พลวัตของเงินเฟ้อและนัยต่อการดำเนินนโยบายการเงิน

Inflation Dynamics and Implications on Monetary Policy

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สายนโยบายการเงิน

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ข้อคิดเห็นที่ปรากฏในบทความนี้เป็นความเห็นของผู้เขียน ซึ่งไม่จำเป็นต้องสอดคล้องกับความเห็นของธนาคารแห่งประเทศไทย

บทสรุป

บทความนี้ต้องการตอบคำถามว่าภายใต้สถานการณ์ปัจจุบันที่เงินเฟ้อดูเสมือนจะมาจากปัจจัยด้านอุปทานนั้น ข้อเท็จจริงเป็นอย่างไร และนโยบายการเงินจะมีบทบาทในการดูแลเงินเฟ้อได้หรือไม่ จากการศึกษาพบว่า ปัจจัยด้านอุปทานมีส่วนสำคัญในการกำหนดเงินเฟ้อของไทย ซึ่งในอดีตปัจจัยดังกล่าวมีลักษณะชั่วคราวและหมดไปในเวลาไม่นาน ดังนั้น ผลกระทบต่อพลวัตของเงินเฟ้อจึงมักหมดไปเองในเวลาอันรวดเร็ว เว้นแต่จะถูกหล่อเลี้ยงจากปัจจัยอื่น เช่น นโยบายการเงินที่ผ่อนคลายเกินควร แต่ในช่วง 5 ปีที่ผ่านมา พลวัตของราคาน้ำมันและราคาสินค้าเกษตรเริ่มเปลี่ยนแปลงไปตามการเปลี่ยนแปลงของโครงสร้างอุปสงค์และอุปทานของน้ำมันและสินค้าเกษตร ทำให้ราคาน้ำมันและราคาสินค้าเกษตรอันเป็นต้นตอของเงินเฟ้อในขณะนี้มีลักษณะที่ยืดเยื้อมากขึ้น ในภาวะดังกล่าวหากนโยบายการเงินช่วยหล่อเลี้ยงให้ความหนืดของเงินเฟ้อสูงขึ้นไปอีก จะยิ่งทำให้ผลของปัจจัยด้านอุปทานต่อเงินเฟ้อมีความต่อเนื่อง ดังนั้น ทางการจำเป็นต้องให้ความสำคัญกับการรักษาวินัยทางการเงิน และระมัดระวังการคาดการณ์เงินเฟ้อที่อาจปรับสูงขึ้นติดต่อกันเป็นเวลานานจนประชาชนเกิดความเคยชิน ซึ่งอาจส่งผลให้เงินเฟ้อทรงตัวอยู่ในระดับสูงต่อไปได้เรื่อยๆ ในที่สุด

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Inflation Dynamics and Implications on Monetary Policy

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Abstract

This paper attempts to provide some facts about the current environment where inflation seems to be originating from supply-side factors. It aims in particular to answer whether or not there is a role for monetary policy to contain such inflation and, if yes, how. From this study, it is found that in the past Thailand's inflation dynamics were largely governed by temporary supply disruptions whose effects on inflation tended to quickly disappear on their own, unless assisted by some other factors such as accommodative monetary policy. During the past five years, however, the nature of these supply shocks has changed in line with the structural shifts in the demand and supply of oil and farm products. As a result, changes in oil and farm prices have themselves become more protracted. Under the circumstance, accommodative monetary policy could keep the impact of supply shocks on inflation even more lasting, and thus the inflation process could become more persistent as well. Therefore, the authorities must maintain high priority on monetary policy discipline and be mindful that persistently high inflation expectations could cause people to become inflation tolerant and ultimately allow inflation to stay high over an extended horizon.

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<u>บทสรุปผู้บริหาร</u>

ภายใต้สภาวะปัจจุบันความเห็นของสาธารณชนต่อการดำเนินนโยบายการเงินเพื่อดูแลจัดการกับเงินเฟ้อแบ่งเป็น 2 ฝ่าย โดยฝ่ายหนึ่งเห็นว่าเงินเฟ้อในปัจจุบันมาจากปัจจัยด้านอุปทานที่นโยบายการเงินไม่อาจเข้าไปจัดการได้ นโยบายการเงินจึงไม่ควรตึงตัวขึ้นแต่น่าจะผ่อนคลายลงเพื่อช่วยบรรเทาภาระต้นทุนทางการเงินของผู้ประกอบการและประชาชน ขณะที่อีกฝ่ายหนึ่งเห็นว่านโยบายการเงินยังจำเป็นต้องตึงตัวขึ้น เพื่อลดแรงกดดันจากภาวะที่อัตราการใช้กำลังการผลิตอยู่ในระดับสูงต่อเนื่องและการคาดการณ์เงินเฟ้อเร่งตัวขึ้นเป็นลำดับ ดังนั้น ความรู้ความเข้าใจถึงพลวัตของเงินเฟ้อและปัจจัยที่ส่งผลกระทบต่อพลวัตดังกล่าว ซึ่งรวมถึงบทบาทของนโยบายการเงินที่จะมีส่วนในการกำหนดพลวัตของเงินเฟ้อ จึงเป็นสิ่งที่สำคัญยิ่งต่อการดำเนินนโยบายการเงิน เพื่อให้เป็นไปอย่างเหมาะสมและทันกาล

บทความนี้จึงมีวัตถุประสงค์เพื่อศึกษาถึงปัจจัยที่มีส่วนในการกำหนดพลวัตของเงินเฟ้อตั้งแต่อดีตจนถึงปัจจุบันทั้งในเชิงคุณภาพและเชิงปริมาณ ผลการศึกษาสรุปสาระสำคัญได้ดังนี้

