-percentage-point increase in Dubai oil price growth causes Thai inflation to rise by approximately 0.03 percentage point after one month. Meanwhile, the effects of a food price change appear to

4. See sources and definitions of all variables in the Appendix

be larger and last slightly longer. The estimates, in particular, are statistically significant for one quarter after a change in food prices occurs. Overall, rises in global food inflation of 1.0 percentage point will result in 0.10-percentage-point increases in headline inflation.

The larger impact from global food price movements on Thailand's inflation may reflect a huge share of food products within the CPI basket. Based on Thailand's household socio-economic survey in 2015, food products, including fresh food, processed food, non-alcoholic beverages and seasonings and condiments, account for 36% of the basket. Gasoline, on the contrary, accounts for only 7-8%. In addition, domestic retail gasoline prices are subject to several taxes and contributions to oil funds, which should help mitigate somewhat the effects of global oil price changes. Meanwhile, certain price adjustment costs encountered by domestic food producers may give rise to a more persistent impact of global food price changes. The government, moreover, allows retail oil prices to adjust promptly to any changes in ex-refinery prices.

Figure 3
The Impact of Oil and Food Price Changes on Headline and Core Inflation



Note: the figure shows the impact of 1 percentage-point change in global oil and food inflation on domestic headline inflation (black lines) and core inflation (blue lines). The dashed lines indicate 95-percent confidence bands. t=0 denotes the month in which commodity price changes occur.

To examine whether the estimated impact is economically important, standardised beta coefficients ($\beta_k \times \frac{stdev(\pi_t^c)}{stdev(\pi_t)}$) are considered. The authors compute such coefficients for 6-month cumulative responses of inflation to each commodity price change. The results suggest that a one-standard-deviation change in both commodity prices causes headline inflation to alter by approximately 0.80 standard deviations, which are considered large. It can, therefore, be concluded that changes in both global oil and food prices are economically-important determinants of Thailand's inflation. The finding is, indeed, not surprising given the high volatility of commodity prices.

The next area of interest is studying whether changes in commodity prices affect Thailand's core inflation, defined as an inflation rate for the CPI basket that excludes fresh food and energy goods. Since innovations in commodity prices likely have direct effects on prices of the two excluded components, examining their impact on core inflation enables the authors to trace any indirect effects on inflation, as well as second-round effects on public's inflation expectations and labor wages. In doing so, the dependent variable in Equation (1) is replaced with π_{t+k}^{core}, representing the

percentage change in Thailand's core CPI. The results can be found in Figure 3, which shows that only global oil price changes have a significant impact on core inflation (blue lines). The impact, nevertheless, is much smaller than that on headline inflation and occurs with a one-month lag. Meanwhile, a global food price change does not have any significant effects on core inflation. The results, hence, imply limited spillovers to prices of core goods and services. Also, they suggest that the observed impact of commodity price changes on headline inflation is mainly attributed to their direct effects on non-core (i.e. fresh food and energy) components.

2.3 Impact Asymmetry and Non-linearity

The estimation so far assumes a linear response of Thai inflation to commodity price changes. Price adjustments, however, are likely to be asymmetric and non-linear. Firms, for example, may adjust their product prices more readily when facing large and/or positive changes in the production costs. In this sub-section, the authors therefore explore whether there exist any asymmetry and non-linearity with respect to inflation responses to global oil and food price changes. They begin by examining whether positive and negative changes have heterogeneous effects on headline inflation. To do so, the explanatory variable π_t^c in Equation (1) is replaced with $\pi_t^{c,pos}$ and $\pi_t^{c,neg}$, defined as:

$$\pi_t^{c,pos} = \begin{cases} \pi_t^c \ if \ \pi_t^c > 0 \\ 0 \ otherwise \end{cases} \text{ and } \pi_t^{c,neg} = \begin{cases} \pi_t^c \ if \ \pi_t^c < 0 \\ 0 \ otherwise \end{cases}$$

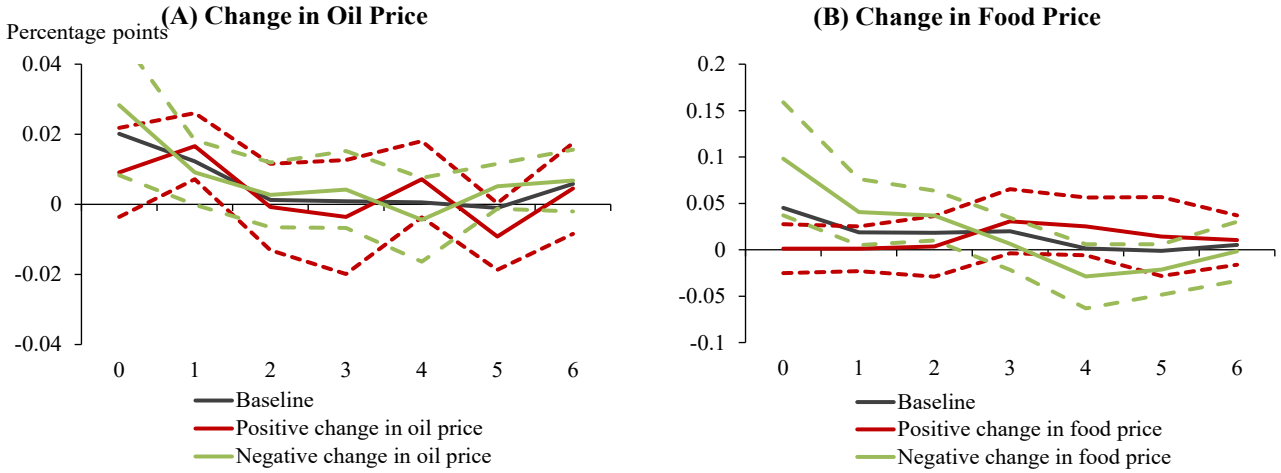
and the following specification is then obtained:

$$\pi_{t+k} = \alpha^k + \sum_{j=1}^{l} \gamma_j^k \pi_{t-j} + \beta_k^{pos} \pi_t^{c,pos} + \beta_k^{neg} \pi_t^{c,neg} + \sum_{j=1}^{k} \theta_j^k \pi_{t+j}^c + \delta_k y_{t+k} + \varepsilon_t^k,$$
$$c \in \{oil, food\}. \qquad (2)$$

The estimated coefficients β_k^{pos} and β_k^{neg} show the effects of positive and negative changes, respectively.

The results, shown in Figure 4, illustrate that negative global oil and food price changes tend to have a disproportionately larger impact on Thailand's headline inflation, particularly for food price changes. In the face of negative changes in global food prices, headline inflation declines by as large as 0.18 percentage point after one quarter, whereas there is a small, delayed and insignificant impact from positive changes. For global oil price changes, there are also slightly larger, and more immediate, effects from decreasing, compared to increasing, oil prices. But, the cumulative pass-through after one month for both positive and negative changes is relatively similar. These results may seem in the first place to contradict intuition, since firms should be more eager to raise, than to lower, prices in response to changing production costs so as to pass the burden to consumers. Meanwhile, when the production costs fall, firms may have incentive to retain product prices to reap greater profits. Nevertheless, since markets for oil and fresh food are highly-competitive, firms may instead become more reluctant to increase prices in order to avoid losing their market share, explaining smaller inflation responses to positive changes in commodity prices. In addition, with an aim of mitigating higher costs of living, the government may take action to reduce the impact from rising prices. The roles of the government will be discussed further in Sub-section 2.6.

Figure 4
The Impact of Oil and Food Price Changes on Headline Inflation: Positive vs. Negative Changes



Note: the figure shows the impact of 1 percentage-point change in global oil and food inflation on domestic headline inflation. The red and green lines present the responses to positive and negative changes, respectively. The dashed lines indicate 95-percent confidence bands. t=0 denotes the month in which commodity price changes occur.

Apart from the impact asymmetry, the effects of commodity price changes may also be non-linear. As firms could face a menu cost while re-optimising their product prices, large changes in commodity prices should have bigger consequences on inflation than small ones. This hypothesis is examined by replacing the explanatory variable π_t^c in Equation (1) with $\pi_t^{c,large}$ and $\pi_t^{c,small}$, defined as:

$$\pi_t^{c,large} = \begin{cases} \pi_t^c \ if\ |\pi_t^c| > stdev(\pi_t^c) \\ 0\ otherwise \end{cases} \text{ and } \pi_t^{c,small} = \begin{cases} \pi_t^c \ if\ |\pi_t^c| < stdev(\pi_t^c) \\ 0\ otherwise \end{cases}$$

and the following specification is then obtained:

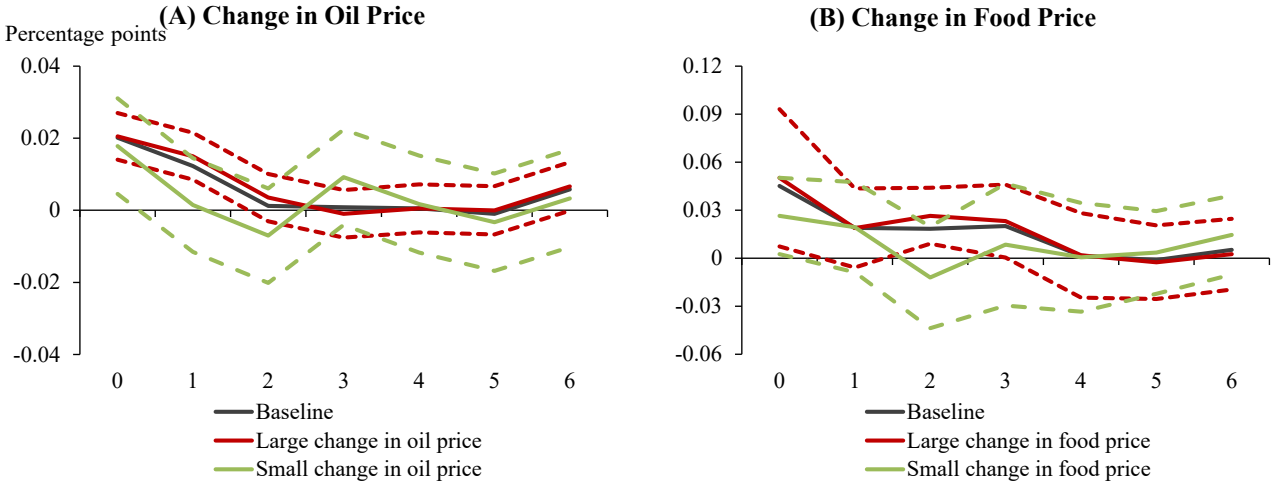
$$\pi_{t+k} = \alpha^k + \sum_{j=1}^{l} \gamma_j^k \pi_{t-j} + \beta_k^{large} \pi_t^{c,large} + \beta_k^{small} \pi_t^{c,small} + \sum_{j=1}^{k} \theta_j^k \pi_{t+j}^c + \delta_k y_{t+k} + \varepsilon_t^k, c \in \{oil, food\}. \quad (3)$$

The estimated coefficients β_k^{large} and β_k^{small} show the effects of large and small commodity price changes, respectively.

Figure 5 shows that inflation responses to commodity price changes clearly feature non-linearity. The impulse responses based on large changes, indeed, resemble the baseline results. Nevertheless, for both global food and oil price changes, the responses to small price movements are statistically significant only in the period of the shock. The estimated pass-through also reduces to 0.04 and 0.02, respectively. The findings, therefore, confirm the existence of menu costs. If small changes occur, firms likely choose to adjust their margins, rather than product prices, and absorb gains and losses by themselves[5].

5. This paper also examines whether there is heterogeneity in the responses to large positive and large negative commodity price changes. The results are shown in Figure 18 in the Appendix. For changes in both oil and food prices, the effects of large negative (positive) changes are similar to the responses to negative (positive) changes shown in Figure 4.