(1) การศึกษาพลวัตของเงินเฟ้อใน<u>เชิงคุณภาพ</u> พบว่าในอดีต อัตราเงินเฟ้อของไทย อาจกล่าวได้ว่าอยู่ในระดับต่ำและค่อนข้างมีเสถียรภาพ แม้ว่าที่ผ่านมาจะมีความผันผวนจากปัจจัยด้านอุปทาน โดยเฉพาะจากราคาน้ำมันและสินค้าเกษตร เกิดขึ้นเป็นระยะๆ รวมทั้งผลจากการเปลี่ยนแปลงของค่าเงินบาท ทว่าปัจจัยที่มีผลต่ออัตราเงินเฟ้อจะหมดไปเองในเวลาอันรวดเร็ว อย่างไรก็ดี ในระยะหลังตั้งแต่ปี 2546 เป็นต้นมา ลักษณะของปัจจัยด้านอุปทานโดยเฉพาะจากราคาน้ำมันและสินค้าเกษตรที่เข้ามากระทบเงินเฟ้อเปลี่ยนแปลงไป กล่าวคือ ราคาน้ำมันและราคาสินค้าเกษตรมีลักษณะที่เพิ่มขึ้นอย่างต่อเนื่อง และโดยรวมมีความผันผวนสูงขึ้นกว่าในอดีต สะท้อนว่ามีแรงผลักดันอื่นนอกเหนือจากปัจจัยด้านอุปทานที่เป็นปัจจัยชั่วคราว ซึ่งพบว่าเป็นผลจากการเปลี่ยนแปลงในโครงสร้างอุปสงค์และอุปทานของน้ำมันและสินค้าเกษตร ที่สำคัญคือ ความต้องการบริโภคที่เพิ่มขึ้นตามการขยายตัวทางเศรษฐกิจและฐานะความเป็นอยู่ที่ดีขึ้นของผู้บริโภคในกลุ่มประเทศเกิดใหม่ โดยเฉพาะจีนและอินเดีย นอกจากนี้ การนำพืชไปผลิตเป็นพลังงานทดแทนการพึ่งพาน้ำมัน ก่อให้เกิดการแย่งชิงทรัพยากรระหว่างการบริโภคและการผลิตพลังงานทดแทน ทำให้ราคาน้ำมันและราคาสินค้าเกษตรมีความสัมพันธ์ไปด้วยกันมากขึ้นกว่าในอดีต ขณะที่อุปทานตอบสนองต่อราคาที่สูงขึ้นน้อยกว่าในอดีต โดยเฉพาะน้ำมัน เมื่อผนวกกับข้อจำกัดในการขยายผลผลิตอื่นๆ เช่น การเกิดภัยธรรมชาติที่รุนแรงบ่อยครั้งขึ้น และความเสี่ยงจากด้านภูมิรัฐศาสตร์ ราคาน้ำมันและราคาสินค้าเกษตรจึงเร่งตัวได้อย่างมากและต่อเนื่องอย่างไม่เคยเป็นมาก่อน ซึ่งมีผลทำให้ผลกระทบต่อเงินเฟ้ออาจจะไม่หมดไปเองอย่างรวดเร็วเช่นในอดีต

(2) เมื่อศึกษาพลวัตของเงินเฟ้อใน<u>เชิงปริมาณ</u> พบว่า ในช่วงปี 2514 – 2519 เงินเฟ้อของไทยเริ่มสูงขึ้นจากปัจจัยชั่วคราวด้านอุปทานที่เข้ามากระทบ แต่เป็นที่น่าสังเกตว่าเมื่อผลของปัจจัยชั่วคราวหมดไปแล้ว เงินเฟ้อยังมีแนวโน้มสูงต่อเนื่องไปอีกหลายปี (ปี 2520 – 2523) การทดสอบ

ทางสถิติแสดงให้เห็นว่าส่วนหนึ่งเป็นผลจากนโยบายการเงินของไทยที่ผ่อนคลายเกินควร เนื่องจากเป็นช่วงที่ไทยยังผูกค่าเงินบาทไว้กับตะกร้าเงินที่มีน้ำหนักส่วนใหญ่อยู่ที่สกุลดอลลาร์ สรอ. และจำเป็นต้องดำเนินนโยบายการเงินไปในทิศทางที่ผ่อนคลายเช่นเดียวกับสหรัฐฯ นอกจากนี้ พบว่าการคาดการณ์เงินเฟ้อ ซึ่งเป็นส่วนที่นโยบายการเงินสามารถเข้าไปมีบทบาทได้ เป็นปัจจัยหนึ่งที่มีส่วนในการกำหนดพลวัตเงินเฟ้อของไทยอย่างมีนัยสำคัญ

(3) เมื่อพิจารณาในรายละเอียดถึงบทบาทของนโยบายการเงินต่อการเปลี่ยนแปลงพลวัตเงินเฟ้อของไทย พบว่าในช่วงที่แนวนโยบายการเงินที่เกิดขึ้นจริงสอดคล้องกับนโยบายการเงินที่ควรจะเป็นตาม Simple monetary policy rules กล่าวคือนโยบายการเงินมีวินัย หรือค่อนข้างเข้มงวด เป็นช่วงเดียวกับที่พบว่าความหนืด (Persistence) ของอัตราเงินเฟ้ออยู่ในระดับต่ำต่อเนื่องหรือปรับลดลง ในขณะที่ในช่วงที่นโยบายการเงินขาดวินัย หรือผ่อนคลายกว่าที่ควรจะเป็น จะให้ผลต่อความหนืดของอัตราเงินเฟ้อในทิศทางตรงกันข้าม

บทสรุปและนัยต่อนโยบาย

กล่าวโดยสรุปคือ แม้ว่าในอดีตพลวัตของเงินเฟ้อของไทยอาจกล่าวได้ว่า ส่วนใหญ่ถูกกำหนดจากปัจจัยชั่วคราวด้านอุปทาน ซึ่งผลกระทบต่อเงินเฟ้อจะหมดไปเองอย่างรวดเร็ว แต่ในระยะหลังพลวัตของเงินเฟ้อเริ่มเปลี่ยนแปลงไปตามการเปลี่ยนแปลงของโครงสร้างอุปสงค์และอุปทานต่อสินค้าโภคภัณฑ์ที่สำคัญของโลก นอกจากนี้ การคาดการณ์เงินเฟ้อ ซึ่งเป็นส่วนที่นโยบายการเงินสามารถเข้าไปมีบทบาทได้ เป็นปัจจัยหนึ่งที่มีส่วนสำคัญในการกำหนดพลวัตเงินเฟ้อของไทย ทั้งนี้ ข้อมูลในอดีตบ่งชี้ว่านโยบายการเงินที่ผ่อนคลายเกินควรมีส่วนช่วยเอื้อให้อัตราเงินเฟ้อสูงขึ้นต่อเนื่องไปอีกหลายปี แม้ว่าผลจากปัจจัยด้านอุปทานที่เข้ามากระทบจะหมดไปแล้วก็ตาม

นัยต่อนโยบาย คือ ในภาวะที่ปัจจัยที่เป็นต้นตอของเงินเฟ้อที่สูงขึ้นมีลักษณะต่อเนื่อง ไม่ว่าปัจจัยที่เป็นต้นตอของเงินเฟ้อจะมาจากอุปทานหรือด้านอุปสงค์ก็ตาม *ทางการจำเป็นต้องให้ความสำคัญต่อการรักษาวินัยทางการเงิน และระมัดระวังการคาดการณ์เงินเฟ้อที่อาจปรับสูงขึ้นและทรงตัวอยู่ในเกณฑ์สูงเป็นเวลานาน จนอาจทำให้ประชาชนเกิดความเคยชินและตั้งราคาต่าง ๆ ในระบบเศรษฐกิจ ทั้งค่าแรงและราคาสินค้าในลักษณะที่จะทำให้เงินเฟ้ออยู่ในระดับสูงต่อไปได้เรื่อย ๆ* ทั้งนี้ เพื่อมิให้ผลกระทบจากปัจจัยชั่วคราวด้านอุปทานยืดเยื้อและฝังตัวต่อเนื่องยาวนานอยู่ในพลวัตของเงินเฟ้อเช่นประสบการณ์บางช่วงในอดีต

Executive Summary

Under the current environment, public opinion regarding the conduct of monetary policy in dealing with inflation is divided into two sides. On the one side, arguments rest on the fact that because present inflation stems from supply-side factors that are beyond the control of monetary policy, a tightening stance is therefore not needed. Rather, monetary policy should become more accommodative to alleviate the financial burden on businesses and consumers. On the other hand, the opposite side views that monetary policy must be tightened to relieve pressure from continuously high capacity utilization and gradually accelerating inflation expectations. Thus, knowledge and understanding of inflation dynamics and their governing factors, including the role of monetary policy, are of utmost importance to the appropriate and timely policy conduct at this juncture.

In accordance with that motivation, this paper aims to shed some light on the factors that underpin Thailand's inflation process from the past to the present, relying on both qualitative and quantitative methods. Our findings are as follows.

First, <u>qualitative</u> analyses of past inflation dynamics reveal that Thailand's inflation has generally been low and stable despite some volatilities resulting from supply shocks, especially from oil and farm prices, and fluctuations in the Thai baht. Nevertheless, up to the beginning of the 2000s, these factors are found to be short-lived and quickly disappear on their own. Since 2003, however, there have been changes in the characteristics of cost-pushed inflationary pressures. Incidentally, the increases in oil and farm prices have become more persistent and overall more volatile compared to the previous periods. This reflects the working of additional sources of pressure on top of temporary supply disruptions, in particular the ongoing structural changes in the demand and supply of the aforementioned commodities. One is strong demand arising from economic growth and higher standards of living of consumers in emerging economies as well as the use of crops to produce bio-fuels, which has led in turn to competition for resources between consumption and bio-fuel production. Another is the lower price elasticity of supply, especially in the case of oil, while restrictions on supply expansions remain, for example due to more frequent natural disasters and geopolitical risks. Consequently, prices of oil and farm products have become more intertwined and risen significantly and continuously during the recent period like never seen before, and with that their impact on inflation tends to be more protracted than in the past.

Second, <u>quantitative</u> analyses show that during 1971 – 1976, Thailand's inflation began to rise as a result of temporary supply shocks. However, despite the short-lived nature of these shocks, inflation continued to be elevated for several more years (1977 – 1980). Given so, our empirical analyses ascertain that this phenomenon could partly be explained by monetary policy that was too accommodative at the time as the pegged exchange rate obliged Thailand's monetary policy to follow the loose monetary policy of the U.S. In addition, we find evidence to suggest that inflation expectation – the part of inflation that monetary policy could potentially control – has been one of the factors that significantly affect inflation dynamics in Thailand.

Finally, an analysis of the role of monetary policy on changes in Thailand's inflation dynamics based on the concept of deviations of monetary policy stance from simple monetary policy rules shows that inflation persistence tends to adjust downwards under an environment of restrictive monetary policy. On the contrary, a lack of monetary policy discipline tends to be associated with an increase in inflation persistence.

Policy implications

From our findings above, the policy implication is that in an event where the underlying cause of rising inflation is persistent in nature, regardless of whether such cause is cost-pushed or demand-pulled, *the authorities must remain committed to achieving monetary policy discipline. In addition, the authorities must be mindful that inflation expectations which persist at an elevated level could cause people to become inflation tolerant and set prices in the economy, namely wages and prices of goods, in a manner that would continue to keep actual inflation at a high level.* This is to ensure that the impact of temporary supply shocks would neither be protracted nor deeply embedded into the inflation dynamics as was the case in certain periods in the past.

1. Introduction

"Nothing is more important to the conduct of monetary policy than understanding and predicting inflation. Price stability is our responsibility as central banks – it is how, in the long run, we contribute to society's welfare. Achieving and maintaining price stability will be more efficient and effective the better we understand the causes of inflation and the dynamics of how it evolves."

Donald L. Kohn
Governor of the Federal Reserve Board
Member of the Federal Open Market Committee
20 May 2005

Casual observation seems to suggest three facts about inflation in Thailand. First, it has been quite low and stable since the mid-1980s up until very recently. Second, it has not been very persistent for the past twenty years or so. That is, a temporary shock, e.g. the exchange rate depreciation in the wake of the 1997 crisis, may cause inflation to fluctuate, but the fluctuations soon fade away. Third, it has become less responsive to the output gap. In other words, the slope of a traditional Phillips curve has flattened, implying that fluctuations in resource utilization tend to have a smaller impact on inflation.

The nature of inflation as mentioned above is the result of a number of factors. One is good luck. In particular, there has been an absence of severe supply disturbances comparable in magnitude to the first and second oil shocks. In addition, globalization and integration of China and subsequently India into world trade have meant greater competition in the final goods market. It then follows that tighter domestic resource utilization has not caused inflation to accelerate that much. At the same time, inflation expectations have been fairly tame. Since people do not expect inflation to move up significantly, they are less worried about the erosion of their purchasing power and thus need not set wages and prices as high to protect themselves from rising prices. As a result, subdued price pressure leads to low actual inflation.

This good life is found not only in Thailand but also in all major industrial economies as well as in many emerging market economies since the Great Moderation which began around the early 1990s. The bad news is that most recently things seem to be changing, starting with the sustained rise in oil prices from 2003 onwards. Next, actual inflation picks up, and not before long inflation expectations also trend up steadily, leading soon to a hot debate. While few people disagree that high inflation is undesirable and that the present increase in inflation started out from supply shocks, in particular the upsurge in world oil and then world farm prices, there is yet no consensus on how policy should deal with the present situation. In particular, should monetary policy act to tame inflation as one may believe, as did Milton Friedman, that inflation is always and everywhere a monetary phenomenon; or since it originates from supply shocks upon which domestic monetary policy cannot influence, monetary policy should instead be silent.

This paper is motivated exactly by this debate. It hopes to take a closer look at the nature of supply shocks which have been hitting the economy in recent years and by doing so assesses whether or not these shocks are likely to be temporary and can go away on their own. If not, then the most important question boils down to what could help contain inflation under the circumstance. To answer the question, we need to look back and learn more about the evolution of inflation dynamics to see whether the generally low and stable nature of inflation in Thailand has been a result of sheer good luck (e.g. from low volatility of shocks) or, at least in part, of well-disciplined monetary policy. Should empirical evidence points towards the conclusion that monetary policy has been effective in helping to contain inflationary pressure, including pressure from supply shocks, then monetary policy would still have a role to play under the present situation.