Figure 5
The Impact of Oil and Food Price Changes on Headline Inflation: Large vs. Small Changes



Note: the figure shows the impact of 1 percentage-point change in global oil and food inflation on domestic headline inflation. The red and green lines present the responses to large and small changes, respectively. The dashed lines indicate 95-percent confidence bands. t=0 denotes the month in which commodity price changes occur. Large (small) changes are defined as changes in oil and food prices larger (smaller) than one standard deviation from their mean.

Last, it is hypothesised that the effects of commodity price changes may be conditional upon the prevailing level of commodity prices (p_t^c). Such hypothesis is examined by replacing the explanatory variable π_t^c in Equation (1) with $\pi_t^{c,high}$ and $\pi_t^{c,low}$, defined as:

$$\pi_t^{c,high} = \begin{cases} \pi_t^c \ if \ p_t^c > avg(p_t^c) \\ 0 \ otherwise \end{cases} \text{ and } \pi_t^{c,low} = \begin{cases} \pi_t^c \ if \ p_t^c < avg(p_t^c) \\ 0 \ otherwise \end{cases},$$

and the following specification is then obtained:

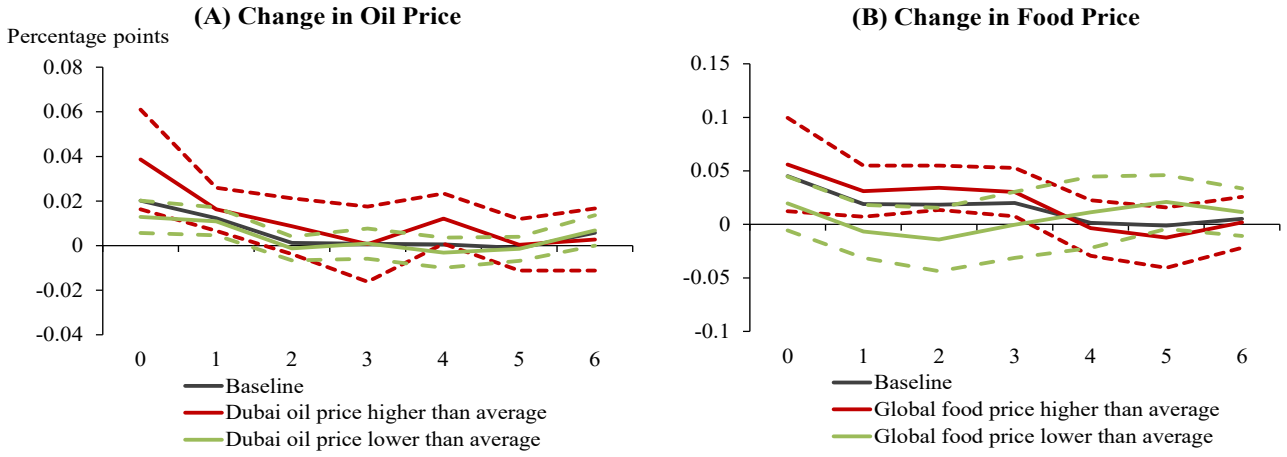
$$\pi_{t+k} = \alpha^k + \sum_{j=1}^{l} \gamma_j^k \pi_{t-j} + \beta_k^{high} \pi_t^{c,high} + \beta_k^{low} \pi_t^{c,low} + \sum_{j=1}^{k} \theta_j^k \pi_{t+j}^c + \delta_k y_{t+k} + \varepsilon_t^k, c \in \{oil, food\} \quad . (4)$$

The estimated coefficients β_k^{high} and β_k^{low} show the effects of commodity price changes when the prevailing level of commodity prices is high and low, respectively. As shown above, commodity prices are considered high (low) when they are above (below) their mean. The finding is shown in Figure 6, where we find that, when Dubai oil prices are at a high level, inflation responses to oil price changes are significantly larger. Their estimated cumulative impact after one month is as high as 0.05, much larger than the baseline results. Impulse responses in the event of low Dubai oil prices are, on the other hand, slightly below the baseline estimates. The explanation for such a finding is that, when global oil prices increase, the content of ex-refinery prices within retail gasoline prices becomes larger, rendering the latter more sensitive to innovations in global oil prices[6]. Likewise, the inflation responses to global food price changes are larger than the baseline

6. The structure of domestic retail gasoline prices includes the ex-refinery prices, excise taxes, municipality taxes, contributions to oil funds and energy conservation promotion funds, marketing margin and VAT.

estimates when global food prices prevail at a high level. In contrast, when they are low, the responses of Thai inflation are found to be insignificant. These results are useful in understanding Thailand's on-going inflation movements. Given that both commodity prices are currently at the down-cycle, any of their changes will not have much influence on Thai headline inflation, thereby explaining the current subdued inflationary pressure.

Figure 6
The Impact of Oil and Food Price Changes on Headline Inflation, Conditional on the Level of Corresponding Commodity Prices



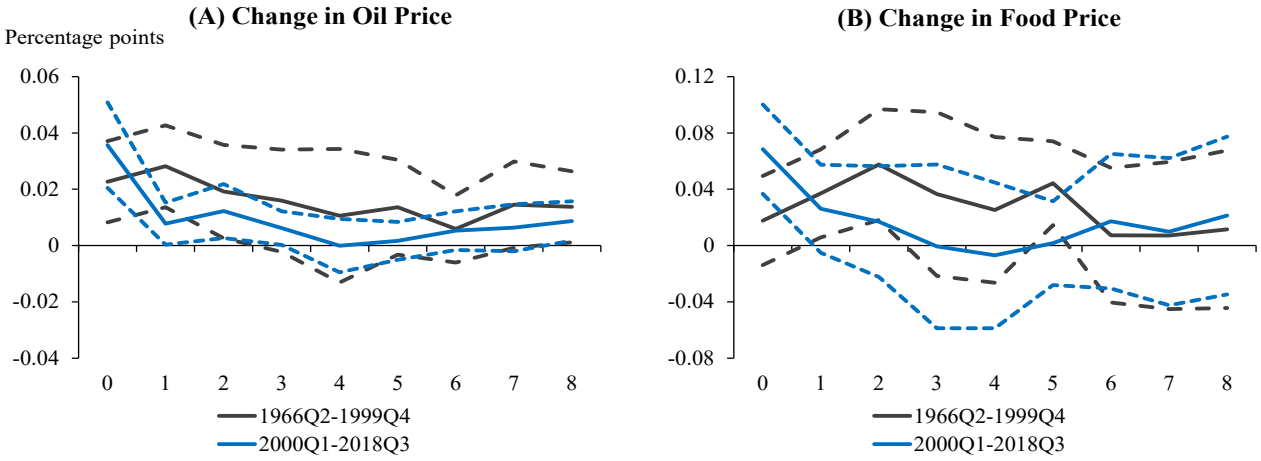
Note: the figure shows the impact of 1 percentage-point change in global oil and food inflation on domestic headline inflation when the corresponding commodity prices are higher (red lines) and lower (green lines) than their average. The dashed lines indicate 95 percent confidence bands. t=0 denotes the month in which commodity price changes occur.

2.4 How Has the Pass-through Changed Over Time?

Another question of interest is whether the pass-through of commodity price changes to Thailand's inflation has declined over time, as widely-documented in the literature. The authors strive to answer the question by estimating Equation (1) for both pre-2000 (from 1966 to 1999) and post-2000 periods. The pre-2000 sample should cover the two oil crises that brought about heightened oil prices and, hence, high global inflation. Given limited data availability, the quarterly data is used for both samples. The impulse responses are reported for $k = 0$ to $k = 8$.

Figure 7 compares the impulse responses between the two periods. In the face of global oil price changes, the inflation responses are found to be larger and more persistent for pre-2000 samples. The cumulative impact of oil price changes after eight quarters is approximately 0.14, much larger than the post-2000 estimate. Responses of Thai inflation to global food price changes, meanwhile, are also found to be statistically significant and more persistent, despite some delay, for pre-2000 samples. The results, therefore, are supportive of the notion of more persistent inflation prior to 1990s, the periods when monetary policy does put much emphasis on price stability. For Thailand, the adoption of an Inflation Targeting regime, which makes explicit the central bank's inflation target, may help explain a more muted response to oil and food price shocks after 2000.

Figure 7
The Impact of Oil and Food Price Changes on Headline Inflation: 1966Q2-1999Q4 vs. 2000Q1-2018Q3



Note: the figure shows the impact of 1 percentage-point change in global oil and food inflation on domestic headline inflation. The black and blue lines present the responses estimated from the sample 1966Q2-1999Q4 and 2000Q1-2018Q3, respectively. The dashed lines indicate 95-percent confidence bands. t=0 denotes the quarter in which commodity price changes occur.

The impact asymmetry and non-linearity are also examined for the responses of core inflation. The results are shown in Figures 19 and 20 in the Appendix. The authors find that only positive changes in global oil prices have statistically significant effects on core inflation at 5% significant level. Meanwhile, for global food price changes, although the authors do not find any significant effects on core inflation in our baseline linear estimates, their negative changes are found to have a significant impact. However, the pass-through from both commodity prices remains low. Now, turning to the results with respect to the impact non-linearity, like with the baseline estimates, the authors do not find any material effects of global food price changes on core inflation for either small and large changes. Meanwhile, only large changes on Dubai oil prices significantly affect core inflation with a one-period lag, though the magnitude of the effects is small. All in all, the impact of commodity prices on core inflation is, once again, found to be limited.

2.5 Robustness Checks

In this Sub-section, a few checks are performed to ensure that the baseline results are robust. First, since both global oil and food prices are found to be an important driver of Thailand's inflation, the authors are aware of the possibility that they are highly collinear, thus causing an endogeneity problem on the parameter estimates. As a result, to address the issue, they are incorporated into the equation simultaneously. The following specification is thus estimated:

$$\pi_{t+k} = \alpha^k + \sum_{j=1}^{l} \gamma_j^k \pi_{t-j} + \beta_k^{oil} \pi_t^{oil} + \sum_{j=1}^{k} \theta_j^{k,oil} \pi_{t+j}^{oil} + \beta_k^{food} \pi_t^{food} + \sum_{j=1}^{k} \theta_j^{k,food} \pi_{t+j}^{food} + \delta_k y_{t+k} + \varepsilon_t^k. \quad (5)$$

As shown in Figure 21 in the Appendix, it is that, after controlling for global food price developments, the impact of global oil price changes to Thai inflation does not alter, thus confirming that the baseline results are robust. However, the inflation responses to global food price changes are clearly smaller than the baseline estimates. In particular, the responses remain statistically significant, but only in the period of the shock, while the cumulative effects after one quarter are reduced to 0.05. The baseline estimate, therefore, needs to be viewed with caution.

Second, the potential outliers in the estimation are taken care of, by excluding observations with headline inflation or commodity price changes greater than two standard deviations from their corresponding average. As in the previous robustness check, the responses of Thai inflation to global food price changes alter from the baseline estimates (Figure 22). Again, such changes do not have any lagged effects on headline inflation, while the magnitude of the impact also declines. Changes in global oil prices, meanwhile, significantly affect Thai inflation both contemporaneously and with a one-period lag. The magnitude of the impact, nonetheless, falls to some extent. Last, the authors attempt an alternative measure of a global food price index, which is obtained from FAO. The results shown in Figure 23 suggest that the baseline estimates are fairly robust. In particular, the estimated coefficients are close to those from the baseline regression. The fact that the lagged responses to food price changes appear insignificant is merely driven by the estimated standard errors that become slightly larger.