The rest of the paper is therefore organized into four parts. Part 2 addresses in particular the issue of ongoing structural changes in the demand and supply of oil and farm products that have led in turn to the changing nature of shocks to inflation. Part 3 is dedicated to the study of Thailand's inflation dynamics, using both univariate and multivariate econometric models to shed light on what factors have importantly governed inflation persistence and trend inflation over the past forty years. Part 4 then takes a closer look at the relationship between monetary policy and inflation dynamics, and Part 5 concludes our findings.

2. Life in retrospect and structural changes in the supply and demand of commodities

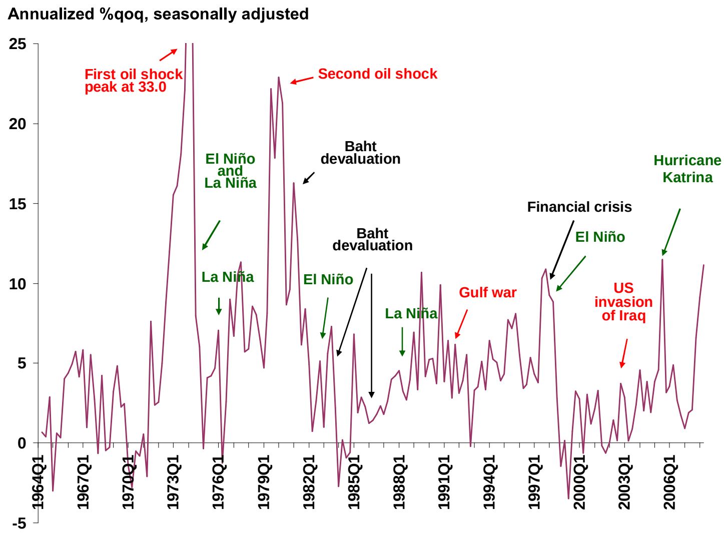
In the introductory part, our motivation sets forth the importance of a thorough understanding of the inflation process as well as its driving factors in the conduct of monetary policy. Given that a lot of attention has recently been placed on the impact of cost-pushed factors, i.e. supply shocks, as well as the general belief that such shocks would go away on their own, we would like to find out if this actually holds true in the present time. Therefore, in this part we aim to shed some light on the relationship between Thailand's inflation dynamics and these supply shocks from the early 1960s onwards. Although supply shocks are also characteristics of other commodities, we choose to focus on oil and farm products for two reasons. First, they are important inputs in the production of other goods and services. Second, they directly constitute around 30 percent of the Consumer Price Index (CPI) basket. As a result, they would naturally tend to have a large impact on inflation.

We begin with an analysis of the changes in and the volatilities of oil and farm prices during different time periods and how such developments translated into the dynamics of Thailand's inflation. We then investigate if the nature of these commodities has evolved over time, in terms of their supply and demand structures as well as shocks. In other words, we would like to know if and how much life has changed and what implications this has for the inflation process, going forward.

2.1 The relationship between supply shocks and inflation

If one were to summarize Thailand's overall inflationary experience during the past four decades in one sentence, one would probably describe it as being stable and benign with only few exceptional periods. Nevertheless, a closer look would reveal several important inflationary shocks during 1964Q1 – 2008Q2, as illustrated by various spikes in Figure 1. In general, these spikes were caused by two kinds of shocks – exchange rate shocks and supply shocks in oil and farm products. While it is not our priority to focus on the role of the exchange rate vis-à-vis inflation in this paper, we can clearly see its impact from the three episodes of Thai baht devaluation in 1981, 1984 and 1987[1], as well as from the 1997 financial crisis when the currency depreciated sharply following the abandonment of the exchange rate peg.

Figure 1: Evolution of Thailand's inflation (1964Q1 – 2008Q2)



Source: Ministry of Commerce and authors' calculations

Exchange rate matters aside, the rest of the spikes were almost entirely caused by global supply shocks in oil and farm products. We are able to identify, in chronological order, the impact of the 1973 and 1979 oil shocks, the Gulf War in the early 1990s, and the severe El Niño during 1997-1998 that greatly affected the prices of major staple products such as cereals and vegetable oils worldwide.

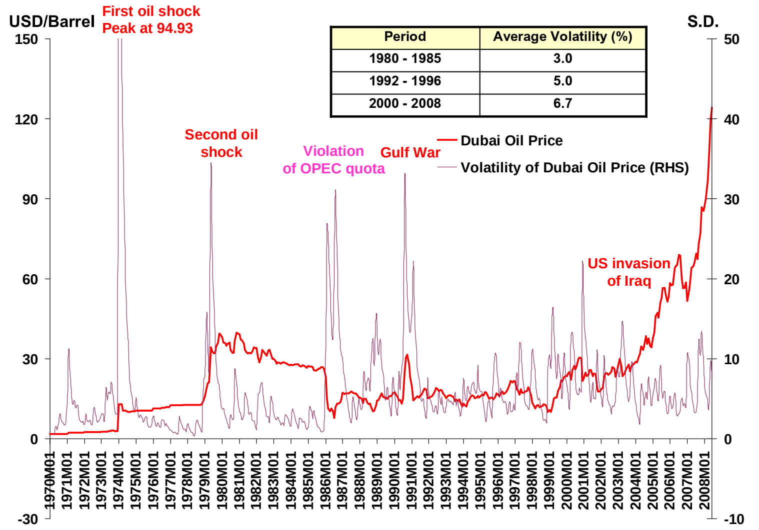
Table 1: Chronology of major supply-related events

Year	Major events
1972-1973	El Niño [1/], First oil shock
1973-1974	La Niña [2/]
1975-1976	La Niña
1979	Second oil shock
1982-1983	El Niño
1988-1989	La Niña
1990-1991	Gulf War
1997-1998	El Niño
2003	US invasion of Iraq
2005	Hurricane Katrina

Remark: we choose to include events during 1964 – 2008 to be consistent with Figure 1.
1/ El Niño causes a severe drought, warmer temperature than normal.
2/ La Niña causes a severe flood, cooler temperature than normal.
Source: Various sources, collected by authors

[1] The impact of the 1987 Thai baht devaluation is not obvious in Figure 1 because of the small magnitude and the concurrent decline in oil prices.

Figure 2: Price and volatility of Dubai oil

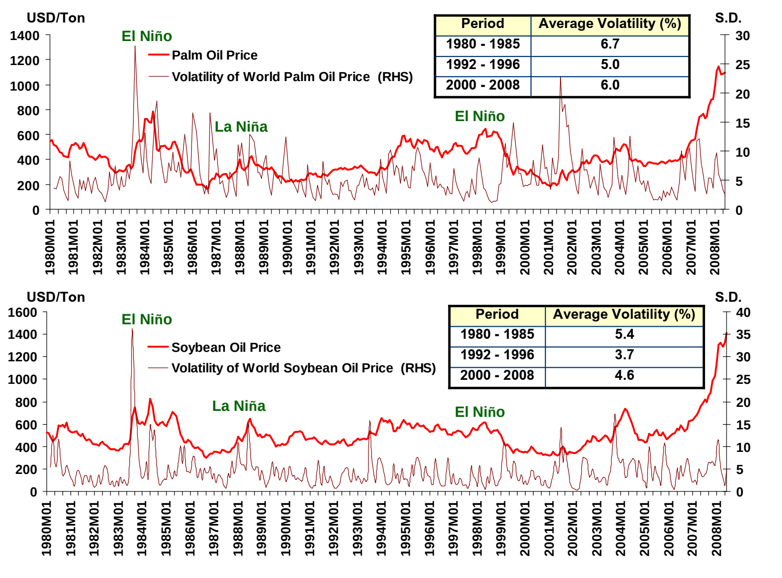


Source: BP, authors' calculation

We list more of these events in Table 1.

To better understand the nature of these supply shocks, we turn to the developments of global oil and farm prices, with Figures 2 and 3 showing two dimensions of the price dynamics, namely price levels and volatility (standard deviation) patterns, of oil and selected major staple products – palm and soybean oil. The reason that we are interested in the volatility patterns of each commodity, constructed by taking the difference in the logarithm of monthly seasonally adjusted price using the exponentially weighted moving average[2], is that such information tells us how protracted shocks were in the past. After having carefully matched the volatility patterns with the historical events in Table 1, we can clearly see two things: (1) each shock was associated with a large spike in volatility, and (2) from the 1970s up until the early 2000s, each spike in volatility disappeared within a very short period of time, indicating that shocks arising from supply disruptions and even political conflicts tended to be short-lived.

Figure 3: Prices and volatilities of selected staple products



Source: IMF, authors' calculations

However, a different picture emerged during the last five years. For oil, we observe that its price began to rise continuously in 2003 or so. Moreover, when we look at the volatility patterns, we notice that they changed in such a way that smaller spikes appeared much more frequently. In other words, volatility was sustained at a higher level, averaging around 6.7 percent in 2000-2008 compared with 5.0 and 3.0 percent in

[2] Equivalent to the generalized autoregressive conditional heteroskedasticity model or GARCH(1,1).

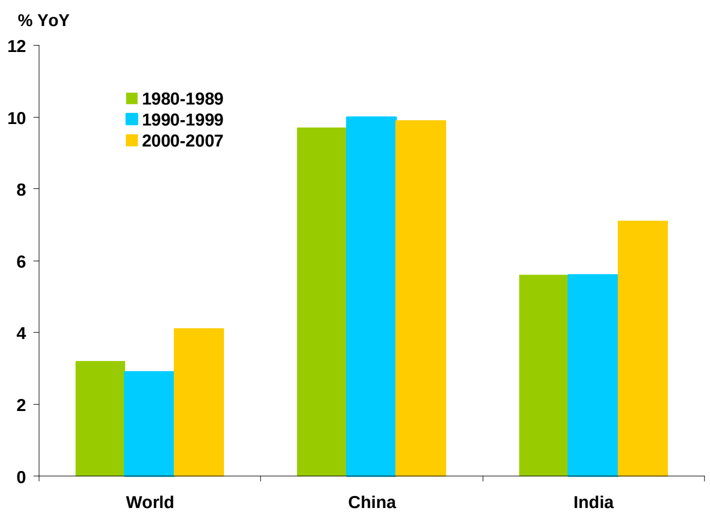
1992-1996 and 1980-1985, respectively, and thus indicating the existence of a factor that kept the price increases steady and prolonged. Though such changes in the volatility patterns are not obvious for the case of farm products, we can still see that their prices also rose significantly and continuously in recent years. Thus, it appears that the nature of oil and farm prices may have changed, and the crucial question is why.

In the next sections, we attempt to shed more light on the factors that contributed to this recent development in oil and farm price dynamics. In particular, we find that such developments arose mainly from significant structural changes in the demand and supply of these commodities, which resulted in market tightness and in turn led to higher sensitivity to shocks. In what follows, our analysis of structural changes on the demand side includes: (1) an increase in demand from emerging markets; (2) an increase in demand for commodities as an asset class; and (3) the impact of food and fuel subsidy programs. Meanwhile, concerning structural changes on the supply side, we emphasize: (1) a decline in the responsiveness of supply to price; (2) market power of major producers (in the case of oil); and (3) greater constraints in supply expansion. We then proceed to look at the impact of shocks under these tight supply and demand conditions. Finally, we close this part by summarizing the lessons learned and implications on inflation dynamics.

2.2 Structural changes in the demand of oil and farm products

In the previous section, we establish that oil and farm prices in the past were almost entirely driven by temporary supply disruptions that were short-lived in nature. Lately though, prices appeared to be governed by an additional force that allowed price increases to be sustained. In this section, we argue that this additional force stemmed from ongoing structural changes in demand that could continue to exert pressures on prices for more periods to come. We present our arguments below.

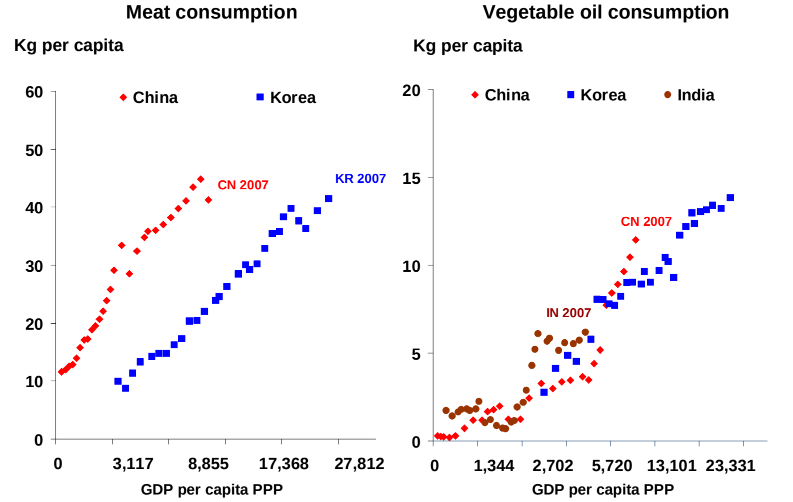
Figure 4: World and selected countries' economic growth



Source: *World Economic Outlook*, IMF (April 2008)

First, strong world economic growth, particularly the strong performance of emerging countries, has led to a significant increase in demand for resources. While this trend is applicable to emerging economies overall, the cases of China and India perhaps stand out the most, following the unleashing of their growth potentials as these economies became more market-oriented (Figure 4). Originally, the impact of such countries' openness to world trade came about in the form of lower production costs, but afterwards as these economies continued to grow and the general standard of living of their population reached a certain point, they began to consume more resources, in particular oil and farm products. Given that the population in these two economies accounts for roughly 37 percent of world population[3], we can imagine just how huge an impact on world resources could be given their potential to consume.