2.6 Policies to Alleviate the Impact of Commodity Prices

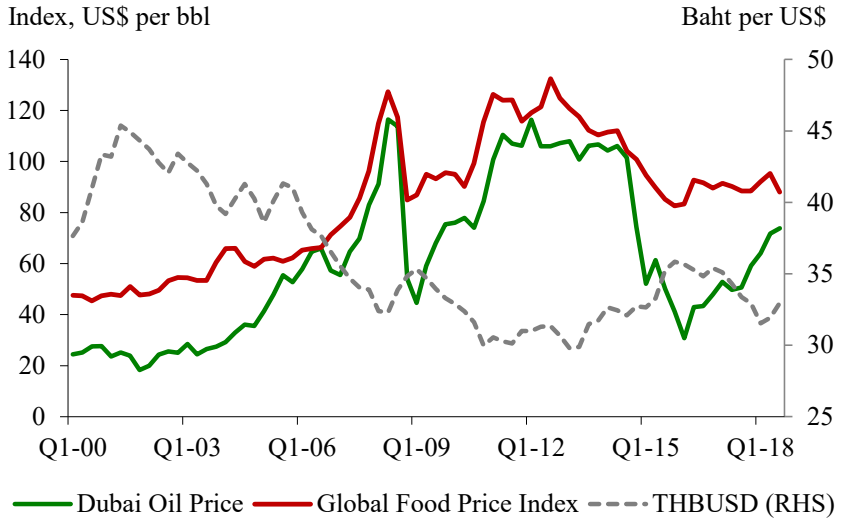
The findings above suggest that both global oil and food prices significantly affect and explain a substantial variation of Thailand's headline inflation. Thai inflation, therefore, tends to exhibit excessive volatility particularly in the short run, which in turn matters for households' costs of living and, in some occasions, price stability. In this Sub-section, the role of government policies, both monetary and fiscal, in alleviating the impact of commodity price changes, is discussed. Without these policies in place, the inflation rates could be even more volatile and complicate decisions of both households and firms.

The first in line is monetary policy, given its mandate in achieving monetary stability and sustainable economic growth. After the adoption of an Inflation Targeting regime in May 2000, the BoT has placed price stability as an overriding objective of monetary policy. Since then, Thailand's inflation rates have substantially declined and shown lower volatility, while public's inflation expectations are well-anchored. Except in the recent periods, inflation has been most of the time within the central bank's announced target. Monetary policy stands ready to offset any shocks that cause inflation to persistently deviate from target, including those triggered by commodity price developments. Such circumstances have made Thailand's inflation less persistent than in the past (Figure 7). Furthermore, changes in commodity prices are found to have limited consequences on core inflation, reflecting the low second-round effects on inflation expectations (Figure 3). All these observations underscore the merits of having price stability and hence well-anchored inflation expectations.

The behaviour of exchange rates could be another factor that helps cushion the impact of global oil and food price changes on Thailand's inflation. Advocates of the flexible exchange rate regime have underlined the role of exchange rates as an absorber to external shocks (Friedman, 1953). That is, when a commodity price increases, an exchange rate tends to appreciate, which

should help lower costs of importing commodities and thus reduce inflationary pressure. For Thailand, the BoT abandoned a fixed exchange rate and adopted a managed-float regime in 1997. The subsequent switch towards an Inflation Targeting framework, which entails monetary policy independence, accommodates such exchange rate flexibility. Under such a regime, the BoT intervenes in the foreign exchange market only when exchange rate movements are excessively volatile. The value of the baht, hence, is mostly determined by the market mechanism. Therefore, exchange rates may play a potential role in lessening the impact of external shocks for the Thai economy. Figure 8 graphs the movements of Thai baht against US$ along with global food and oil prices. It can be seen that exchange rates potentially act as a shock absorber. That is, whenever oil and food prices rise, the baht tends to appreciate against US$. The cointegration analysis (results are available upon request) suggests that 1% increases in commodity prices are coincided with a 0.2% baht appreciation. Regardless of what induce the cointegration between commodity prices and an exchange rate, such a relationship implies that, without such strengthening, Thailand's headline inflation may rise to an even larger extent than suggested by the baseline estimate.

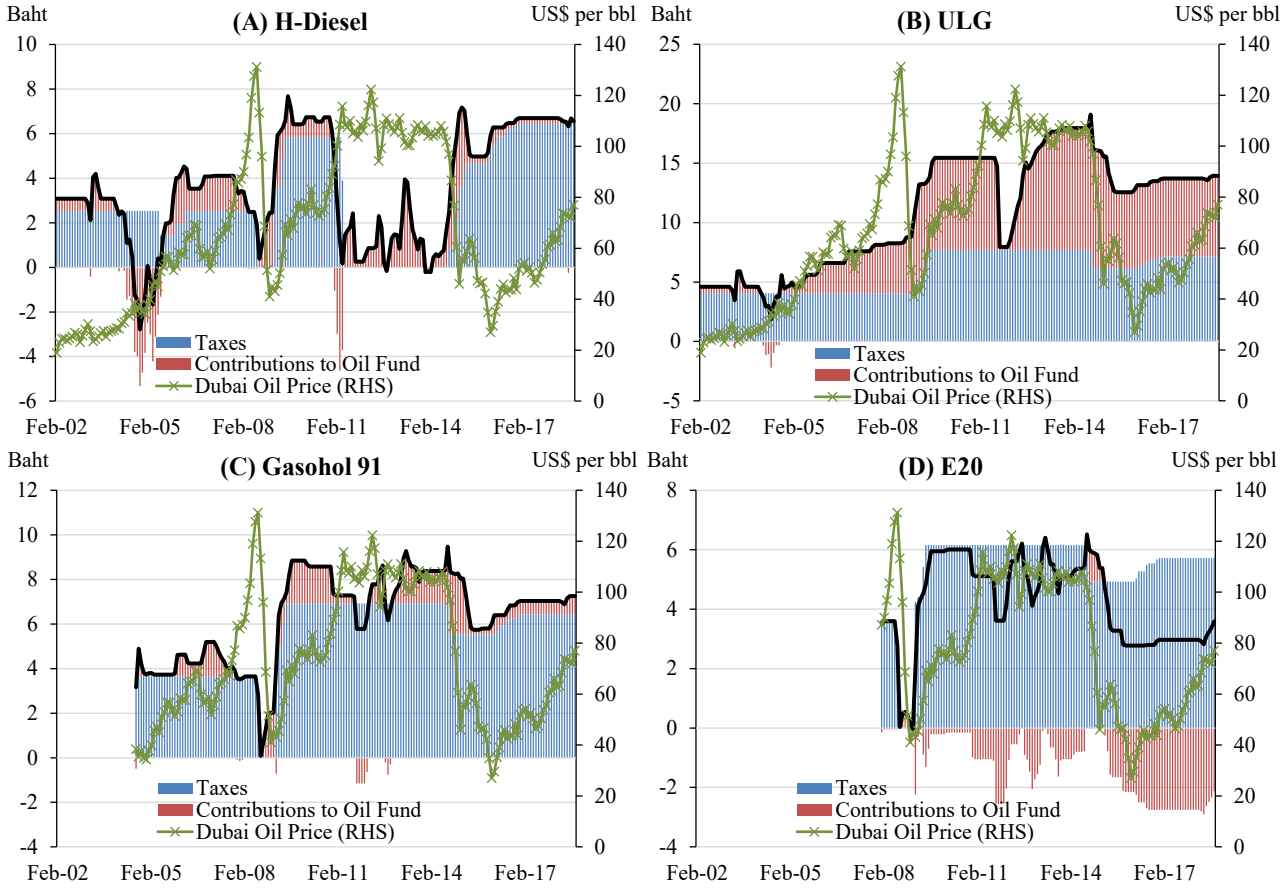
Figure 8
Global Commodity Prices and the Baht Exchange Rate



Source: World Bank, Bloomberg, Energy Policy and Planning Office and BoT

Apart from monetary policy and exchange rates, the government also plays an important role in countering shocks to commodity prices, especially those to crude oil prices. Considering the structure of domestic retail gasoline prices, it contains excise taxes and contributions to oil funds, which serve as the degree of freedom that the government can exploit in stabilising retail prices. In some occasions, normally when Dubai oil prices climb up to a certain level, contributions to oil funds even become negative, implying that the government is subsidising retail prices. Figure 9 shows developments of taxes and oil fund contributions for selected types of petroleum: H-diesel, ULG, Gasohol 91 and E20, all of which have a high share of consumption in Thailand. The Figure clearly illustrates the role of taxes and oil fund contributions in cushioning the impact of rising oil prices during 2008, when daily Dubai oil prices reached US$145 per barrel. Except for ULG, both taxes and contributions were cut immensely for other petroleum. It is also observed that both were raised significantly after global oil prices had fallen at the end of the same year.

Figure 9
Taxes and Contributions to Oil Fund For Selected Petroleum



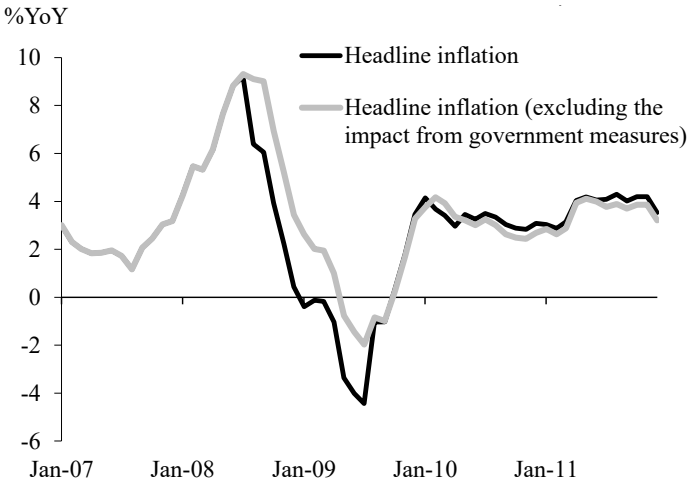
Note: H-Diesel denotes high speed diesel. ULG is Unleaded premium gasoline. while E20 is Gasoline with Ethanol 20% by volume.
Source: Energy Policy and Planning Office, and Bloomberg

Nevertheless, in other periods, there seems to be a mixed relationship between taxes and oil fund contributions, and Dubai oil prices. For H-diesel, their correlation is clearly negative. That is, taxes and contributions tend to fall as global oil prices increase. Retail diesel prices are, thus, stabilised. During 2011-2014, for example, when Dubai oil prices were higher than US$100 per barrel, all the taxes were lifted. Diesel prices were, indeed, held fixed in certain periods. This is achieved by daily adjustments of oil fund contributions. Over the recent periods (October 2018), as Dubai oil prices are approaching US$80 per barrel, the government stepped in to stabilise diesel prices by cutting oil fund contributions and eventually introducing subsidies. A diesel price ceiling of 30 baht per liter was announced at that time. Such active government intervention towards diesel prices is not surprising, as diesel is mostly used by low-income households and industries. On the contrary, global oil prices tend to move positively with taxes and contributions imposed on ULG, Gasohol 91 and E20. This might be explained by a tendency of the government to nullify any changes in taxes and oil fund contributions collected from diesel usage. Net effects of such government intervention on retail gasoline prices are left for further researches.

The episode of 2008 highlighted the role of government measures in stabilising shocks to global oil and food prices. Over the periods leading up to 2008, both commodity prices were on a rising trend, driven by a wide range of factors. Commodity prices then peaked during the midst of 2008, causing inflation to rise and the central bank to hike policy interest rates globally. Households, therefore, encountered economic hardship in terms of heightened costs of living. Consequently, the

Thai government introduced several measures to alleviate such rising living costs, which comprised cutting oil excise tax rates aforementioned, preventing a rise in household LPG prices, subsidising electricity and water fees, and free fares for third-class trains and buses. Figure 10 shows the extent these measures helped in softening Thailand's headline inflation. In particular, headline inflation is purged of any impact from government policies. It can be seen that, without those policies, inflation could be higher by around two to three percentage points from mid-2008 to mid-2009. Although inflation was on the decline over such periods, those measures were critical in mitigating the high level of living costs.