Figure 5: Potential consumption in China and India



Remark: Data points indicate annual observations from 1980 to 2007
Source: *World Economic Outlook*, IMF and USDA

To begin with, as the Chinese and Indian economies expanded and engaged in more energy intensive production, their demand for oil rose. More oil was also needed for transportation and freight given that the logistics in such countries still depended largely on road transports, i.e. trucking. Meanwhile, consumers themselves began to desire motor vehicles, which of course means even more demand for oil. In addition, as income rose, consumers increased not only their per capita consumption of staple foods but also switched to consume more meats. Since animals generally consume more cereals and grains than human, such a change in diet amplified the demand for staples.[4]

But just how persistent is this phenomenon? Given that the change is structural in nature, we tend to believe that pressures on resources would not simply go away despite a cyclical slowdown in the global economy in the short-run. In particular, we assess that the Chinese and Indian people still have much more potential to consume. To illustrate, Figure 5 plots per capita consumption of meats and vegetable oils in both countries against their per capita GDP. It reveals that the income level of both countries is still low compared with a developed Asian country such as Korea (selected based on similar consumption culture). Given the positive correlation between per capita consumption and per capita GDP, it can be seen that as these consumers become richer, their diets will continue to change as mentioned, which would at least sustain prices of staples at a high level.

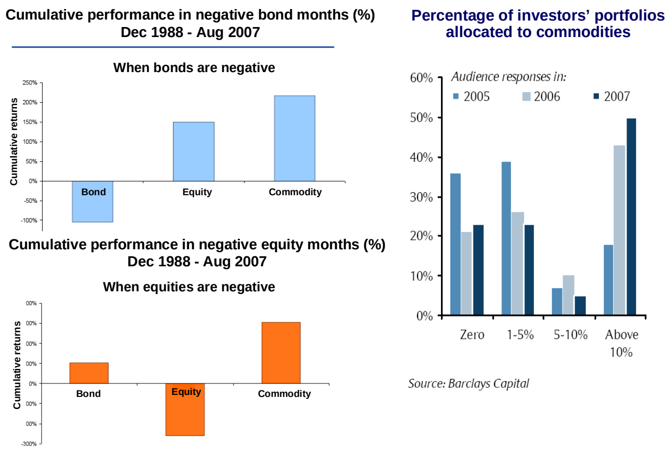
In addition to the direct demand for consumption of farm products, there is also an indirect demand stemming from the need for energy. In this regard, the persistent surge in oil prices already triggered the world to invest in the quest for cheaper energy alternatives, e.g. bio-fuels. In turn, this effort led to higher strains in the world market for

[3] World Development Indicators Database from the World Bank, as of 1 July 2008.

[4] The feed-to-meat conversion ratio for each type of meat is as follows. Production of 1 kg poultry meat requires about 2 kg grains, 1 kg pork requires 4 kg grains, and production of beef in feedlots utilizes as much as 7kg grain/kg meat production. (Rosegrant *et al.* [1999]) As demand for meats increases, the demand for grains and protein feeds used in producing meats grows proportionally and by more than the demand for direct consumption by human.

agricultural products, particularly oil palm, soybean, tapioca, maize and sugarcane. As a result, the prices of these major farm products rose and became more intertwined with the price of oil than before.

Figure 6: Commodities as a class of asset



Source: Barclays Capital

Apart from real (physical) demand for commodities discussed above, another source of demand pressure on commodity prices stemmed from an increase in demand for commodities as a class of assets. Lately, the returns from commodity investments exceeded those from other types of financial assets as depicted by Figure 6, left panel. It can be seen that during months of negative returns in either the bond or equity markets between the period spanning from December 1988 to August 2007, returns on commodities were positive, thus offering a safe option in portfolio diversification to investors. Consequently, investors began to increase their stakes in this market as shown in Figure 6, right panel, with the proportion of investors holding more than 10 percent of their portfolios in commodities rising steadily over 2005 – 2007. Moreover, the declining trend in the U.S. dollar probably helped magnified this transition as investors quickly diverged away from holding U.S. dollar assets. In addition, because prices of commodities themselves are part of inflation, investors recognized this type of investment as hedging instruments against rising inflation, adding also to the demand for commodities as an asset class. Taken together, these factors led to an influx of investment funds into the commodity markets starting firstly with oil, then other commodities such as gold and metals, and more recently farm products.[5]

On top of the structural changes in the demand of oil and farm products, the problem is complicated by government policies. For example, several developing countries tried to help their people from the higher costs of living and averted the rises in domestic inflation by implementing various aid programs, e.g. introducing caps on fuel prices, continuing to subsidize domestic food and fuel prices, and imposing export quotas on some products, especially rice, to protect their countries from food shortage. These measures, in turn, kept food and oil prices artificially low, continuing to sustain high demand and further exerting upward pressures on world demand and prices.

[5] While the above reasons are probably related to non-speculative investments, investors who are purely interested in very short-term speculative gains may also play a role in exaggerating demand and prices by betting on future directions of prices. However, disagreements remain regarding the magnitude of the impact of such behaviour on prices. A recent study by the Interagency Task Force on Commodity Markets in July 2008 finds no statistically significant causation between speculative activities and prices and concludes that recent price increases were more largely determined by real forces of demand and supply.

From above, we can see how these ongoing structural changes in demand led to persistent increases in the prices of oil and farm products over the last five years. However, these demand pressures alone could rarely make prices jump. This brings us to the next section where we turn to the supply side that underwent major structural changes as well.

2.3 Structural changes in the supply of oil and farm products

This section is divided into two parts mainly because, in comparison to demand side factors, supply side factors are generally more specific to each commodity. We begin with an analysis of structural changes in the supply of oil, followed by farm products.

2.3.1 Structural changes in the supply of oil

The unfortunate truth is that supply of oil simply was unable to match demand during recent times.[6] Apart from the structural shifts in world demand for energy discussed in Section 2.2, fundamental changes in the structure of the supply of oil also took place. Below, we discuss two important causes: (1) lower elasticity of supply to price; and (2) the return of the Organization of the Petroleum Exporting Countries (OPEC)'s dominance.