Figure 10
Headline Inflation (Excluding the Impact from Government Measures)



Note: An inflation measure that excludes the impact from government measures is one of the underlying inflation indicators constructed and monitored by the Bank of Thailand.
Source: Ministry of Commerce and BoT

3. Effects of Global Oil and Food Prices on Thailand's Inflation: Trend-Cycle Approach

In this section, the authors follow Forbes et al (2017) by disentangling trend and cyclical components from headline inflation measures, and then exploring the relative importance of global versus domestic factors in explaining the extracted trend and cycles. The approach allows them to confirm whether innovations in global oil and food prices can have persistent effects on Thailand's inflation. To the extent that commodity price developments matter for trend inflation, monetary policy may need to take care of them. The earlier finding based on the local projections suggest that global oil and food price changes only have short-lived, despite economically important, effects on headline inflation. However, this may be owing to the dominance of short-term volatility in headline inflation that masks any persistent effects from developments in commodity prices. The trend-cycle approach amounts to estimating separately and directly the impact of commodity prices on the trend and transient components of inflation, and hence should be more appropriate in detecting any persistent impact.

3.1 Extracting Trend Inflation

In order to extract trend inflation, the authors rely on the multivariate unobserved component stochastic volatility (MUCSV) model with outlier adjustments a la Stock and Watson (2016)[7]. This model has been employed by Manopimoke and Limjaroenrat (2017) in estimating trend inflation for Thailand. Therefore, the trend estimates from the latter paper are used for this exercise.

In brief, the model assumes that trend inflation is made up from the weighted average of sectoral trend inflation. Inflation of each sector i ($\pi_{i,t}$), meanwhile, is expressed as the sum of a permanent (τ_t) and transitory (ε_t) component. The permanent or trend component follows a random walk process, while the transitory component is serially uncorrelated. The innovations to both components $(\mu_{\tau,t}, \mu_{\varepsilon,t})$ have variances that evolve over time according to independent stochastic volatility processes. The innovation to the temporary component can also have heavy tails (s_t). The model specification is as follow:

$$\pi_{i,t} = \alpha_{i,\tau,t}\tau_{c,t} + \alpha_{i,\varepsilon,t}\varepsilon_{c,t} + \tau_{i,t} + \varepsilon_{i,t} \quad (6)$$

$$\tau_{c,t} = \tau_{c,t-1} + \sigma_{\Delta\tau,c,t} * \mu_{\tau,c,t} \quad (7)$$

$$\varepsilon_{c,t} = \sigma_{\varepsilon,c,t} * s_{c,t} * \mu_{\varepsilon,c,t} \quad (8)$$

$$\tau_{i,t} = \tau_{i,t-1} + \sigma_{\Delta\tau,i,t} * \mu_{\tau,i,t} \quad (9)$$

$$\varepsilon_{i,t} = \sigma_{\varepsilon,i,t} * s_{i,t} * \mu_{\varepsilon,i,t} \quad (10)$$

$$\alpha_{i,\tau,t} = \alpha_{i,\tau,t-1} + \rho_{i,\tau}\varphi_{i,\tau,t} \text{ and } \alpha_{i,\varepsilon,t} = \alpha_{i,\varepsilon,t-1} + \rho_{i,\varepsilon}\varphi_{i,\varepsilon,t} \quad (11)$$

$$\Delta\ln(\sigma^2_{\Delta\tau,c,t}) = \gamma_{\Delta\tau,c} * \vartheta_{\Delta\tau,c,t},\ \Delta\ln(\sigma^2_{\varepsilon,c,t}) = \gamma_{\varepsilon,c} * \vartheta_{\varepsilon,c,t},\ \Delta\ln(\sigma^2_{\Delta\tau,i,t}) = \gamma_{\Delta\tau,i} * \vartheta_{\Delta\tau,i,t},$$
$$\Delta\ln(\sigma^2_{\varepsilon,i,t}) = \gamma_{\varepsilon,i} * \vartheta_{\varepsilon,i,t} \quad (12)$$

where the variance-covariance matrix $(\mu_{\varepsilon,c}, \mu_{\tau,c}, \mu_{\varepsilon,i}, \mu_{\tau,i}, \varphi_{\varepsilon,i}, \varphi_{\tau,i}, \vartheta_{\varepsilon,c}, \vartheta_{\Delta\tau,c}, \vartheta_{\varepsilon,i}, \vartheta_{\Delta\tau,i})$ is iid (independent and identically distributed) standard normal.

The model assumes a common latent factor in both the trend and transitory components of inflation. Let the subscripts c denote the common latent factor and i denote the sector. Equation (6) represents sector i inflation as the sum of a common factor for trend inflation, $\tau_{c,t}$, a common transient component, $\varepsilon_{c,t}$, and sector-specific trends and transient components, $\tau_{i,t}$ and $\varepsilon_{i,t}$, and where the factor loadings are time-varying and evolve according to a random walk (11). Equations (7)-(10) allow for stochastic volatility in innovations to both the common and sector-specific components, where the stochastic volatility evolves according to the logarithmic random walk (12). The transitory innovation is modeled as a mixture of normal and allows for outliers through the independent random variables $s_{c,t}$ and $s_{i,t}$ in (8) and (10), respectively. $s_t = 1$ with probability (1- p), and $s_t \sim U[2,10]$ with probability p. The model is estimated using Bayesian methods. The authors follow Stock and Watson (2016) in setting the priors. Please refer to their paper for details.

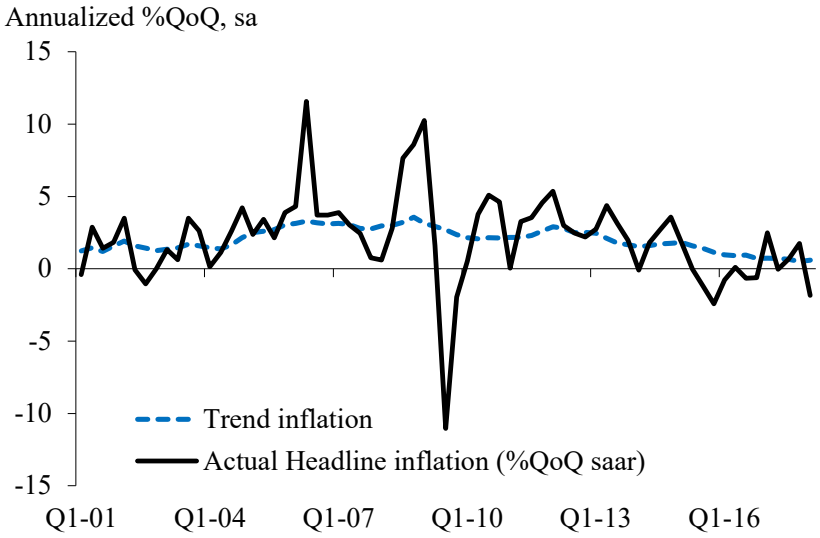
7. The 2016 paper is an extension of Stock and Watson (2007), which extract trend inflation in a univariate setting, i.e. directly from aggregate headline inflation.

The sectoral trend inflation is the sum of the contribution of the common latent factor to that sector and the sectoral trend ($\alpha_{i,\tau,t}\tau_{c,t} + \tau_{i,t}$). To obtain aggregate trend inflation, the sum of the sectoral trend, weighted by the share w_{it} of sector i in the CPI basket is computed:

$$\text{Aggregate trend} = \tau_t = \tau_t \sum_{i=1}^{n} w_{it}(\alpha_{i,\tau,t}\tau_{c,t} + \tau_{i,t}), \quad (13)$$

where n denotes the number of sectors. Based on Manopimoke and Limjaroenrat (2017), headline inflation is disaggregated into 10 major sectors: (1) raw food; (2) prepared food, non-alcoholic beverages, seasonings and condiments; (3) apparel and footwear; (4) housing and furnishing (excluding gases and electricity); (5) medical and personal care; (6) transportation and communication (excluding fuel); (7) recreation and education; (8) tobacco and alcoholic beverages; (9) gases and electricity; and (10) fuel. Given dispersion in trend inflation across sectors, extracting trend inflation in a multivariate setting is believed to entail more accurate trend inflation compared that from a univariate setting.

Figure 11
Estimated Trend Inflation and Actual Inflation



Source: Ministry of Commerce and estimated by authors

Figure 11 shows the extracted trend inflation along with actual headline inflation. By construction, headline inflation fluctuates around its trend, with some extreme movements, e.g. in the fourth quarter of 2008 (negative commodity price shocks). The trend is slow-moving, always positive and, for most of the time, stays close to the BoT's inflation target. The authors can also observe that, from 2004 to 2013, trend inflation stood at a high level relative to other periods. Since 2014, it has been on a declining trajectory, consistent with the worldwide low inflation phenomenon. The latest figure of trend inflation is as low as 1%, falling from the pre-crisis average of 2.5%.

3.2 What (Other Than the Trend) Explains Inflation Dynamics?

The authors, first, explore what variables other than the slowing-moving trend may help improve our understanding of inflation dynamics. In particular, of interest is the role of global oil and food prices in driving the cyclical component of inflation. Based on the earlier finding that both commodity prices do have economically important and short-lived effects on Thailand's headline inflation, they expect to find a strong and statistically significant impact in this exercise. Hence, the following equation is estimated:

$$\pi_t = \alpha + \beta\tau_t + \gamma X_t + \varepsilon_t \quad (14)$$

where X_t is a variable that can help explain the cyclical movements of inflation around its trend, including growth of global food and oil prices. According to theories, a set of variables that potentially drive inflation cycles also comprises percentage changes in the baht-US$ exchange rate, average labour earning growth, the output gap, the unemployment gap, short-term and medium-term inflation expectations. The output gap and the unemployment gap are a deviation of real GDP and unemployment rates from their corresponding HP-filtered trend, respectively. With respect to inflation expectations, short-term (1-year) inflation expectations are obtained from Consensus Economics, while medium-term expectations (5-year) are extracted from government bond yields using a macro-finance term structure model. Each variable in the set is included in equation (14) one at the time. The equation is estimated using the quarterly data from 2002 to 2017, given data availability. Since the inflation data of the fourth quarter of 2008 could be an outlier, the estimation results for both with and without a dummy variable for such period are presented.

Table 1
Explaining Inflation: the Trend and Other Variables

	Without 2008Q4 Dummy			With 2008Q4 Dummy		
	Coeff on Trend	Coeff on Interested Variable	R^2	Coeff on Trend	Coeff on Interested Variable	R^2
Oil price growth	1.27 (0.00)	0.12 (0.006)	0.50	1.65 (0.00)	0.07 (0.00)	0.66
Food price growth	1.17 (0.01)	0.23 (0.013)	0.44	1.66 (0.00)	0.11 (0.04)	0.61
% changes in the Baht exchange rate	1.47 (0.01)	-0.14 (0.53)	0.17	1.90 (0.00)	0.01 (0.95)	0.56
Average labor earning growth	1.37 (0.03)	0.20 (0.29)	0.18	1.86 (0.00)	0.06 (0.61)	0.57
Output gap	1.24 (0.03)	0.69 (0.04)	0.30	1.74 (0.00)	0.36 (0.08)	0.59
Unemployment gap	1.51 (0.00)	-5.08 (0.11)	0.23	1.89 (0.00)	-2.73 (0.24)	0.58
1-year consensus forecast	1.37 (0.01)	3.13 (0.05)	0.34	1.82 (0.00)	1.39 (0.17)	0.60
5-year inflation expectations	1.49 (0.00)	12.44 (0.00)	0.52	1.78 (0.00)	7.70 (0.00)	0.67

Note: The coefficients are estimated using the data from 2002Q1 to 2017Q4, except for 1-year consensus forecast regression, whose sample starts from 2004Q1. P-value is shown in parentheses.

The results are shown in Table 1, reporting coefficients on trend inflation, coefficients on each of the extra explanatory variables and the corresponding p-values (in parentheses) and adjusted R-squared for each specification. First, it is found that the coefficient on trend inflation is positive and highly significant. However, as in Forbes et al. (2017), the coefficient is always larger than one, which results from the fact that the constant term in the regression tends to be negative. Without constant, such coefficient would be close to one by construction. Concerning coefficients on other variables, both oil and food price growth are found to be positive and statistically significant, even after 2008Q4 dummy variable is added into the equation. The R-squared for all specifications with global food and oil prices is also large and higher than most of other standard macroeconomic variables, implying significant contributions of commodity prices on the movements of headline inflation around its trend. As in the results found in Section 2, growth of global food prices has a higher pass-through than that of oil prices. Among the rest of the variables, only 5-year inflation expectations and the output gap significantly influence inflation cycles in both regression (i.e. with and without a dummy variable) at 1% and 10% level of significance, respectively. However, whether inflation expectations cause actual inflation remains a puzzle, since the estimate may be subject to a reverse-causality problem. Meanwhile, the coefficient on 1-year inflation expectations is significant in the specification without a dummy variable; however, with it, the coefficient becomes statistically insignificant. Last, the authors did not find any significant effects from changes in the baht exchange rate, the unemployment gap and average labour earning growth on Thailand's headline inflation cycles.

The above findings highlight the importance of both global oil and food price dynamics in driving inflation around its trend. This is consistent with the results found earlier from the local projection approach, where commodity price developments explain substantial short-term fluctuations of headline inflation. Many other standard macroeconomic variables, which are mainly domestic factors, however are not behind the cyclical movements of Thailand's inflation.

3.3 What Explains Trend Inflation?

Next, the drivers of trend inflation are investigated. The analysis here will entail important policy implications, since monetary policy should take into account, or respond to, shocks that have persistent effects on inflation over the medium term (i.e. ones that matter for trend inflation). As mentioned above, this is also to confirm whether commodity price shocks do have merely a transient impact on Thai inflation. Therefore, the following specification is estimated:

$$\Delta\tau_t = \alpha + \sum_{j=0}^{L} \gamma_j X_{t-j} + e_t \qquad (15)$$

Since many of the explanatory variables of interest may affect trend inflation with a lag, the authors sometimes include lags of each of those variables. L is the number of lags of each variable (either 0 or 4). Table 2 shows the estimation results, reporting the coefficient estimates for each of the explanatory variables as well as the corresponding p-value and adjusted R-squared. Whenever lagged variables are included, the sum of the coefficient estimates and the p-value from a Chi-squared test of their joint significance are reported.

The results suggest that oil price growth, food price growth, 5-year inflation expectations and the output gap again are variables that significantly affect trend inflation for both specifications (i.e. with and without their corresponding lagged values). The fact that the output gap affects trend inflation implies that the extracted trend inflation, to some extent, captures medium-frequency movements of inflation, making it possible to be explained by economic cycles. Despite the fact

that the coefficient on the output gap and 5-year expectations is much larger than that on oil and food price growth, the latter are found to explain a larger variation of changes in trend inflation (see the adjusted R-squared). This may be owing to the low variation of the output gap and inflation expectations. The results, once again, highlight the dominant role of global commodity prices in driving Thailand's inflation. For the rest of the variables, the authors we did not find any significant effects from the unemployment gap and 1-year inflation expectations. Furthermore, they found that trend inflation is also significantly influenced by labour earning growth and changes in the baht-US$ exchange rate. The latter result with regard to exchange rates is in line with the finding in Forbes et al. (2017) in the case of UK.

Table 2
Explaining Trend Inflation

	No lag		4 lags	
	Coeff	R^2	Sum of Coeff	R^2
Oil price growth	0.005 (0.009)	0.10	0.013 (0.00)	0.28
Food price growth	0.01 (0.007)	0.11	0.019 (0.00)	0.25
% changes in the Baht exchange rate	-0.01 (0.24)	-0.00	-0.06 (0.014)	0.11
Average labor earning growth	0.02 (0.01)	0.04	0.002 (0.95)	0.08
Output gap	0.05 (0.04)	0.15	0.07 (0.00)	0.15
Unemployment gap	-0.22 (0.46)	0.01	-0.24 (0.46)	-0.01
1-Year consensus forecast	0.09 (0.104)	0.02	0.12 (0.63)	0.11
5-Year inflation expectations	0.36 (0.03)	0.05	1.48 (0.00)	0.23

Note: The coefficients are estimated using the data from 2002Q1 to 2017Q4, except for 1-Year consensus forecast regression, whose sample starts from 2004Q1. P-value is shown in parentheses. For specification with lagged variables, we report the sum of coefficients on both contemporaneous and lagged variables, while the statistical inference is based on Chi-squared test.

3.4 Some Explanation

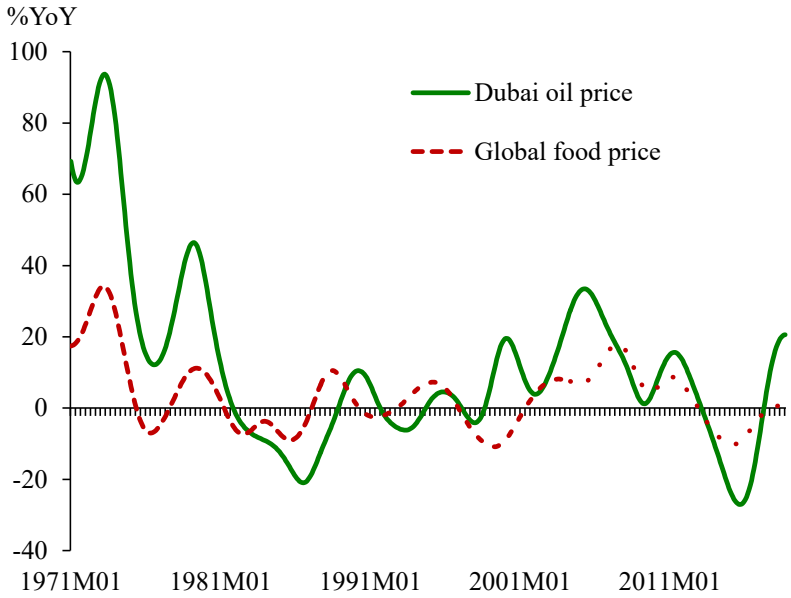
The finding from the previous sub-section suggests that commodity price changes are important drivers of both permanent and transient variations, and hence can have persistent effects on Thailand's inflation. This result has important implications on monetary policy decision-makings. As argued in Cecchetti and Moessner (2008), in deciding how to react to price increases/decreases, policymakers need to know whether certain shocks have temporary or persistent effects on inflation. If it is the former, then commodity price changes are less likely to affect headline inflation over the medium-term horizon relevant for monetary policy, and the price changes can

safely be ignored. If, however, it is the latter, then they are more likely to affect inflation over the horizons relevant to policymakers. Without proper monetary policy responses, inflation may persistently deviate from the target, which will in turn impair an ability of monetary policy in anchoring inflation expectations.

Nevertheless, the result may appear to contradict the earlier finding from the local projection exercise that commodity price changes merely have a short-lived impact on headline inflation and, therefore, should not matter for trend inflation dynamics. This paper argues that the fact that such changes significantly affect trend inflation is possibly due to the persistence of global food and oil inflation dynamics themselves, which in turn results in the persistent responses of Thailand's inflation to their initial changes.

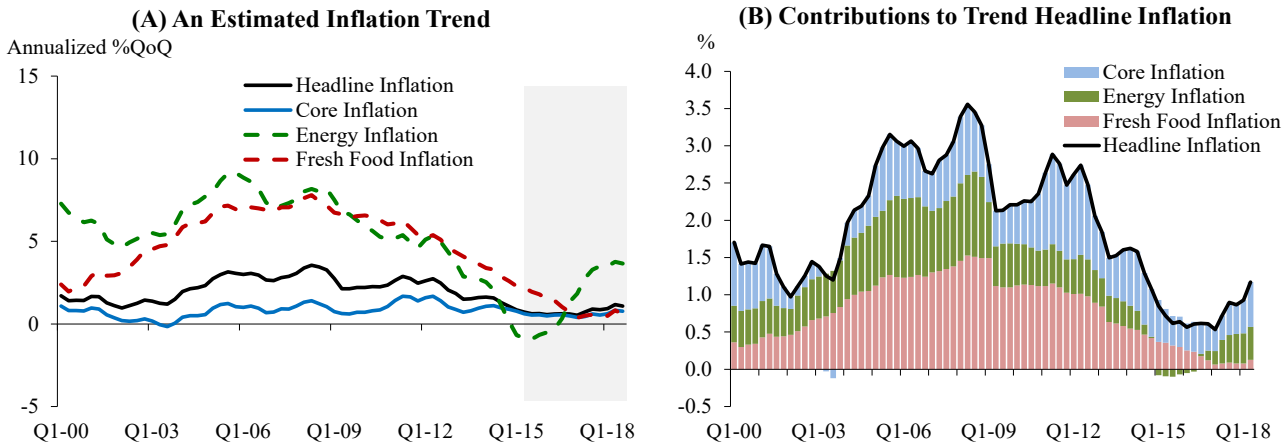
Evidence of commodity inflation persistence can, primarily, be found in the dynamics of global oil and food inflation trend. The trend is obtained by computing growth rates of HP-filtered trend of both commodity prices. From Figure 12, it can be clearly noticed that their trend growth rates are time-varying and exhibit a non-mean-reversion property, thus signaling some degree of inflation persistence. Global food inflation trend has risen consistently since 2001, and stabilised at around 9% during 2002 and 2011. The trend declined since then, and the latest figure is as low as 1%. Like food prices, global oil inflation trend were relatively high before 2012, but then began to fall and recorded a large negative value. The trend only rebounded during mid-2015. There is, consequently, a possibility that such changes in trend growth of global commodity prices directly translate into changes in domestic trend inflation. Figure 13 shows Thailand's trend inflation along with the trend of each inflation component, i.e. energy, fresh food and core inflation, all of which are estimated by the MUCSV model aforementioned. Developments of Thailand's fresh food and energy inflation trend are found to coincide well with the trend growth of commodity prices, i.e. high in 2000s and low in 2010s. Trend headline inflation responds to changes in energy and fresh food inflation trend, accordingly.

Figure 12
The Trend Growth Rate of Global Commodity Price



Note: A trend is computed using the Hodrick-Prescott (HP) filter
Source: World Bank, Bloomberg and estimated by authors

Figure 13
An Estimated Trend of Headline Inflation and Its Components



Note: Trend inflation is estimated by a Multivariate Unobserved Component Stochastic-Volatility (MUCSV) Model with Outlier Adjustment a la Stock and Watson (2016).
Source: Ministry of Commerce and estimated by authors

To confirm that the persistence of commodity price inflation, as reflected by changes in commodity inflation trend, matters for changes in trend headline inflation, the following specification is estimated:

$$\Delta\tau_t = \alpha + \gamma\Delta\tau_t^c + e_t \qquad (16)$$

where τ_t^c is the trend growth rate of commodity prices. The results are shown in Table 3 below, which suggest that changes in the trend growth rate of both global oil and food prices significantly affect changes in trend inflation, despite small R-squared. The hypothesis that the observed persistent effects of commodity price changes on Thailand's inflation are explained by the persistence of commodity price inflation itself is, thus, not rejected.

Table 3
Explaining Trend Inflation Using Commodity Price Growth Trend

	Coeff	R^2
Oil price growth trend	0.22 (0.04)	0.04
Food price growth trend	0.44 (0.054)	0.07

Note: The coefficients are estimated using the data from 2002Q1 to 2017Q4.
P-value is shown in parentheses.

3.5 Structural Changes in Global Oil and Food Markets, and Thailand's Current Low Inflation

The recent finding on the significant effects of commodity price growth on trend inflation is useful in understanding Thailand's current low inflation. Thai Headline inflation declined immensely since the end of 2014, and stood at a low level since then. Core inflation has, also, been lower than its historical average, partially driven by a stagnant economy. The trend inflation estimates have clearly confirmed that Thailand's inflation over the long run is likely to be lower than in the past, or that it may exhibit a sluggish return to the central bank's target.