Lower elasticity of supply to price

The degree of supply responsiveness to price plays an important role in dictating the future of oil prices. Consider a case of an increase in demand. The more inelastic (less responsive to price) supply is, the higher price increase would be required to induce supply, and the new equilibrium would be reached at a higher price than would have been if supply were more elastic. To illustrate, we compute the price elasticity of oil supply between 1995 – 2001 and 2002 – 2007, and find that the elasticity fell by roughly half, from 0.2 to 0.1[7] between the two periods. Furthermore, we suspect that the elasticity could have been even higher prior to 1995[8]. In this regard, we believe that two main factors contributed to this change, as discussed below.

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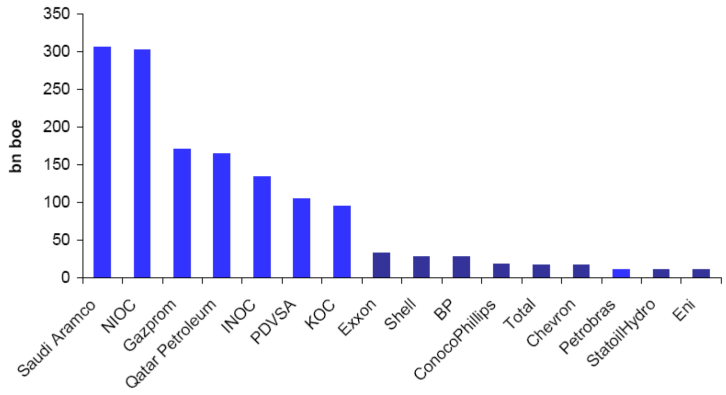
[6] A production decline was generally observed worldwide, and there were also numerous reports of depletions. For example, the second largest oil field, the Burgan field in Kuwait, was reported to have entered a decline in November 2005. In March 2006, Mexico announced that its Cantarell Field had entered depletion. In April 2006, a Saudi Aramco spokesman also admitted that its mature fields were declining. (http://en.wikipedia.org/wiki/peak_oil)

[7] Estimated using two-staged least square regressions where oil production is a function of Dubai oil price. The list of instruments includes a constant and trading partners' GDP as a proxy for world demand.

[8] We are not able to compute the price elasticity of oil supply prior to 1995 due to the unavailability of quarterly oil production data and trading partners' GDP.

Figure 7 IOC and NOC oil and gas reserves (billion barrels of oil equivalent)



Source: Deutsche Bank

National Oil Companies (NOCs)' controls over proven reserves

The first factor contributing to the reduction in price elasticity of supply is the concentration of proven reserves in the hands of NOCs, as shown in Figure 7. In the past, these reserves belonged to International Oil Companies (IOCs) whose motivation was mainly profit based. Thus, higher prices as a result of rising demand would be met by an increase in production. The situation changed, however, following a series of nationalization of oil companies that began soon after the end of the 1973 Arab oil embargo, with the most notable one being the nationalization of Aramco by Saudi Arabia in 1980. Incidentally, profit was not the only objective of this group of oil producing nations. Since oil, like any other scarce resources, would eventually be used up, these oil producing nations had been undertaking a series of economic and infrastructural development plans with the aim to diversify their sources of income away from oil. Moreover, recent political conflicts might have made these nations more inclined towards holding on to their reserves despite soaring prices.

Costly alternatives leading to underinvestment

"All the easy oil and gas in the world has pretty much been found. Now comes the harder work in finding and producing oil from more challenging environments and work areas."

W.J. Cummings
Company Spokesman
Exxon Mobile Corporation
December 2005

So far, we have yet to mention the role of IOCs in meeting the gap between demand and supply of oil. Apart from the limited size of their proven reserves, IOCs' prominence in world supply of oil was greatly constrained by limited access to the sources of the much demanded light sweet crude oil found mostly within the Middle-east nations. Given no access to these sources, IOCs must turn to the less cost-efficient sources of heavy, low-grade oil. The massive reserves of the Canadian tar sands (or oil sands)[9] are a good example of this. Though such vast reserves represented a source of hope, production continued to lag behind consumption.[10] Unfortunately, the extraction of these heavy tar sands required larger amounts of water and energy than conventional crude oil extraction. Moreover, they were difficult to transport through normal oil pipelines and more expensively to refine into gasoline, diesel fuel and other products. In addition, due to greater environmental damages[11] caused by the extraction of tar sands compared to conventional crude oil, they were generally not accepted by environmental groups such as Greenpeace, who called for cleaner and more expensive production technologies.[12] Therefore, even though the recent surge in oil prices made investments in tar sands industries more attractive, developments remained a challenge and would certainly take time. As a result, we probably cannot expect IOCs' production to gain a more prominent role in meeting world demand for oil in the foreseeable future.

The return of OPEC's dominance

The second cause of a shift in the nature of oil supply is the return of OPEC's dominance over the world oil market. Despite an overall decline in its market share as shown in Figure 8, OPEC was successful in exerting its power over the last decade or so. One important factor that allowed this cartel to regain its authority was "good luck" – namely the strong and sustained rise in demand coupled with the failure of production elsewhere in serving these growing needs (Figure 9). Given the concentration of proven reserves in the hands of OPEC nations as mentioned above, the cartel was able to successfully manipulate the market through its quota announcements and answers to calls on OPEC. By setting its quota at a low level, the gap between total demand and supply would widen, resulting in calls for OPEC at a higher price than was initially the case. Figure 10 illustrates this dominance of OPEC over total production growth. It can be seen that changes in total supply (the gradient of the line graph) moved with changes in OPEC's supply (the bar graph). For example, a reduction in supply seen in 2002 coincided with a reduction in supply from OPEC. Similarly, the continuous increase in supply during 2003 – 2004 corresponded with increases in OPEC's supply. Hence, we can clearly ascertain the influence of this cartel's action on world supply of crude oil and thus crude oil price. This important role of OPEC is empirically confirmed by Kaufmann (2004) and Dées *et al.* (2007), who conclude that oil prices were determined by market conditions as well as OPEC's decisions about quota and capacity utilization.