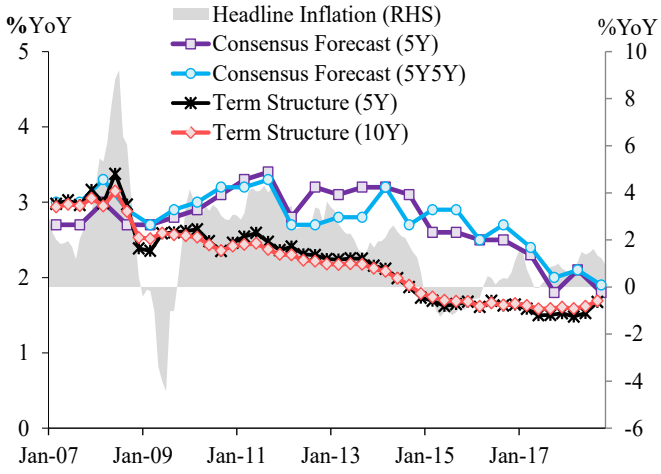
So, what explains such low trend inflation? Economists have proposed a number of factors that potentially contribute to low inflation dynamics including, for instance, globalisation, an expansion of e-commerce and the move towards an aging society. The results of this study, additionally, suggest that falling trend growth of commodity prices could also be the other main culprit that triggers a decline in Thailand's fresh food, energy and, hence, headline inflation trend. Over the past 4-5 years, global commodity markets have witnessed major structural shifts that have evidently altered commodity price and global inflation dynamics. Before the 2008 global financial crisis, the rise of emerging market economies, especially China and India, led to high demand for commodities. The insufficient supply and the financialisation of commodity markets were also among other factors contributing to price surge and explaining consistent growth of commodity prices during 2000s. However, the global financial crisis and the ensuing sluggish economic recovery have softened demand for commodities. On the supply side, technological advancements in oil extraction and production, namely the shale oil revolution, have substantially lowered costs of oil production. Such advancements have contributed to lower global crude oil prices since the end of 2014. Global oil supply has also become more price-elastic; that is, the supply becomes more responsive to shocks, leaving oil prices intact. At the same time, food production also has benefitted from improved technology as well as fewer supply disruptions, particularly from disasters. The poor demand and benign supply conditions together explain why food prices are now still in the down-cycle. These structural shifts in the global commodity markets have been an inevitable force that drive global and Thailand's inflation down over the past few years.

The low actual and trend inflation in Thailand have led to several policy implications. First, as headline inflation has missed the BoT's officially announced target for three consecutive years, this may threaten monetary policy credibility, namely an ability of the policy to achieve inflation target. In this light, the BoT constantly monitors the public's medium-term inflation expectations (5 to 10 years ahead) to judge whether inflation expectations remain well-anchored, which in turn signals whether monetary policy remains credible. Both survey-based and market-based inflation expectations, depicted in Figure 14, are monitored by the central bank's staff. The Figure shows that medium-term inflation expectations have declined since the episode of falling commodity prices commenced. Market-based expectations extracted from the term-structure model were faster to react as they fell considerably to around 1.6-1.7% in 2015. Survey-based expectations from Consensus Economics only declined much at the end of 2017.

Declining inflation expectations have left the BoT with a challenge in assessing whether there are risks of inflation expectation de-anchoring and whether they reflect a shift in the long-term mean (or steady state) of the inflation process (Ciccarelli and Osbat, 2017)[8]. The New Keynesian theory has highlighted the possibility that, if left uncontrolled, falling inflation expectations could contribute to further deflationary pressure. Actual inflation may, hence, fall even further, threatening the BoT's commitment in maintaining price stability. Worse, the public's inflation expectations could become more backward-looking, thereby adding more persistence to inflation dynamics.

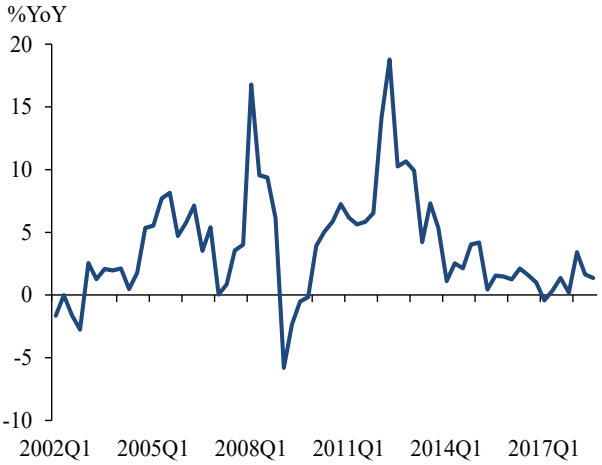
The low inflation phenomenon also has a bearing on wage growth dynamics. As firms form expectations regarding future inflation developments in their wage-setting decisions, both low actual and expected inflation can result in subdued wage growth. Figure 15 plots non-agricultural average labour earnings growth, which, like inflation, has been at a low level since 2014. Although slow wage growth may be mainly due to structural changes in the labour markets, historically low inflation in Thailand cannot be disregarded as one of the major causes. The danger is that, if labour earnings growth remains low, inflationary pressure that arises from labour costs will also be small and may not be sufficient to bring inflation back towards the target. The so-called wage-price spiral could, hence, occur.

Figure 14
Medium-term Public's Inflation Expectations



Note: "Term Structure" inflation expectations are extracted from a semi-structural macro-finance term structure model. See Apaitan (2015) for more information. 5Y5Y denotes 6-10 years.
Source: Ministry of Commerce, Consensus Economics and BoT

Figure 15
Non-agricultural Average Labor Earnings Growth



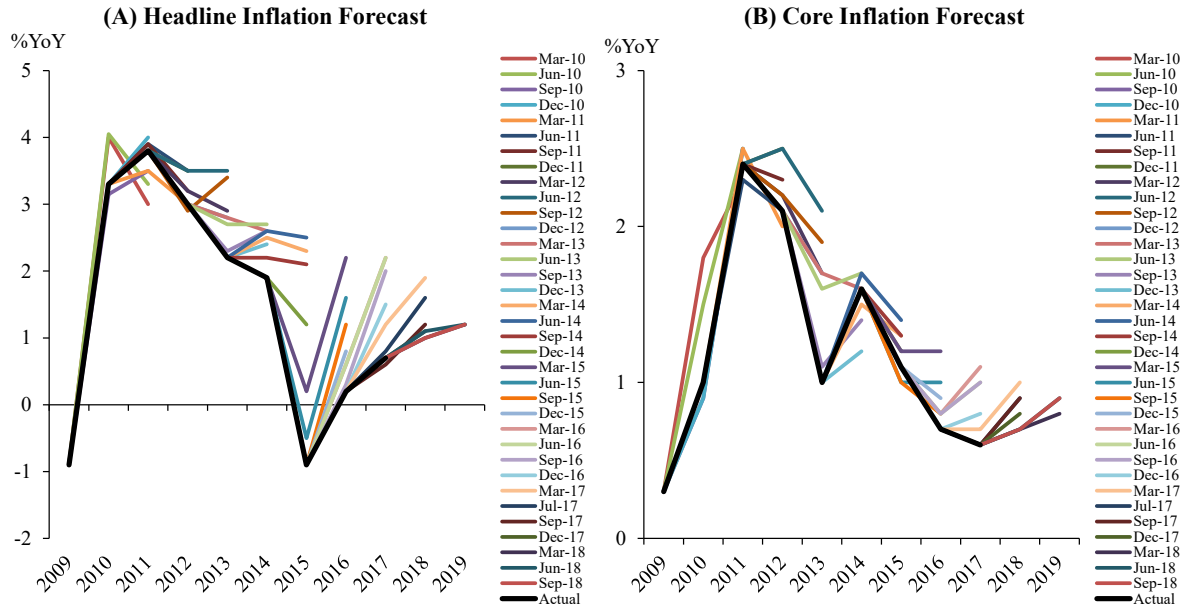
Source: National Statistical Office, and calculated by BoT

Despite an on-going economic recovery, the subdued inflationary pressure has contributed to low inflation out-turns. The BoT has, therefore, consistently adjusted downward its forecasts of headline and core inflation, as shown in Figure 16. In 2015, the BoT's macroeconomic model still forecasted headline inflation to converge back to 2%. The latest forecast, however, shows that headline inflation may average at around 1% in the next 1-2 years. For core inflation, its forecasts

8. Conceptually, shifts in the mean inflation rate expected in the long run indicate impaired trust in the central bank's commitment to achieve and maintain price stability. In fact, they imply a de-anchoring of public perceptions of the central bank's inflation target from the officially announced target.

have also been gradually adjusted downward since 2014. These projections, despite being short-term, have underscored the possibility that developments of global oil and food prices may have an impact on the country's inflation dynamics over the long run, and hence on monetary policy.

Figure 16
Bank of Thailand's 2-Year-Ahead Forecast of Headline and Core Inflation



Note: Each line in the figure shows inflation forecasts shown in each Monetary Policy Report from 2010 onwards. The black lines depict actual inflation.
Source: Ministry of Commerce and BoT

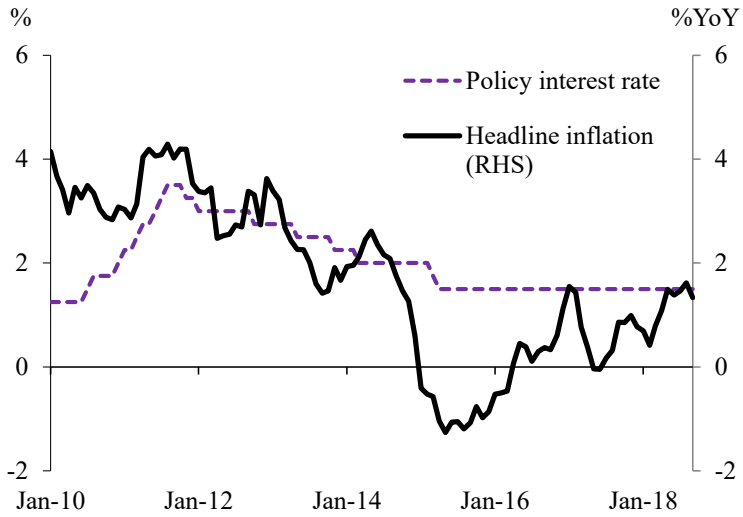
4. Implications on Monetary Policy

Recognising that growth of global oil and food prices can have both short-term and long-term consequences on Thailand's inflation, the next subject for discussion is the implications on monetary policy. First, the implications on monetary policy deliberations at each Monetary Policy Committee (MPC)'s meeting are explained. Then, the implications on the setting of inflation target are discussed.

4.1 Implications on Monetary Policy Deliberations

Generally, the central bank can safely ignore changes in global oil and food prices given that inflation volatilities induced by commodity price developments are usually short-term in nature. However, on certain occasions, those changes can be persistent, and hence lead to changes in the dynamics of trend inflation. Like in the recent episode, there can be long, or even sustained, deviations of actual inflation away from target that are driven in part by commodity price changes.

Figure 17
Thailand's Inflation and Policy Interest Rate



Note: The Bank of Thailand currently uses a 1-day bilateral repurchase rate as the monetary policy interest rate.
Source: Ministry of Commerce and BoT

Nevertheless, given the inefficiency in addressing supply shocks, monetary policy is having a hard time in preserving price stability. Policy reactions to offset supply shocks will also induce trade-offs in terms of worsened growth and financial stability, which are another key mandates of the central bank. The BoT, therefore, faces a challenging task in striking the right balance between maintaining price stability, growth stability and financial stability. In the present context, against the background of Thailand's low inflation, the MPC has decided to keep its policy rate at a low level of 1.5% since 2015, in spite of the fact that the economy has continued recovering (Figure 17). However, a low-for-long interest rate is not without costs. The MPC has acknowledged the possibility that low interest rates may lead to the search-for-yield behaviour and heightened risks to financial stability. Keeping rates too low for extended periods may render monetary policy itself a source of financial imbalances and economic overheating. Nevertheless, raising the policy rate too early and too much could pose risks to an inflation recovery. That is, if the MPC puts too much emphasis on economic growth and financial stability objectives, it may take more time for inflation to revert back to target. Inflation could become more persistent, thus requiring a longer monetary policy normalisation process.

4.2 Implications on Setting of an Inflation Target

4.2.1 Should the Central Bank Use Core or Headline Inflation as a Target?

The main results of this study suggest that headline inflation, notably the non-core component, is to a non-negligible extent driven by external factors, especially commodity price dynamics. Headline inflation has, therefore, been volatile and may not be perfectly controlled by monetary policy. The BoT, consequently, faces an important question of whether headline inflation should serve as a target measure for Thailand. Or, core inflation, which is quite insulated from global oil and food price shocks, should instead be targeted.

Thailand is indeed the last country to abandon core inflation as an inflation target. After adopting the Inflation Targeting framework, the BoT introduced core inflation of 0-3.5% as an inflation target. The rationale for targeting core inflation is that such inflation measure is less volatile, less subject to supply-side innovations and can be influenced by monetary policy. The "core" inflation targeting framework has proven to be successful in terms of macroeconomic achievement.[9] Nevertheless, in 2015, the BoT switched to "headline" inflation targeting, citing an ease of public communication and in anchoring public's inflation expectations, given that headline inflation reflects better the households' costs of living.

Though headline inflation is proven to be volatile and largely driven by external shocks, the BoT believes that it remains an appropriate target for Thailand. The fact that headline inflation reflects the overall costs of living and hence is easily-understood by the public remains a key reason. Core inflation, on the other hand, is not a widely-known concept, and could create confusion to the public when they make price-setting or wage-setting decisions.

Another important reason to support headline inflation as a target measure is based on the authors' trend inflation estimates for the CPI components. From Figure 13, huge and persistent dispersion in core and non-core inflation trend, particularly before 2015, are observed. Thailand's core inflation tended to be biased downward. This implies that core inflation is far from being a good underlying inflation indicator and so is not an appropriate anchor for the public's inflation expectation formation. In particular, the "core" inflation target could be "too high" or "too low" to reflect the economy's true costs of living. In the current context where fresh food and energy inflation trend are relatively low, the core inflation target could be higher than the overall living costs. This may have adverse consequences on resource allocations and macroeconomic stability. Take, for example, the effects on interest rate pricing. A too high core inflation target could lead to "too high" ex-ante nominal interest rates and hence underinvestment. The high ex-post real interest rates also contribute to unnecessary wealth redistributions from borrowers to savers. On the other hand, a too low core inflation target implies "too low" nominal interest rates and under-saving. Furthermore, headline inflation out-turns that persistently deviate from the "core" inflation target could derail the credibility of such "core" inflation target in serving as an anchor for public's inflation expectations. Nevertheless, employing headline inflation as a target brings about challenges to monetary policy deliberations as described in Section 4.1 above.

4.2.2 What Should Be an Appropriate Level of the Inflation Target?

Given the prominent role of external factors in driving trend inflation, another challenge to monetary policymakers is how to determine the target level of inflation. Structural changes in global oil and food price dynamics can induce changes in trend inflation, and so may influence a long-term equilibrium of inflation and affect an ability of monetary policy in controlling inflation back towards the target. For Thailand, structural changes in the commodity markets have resulted in low inflation dynamics and posed a concern over the appropriateness of the current target level at 2.5+/-1.5%. In particular, the current target may be too high to achieve, affecting policy credibility. Furthermore, it may call for large, prolonged monetary expansion to bring inflation towards target. This may foster economic overheating and financial instability. Nevertheless, the MPC is also aware of potential long-term costs from lowering the inflation target. One of these is

9. See Grenville and Ito (2010). The core inflation target was revised once in 2010 to the target range to 0.5-3%, with the aim of strengthening the commitment towards price stability and avoiding the potential for deflation risks.

a reduction in neutral nominal interest rates, which means the lower monetary policy space. There may also be increasing risks of deflation. Furthermore, monetary policy commitment towards the pre-announced target can be derailed. Any adjustments made to the inflation target must, therefore, be carefully reviewed.

However, it is argued that a too rigid inflation target that does not take into account changing inflation dynamics, particularly those induced by commodity price developments, implies that prolonged deviations of inflation away from target may frequently occur, like in the present context. As argued earlier, monetary policy actions to offset commodity price shocks so as to preserve price stability may, nonetheless, weaken the attainment of other policy objectives. To accommodate the maintenance of multiple objectives, the BoT has indeed gradually moved towards enhancing the flexibility of monetary policy framework. In 2015, as the BoT switched from core to headline inflation targeting, the point target with a tolerance band is adopted. While the point target raises the ability of the central bank in anchoring inflation expectations, the tolerance band helps preserve the bank's flexibility in pursuing other policy objectives, at least in the short run. The band also helps accommodate large short-term inflation volatility that usually results from supply shocks. It, thus, ensures that the inflation target is not strictly-defined such that it derails economic growth and financial stability. Then, in 2016, the target horizon was extended to medium term in line with international practices. The move allows policymakers to ignore temporary effects of shocks, particularly shocks to global oil and food prices, on inflation and focus on those that have a persistent impact and matter for inflation expectations and trend inflation.

Whether the moves are adequate in the circumstance that commodity price shocks may affect trend inflation remains an important question. It is argued that potential shifts in commodity price dynamics support the case for even greater flexibility in the monetary policy framework, notably the inflation target, since such shifts may cause inflation to persistently deviate from the target, making the latter difficult to attain and hence constraining monetary policy decisions. Two plausible solutions are presented here. First, the inflation target should be allowed to adjust more promptly to external or non-core developments. This should allow the target to be a credible anchor for long-term inflation dynamics. In addition, it helps avoid excessive monetary policy expansion or tightening that could threaten other policy objectives. However, it entails some costs since the inflation target may change too often, which in turn results in higher uncertainty regarding future inflation. The public may also doubt the commitment of the central bank in pursuing a price stability objective. The other solution is to adopt the range, instead of point, target. The range target, in the authors' reckoning, means that the central bank is satisfied whenever actual inflation falls within the band. There is, hence, no committed or explicit mid-point that the central bank has to achieve over the medium run. Both arguments give the central bank more flexibility in deliberating policies. Nevertheless, without the explicit mid-point, an ability of the target to serve as an anchor for inflation expectations could be derailed. Furthermore, according the New Keynesian theory, this may result in price dispersion which worsens resource allocations and welfare. Last, monetary policy decisions will also become harder to predict, which may weaken the effectiveness of monetary policy.

5. Conclusion

This paper relies on two approaches to examine the roles of global oil and food prices on Thailand's inflation. First, the local projection method is adopted to quantify the sensitivity of Thailand's headline and core inflation to commodity price changes, and then the trend-cycle approach following Forbes et al. (2017) is used to examine whether changes in commodity prices matter for trend inflation. The results from the local projections suggest that global oil and food price changes have significant and economically important, but short-lived, effects on Thailand's headline inflation. However, the pass-through is found to be smaller and less persistent than in the past, while core inflation is barely affected. The impact asymmetry and non-linearity are also evident. In particular, large negative changes in commodity prices tend to have a disproportionately bigger impact on inflation. Nevertheless, the trend-cycle analysis suggests that changes in commodity prices can impact trend inflation. This, it is argued, could be owing to the fact that those changes themselves can be persistent. This latter finding is useful in understanding the current low inflation dynamics in Thailand, since trend growth rates of commodity prices have decreased over the recent years and potentially dragged down Thai inflation.

Three challenges to monetary policymaking are discussed, one related to interest rate decisions and the others to the setting of the inflation target. First, as commodity price developments may have long-lasting effects on inflation, policymakers face a crucial task in distinguishing between transient and permanent effects of the price changes so as to form appropriate policy decisions. The fact that they may matter for trend inflation complicates monetary policy decisions that need to strike the right balance between maintaining several objectives. The economy could face large trade-offs in terms of output fluctuations if the central bank responds to commodity price changes. However, if monetary policy is irresponsive, the anchoring of inflation expectations may be adversely affected. Second, as headline inflation, to a large extent, is driven by external shocks, there exists a question of whether it should serve as a target measure for Thailand. In this regard, it is argued that core inflation, an alternative target, is not a good underlying inflation measure, while being inferior to headline inflation in terms of public communication. Last, an appropriate level of inflation target is another issue facing monetary policymakers, since changes in commodity prices can influence trend inflation. This paper concludes by arguing that, although the BoT has moved towards greater flexibility in the monetary policy framework, which should accommodate a deviation of inflation from target, even greater flexibility of the framework may be needed.

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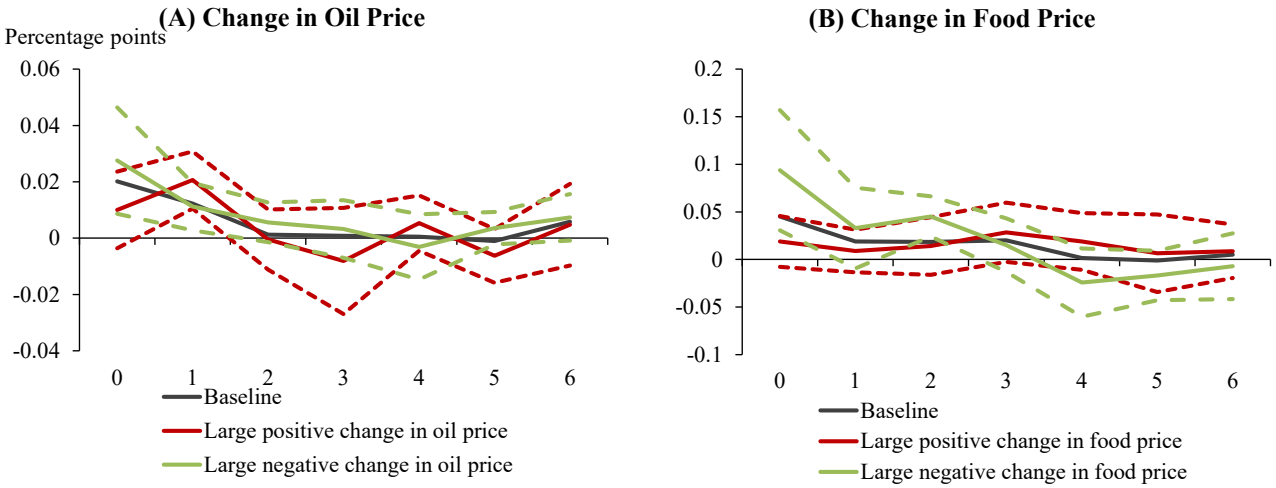
Appendix

Table 4
Sources and Definitions of Variables

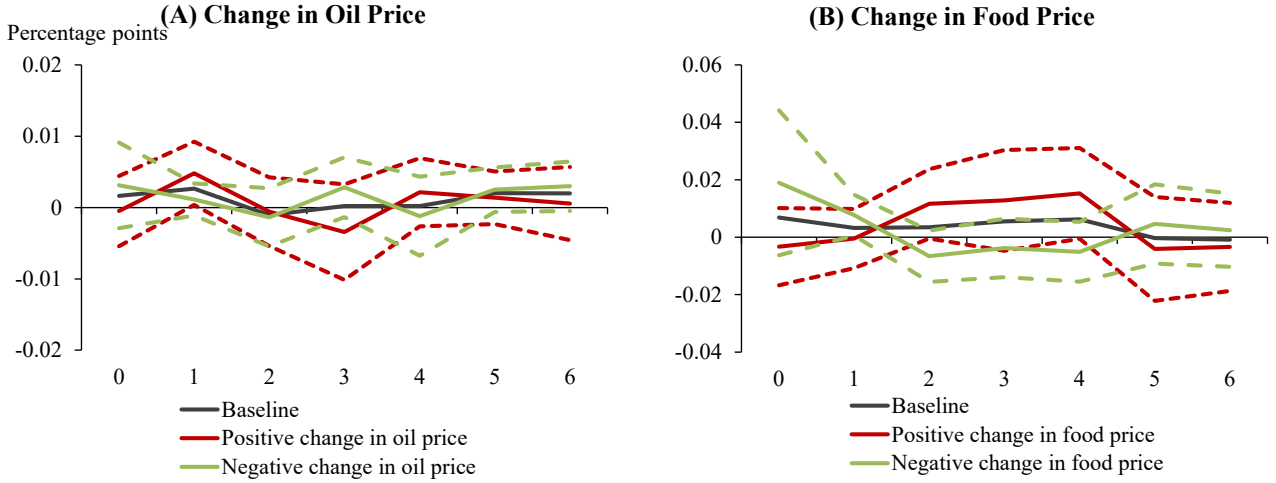
Definitions	Sources	Note
Consumer Price Index	Ministry of Commerce /IMF	The CPI data prior to 2000 from the IMF database (2010=100) is used.
Global oil price	Bloomberg/World Bank	Dubai crude oil price (Unit: US$ per barrel)
Global food price	World Bank	Global food price index based on nominal US$ (2010=100)
Output gap	NESDB	Output gap is defined as the deviation of real GDP from the potential output. Real GDP is seasonally adjusted. The quarterly real GDP is interpolated to obtain monthly data using quadratic interpolation. The potential output is extracted by Hodrick–Prescott filter.
Unemployment gap	NSO/BoT	Unemployment gap is the deviation of an unemployment rate from the natural rate of unemployment. An unemployment rate (U3) is seasonally adjusted, while the natural rate of unemployment is extracted by Hodrick–Prescott filter.
Baht-US$ exchange rate	BoT	Monthly average of a daily exchange rate
Average labour earning	Labor force survey (NSO)	Average of nonagricultural Thai labours' salaries and overtime payments
Short-term Inflation Expectation	Consensus Economics	1-year ahead inflation expectations by professional economic forecasters
Long-term Inflation Expectation	BoT	5-years ahead inflation expectations extracted from government bond yields using macro-finance term structure model. See Apaitan (2015)

Figure 18
The Impact of Oil and Food Price Changes on Headline Inflation: Large Positive vs. Large Negative Changes



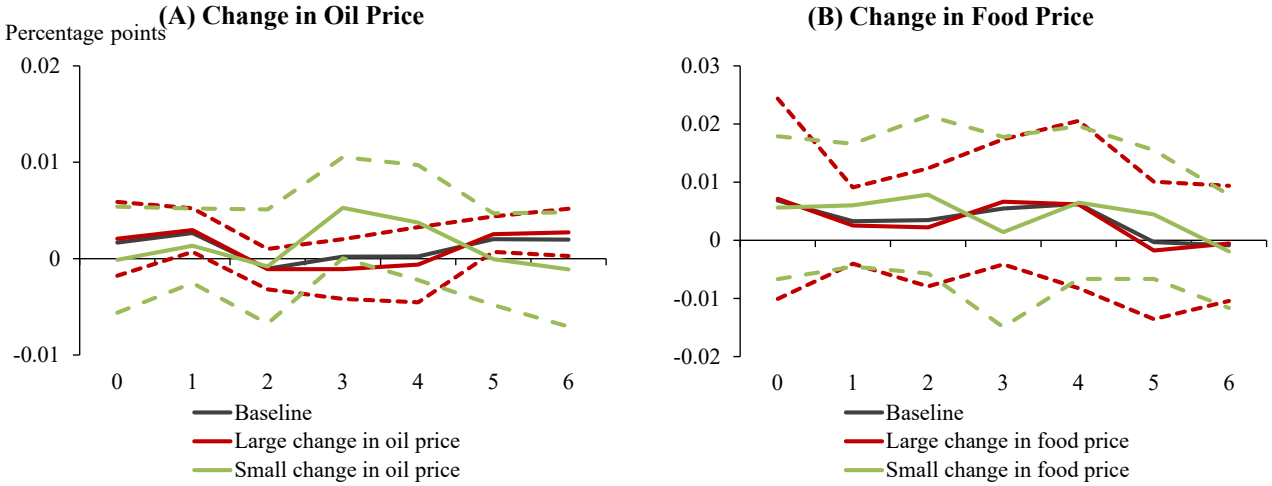
Note: the figure shows the impact of 1 percentage-point change in large global oil and food inflation on domestic headline inflation. The red and green lines present the responses to large positive and large negative changes, respectively. The dashed lines indicate 95-percent confidence bands. t=0 denotes the month in which commodity price changes occur. Large changes are defined as changes in oil and food prices larger than one standard deviation from their mean.

Figure 19
The Impact of Oil and Food Price Changes on Core Inflation: Positive vs. Negative Changes



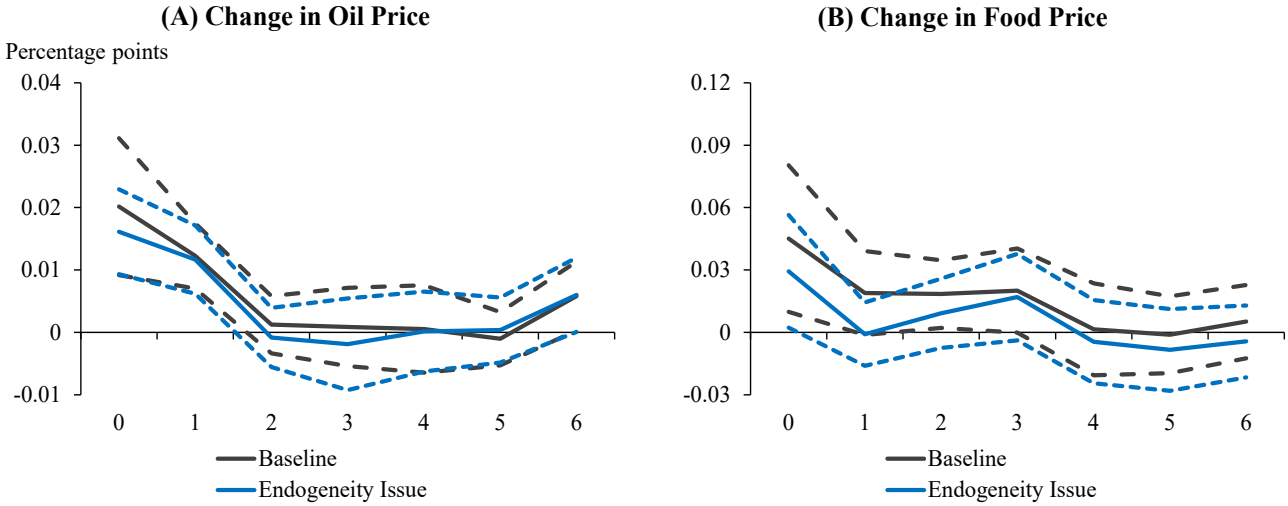
Note: the figure shows the impact of 1 percentage point change in global oil and food inflation on domestic core inflation. The red and green lines present the responses to positive and negative shocks, respectively. The solid line is the impulse response function (IRF), while the dashed lines indicate 95 percent confidence bands. t=0 denotes the quarter of the shock. Also juxtaposed in the figure is the baseline IRF as shown in figure 1.

Figure 20
The Impact of Oil and Food Price Changes on Core Inflation: Large vs. Small Changes



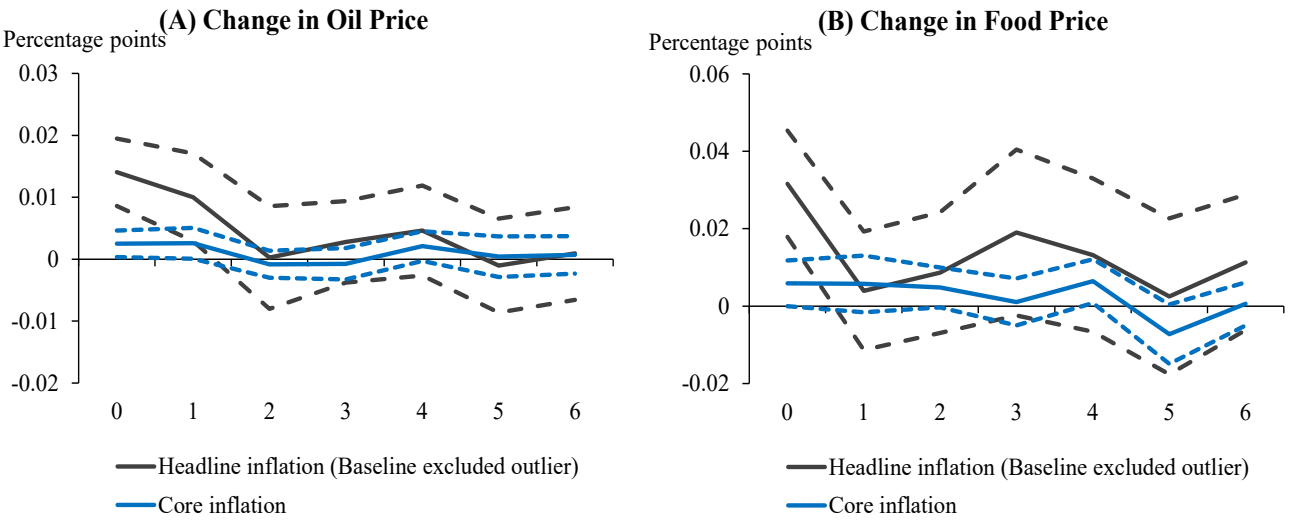
Note: the figure shows the impact of 1 percentage-point change in global oil and food inflation on domestic core inflation. The red and green lines present the responses to large and small changes, respectively. The dashed lines indicate 95 percent confidence bands. t=0 denotes the month commodity price changes occur. Large (small) changes are defined as changes in oil and food prices larger (smaller) than one standard deviation from their mean.

Figure 21
The Impact of Oil and Food Price Changes on Headline Inflation: Endogeneity Issue



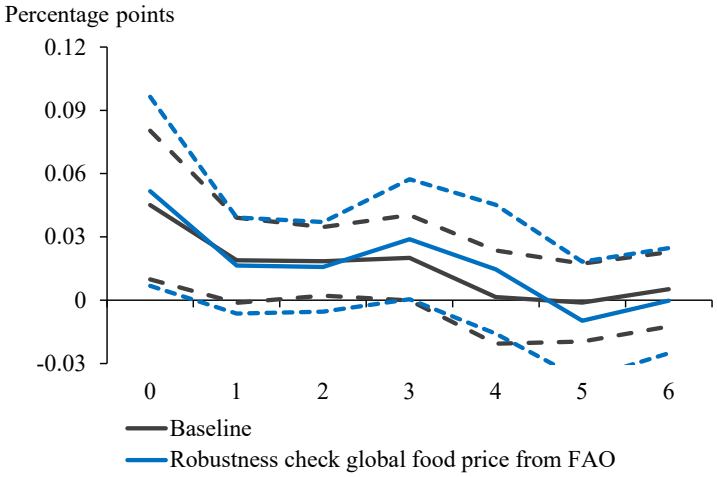
Note: the figure shows the impact of 1 percentage-point change in global oil and food inflation on domestic headline inflation. The black lines present the baseline responses, whereas the blue lines are from estimating the model that includes both oil and food price changes simultaneously. The dashed lines indicate 95 percent confidence bands. t=0 denotes the month in which commodity price changes occur.

Figure 22
The Impact of Oil and Food Price Changes on Headline Inflation: Outlier Exclusion



Note: the figure shows the impact of 1 percentage-point change in global oil and food inflation on domestic headline inflation. The black lines present the baseline responses, whereas the blue lines are from the estimation that excludes extreme observations. The dashed lines indicate 95 percent confidence bands. t=0 denotes the month commodity price changes occur.

Figure 23
The Impact of Food Price Changes on Headline Inflation: FAO Food Price Index



Note: the figure shows the impact of 1 percentage-point change in global food inflation on domestic headline inflation. The black lines present the baseline responses, whereas the blue lines are from the estimation that relies on food price index from FAO. The dashed lines indicate 95-percent confidence bands. t=0 denotes the month in which commodity price changes occur.