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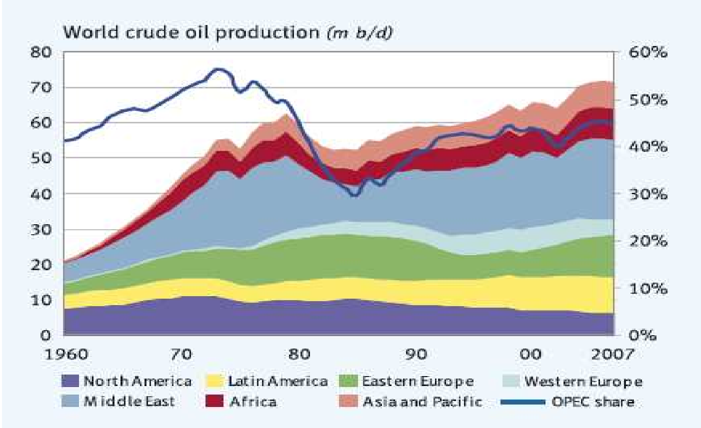
[9] The sands are naturally occurring mixtures of sand or clay, water and an extremely dense and viscous form of petroleum called bitumen.
[10] In 2006, tar sands production in Canada amounted to approximately 1.25 million barrels per day compared with world oil demand of almost 85 million barrels per day. (Government of Alberta, 2008)
[11] Main concerns include land damage, greenhouse gas emission and water usage. For example, carbon dioxide emission is around three to five times greater than in the case for conventional crude oil extraction.
[12] http://www.greenpeace.org and http://www.treehugger.com

But why should the cartel work? What happened to individual countries' incentive to cheat?[13] Here, we argue that because of the demand nature of price increases in recent years, oil producers expected oil price to continue along an upward trend for still some time. Since production decisions depended on expected future prices, individual countries certainly had more incentives to stick to their quotas in order to continue reaping the benefits of higher future prices rather than cheat for the sake of short-term gains. As a self-fulfilling prophecy, actual price rose, feeding back into expected future prices again and so on. However, because higher prices would eventually hurt the real economies of oil importers and users, this trend could only continue up to a threshold before a significant demand correction would be triggered. At that point, the cartel's position could reverse, relieving some of the pressures on prices.

2.3.2 Structural changes in the supply of farm products

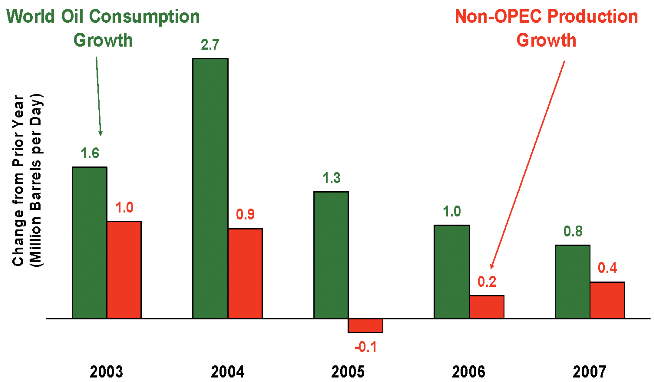
The main factor leading to a change in the structure of farm product supply is the increase in constraints on production expansions. Compared with oil, the price elasticity of farm supply tends to be higher. That is, if the price of a product increases in a certain year, farmers would

Figure 8: World crude oil production



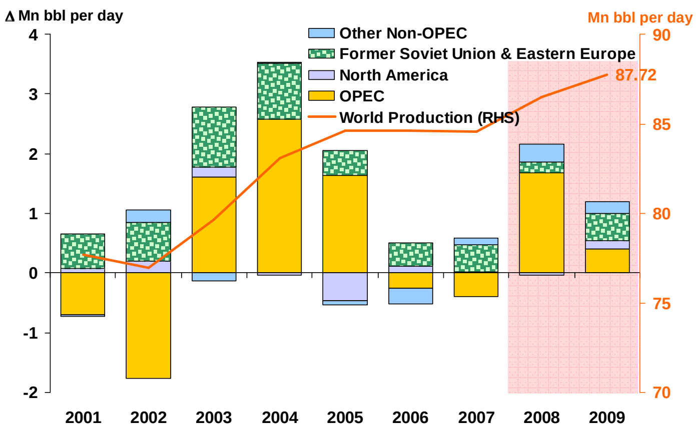
Source: OPEC's *Annual Statistical Bulletin 2007*

Figure 9: Gap between demand and non-OPEC supply



Source: Energy Information Administration, *Short-term Energy Outlook June 2008*

Figure 10: World supply of crude oil



Source: Energy Information Administration, *Short-term Energy Outlook June 2008*

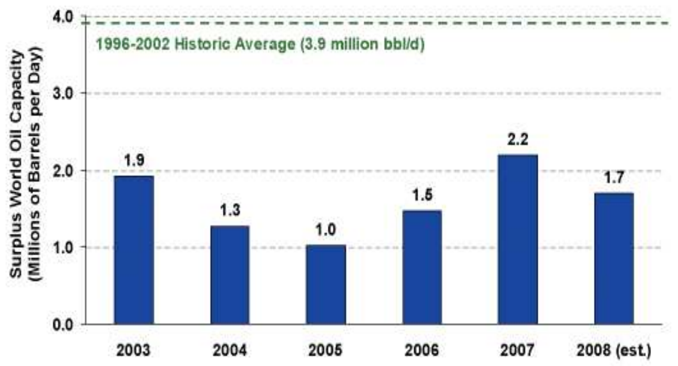
13 as was the case in the 1980s which signified the collapse of the OPEC cartel

want to produce more of such product in the next crop season. As more supply becomes available, the price of such product eases. Thus, higher farm prices resulting from an increase in demand is likely to induce a significant supply response. However, life is *not* that simple. In recent years, reality demonstrated a number of limitations on farm production expansions such as the scarcity of water and new planting areas as well as the need for specific cultivation conditions for most crops, which generally rested on favourable weather conditions. Hence, in the short-run, supply often did not increase immediately as wished for by both consumers and producers. In the long-run, however, with steady investments in agricultural researches and developments, one could hope for new technologies that would allow the supply of crops to be more flexible in meeting consumer demands. Such technologies may include new techniques to increase productivity, to reduce crop dependency on weather conditions, or to produce safer genetically modified organisms (GMOs). Nevertheless, given the increasing concerns over environmental and health risks, any new technology will need to be more carefully engineered. As a result, these developments would also take time and we could still be in this tight supply and demand conditions for another while.

2.4 An exacerbating impact of shocks under tight demand and supply conditions

Sections 2.2 and 2.3 establish that the global commodity markets, namely oil and farm products markets, underwent structural changes in their demand and supply conditions. These tight conditions exerted pressure on prices not only directly but also indirectly through the effects of incoming shocks. That is to say, the impact of adverse shocks was typically amplified when market conditions were already constrained. At the same time, supply shocks that used to be pronounced but short-lived in the past (as they were not sustained by ongoing demand shifts) recently became less prominent but more numerous. We elaborate on the interactive effect of market tightness and frequency of shocks below.

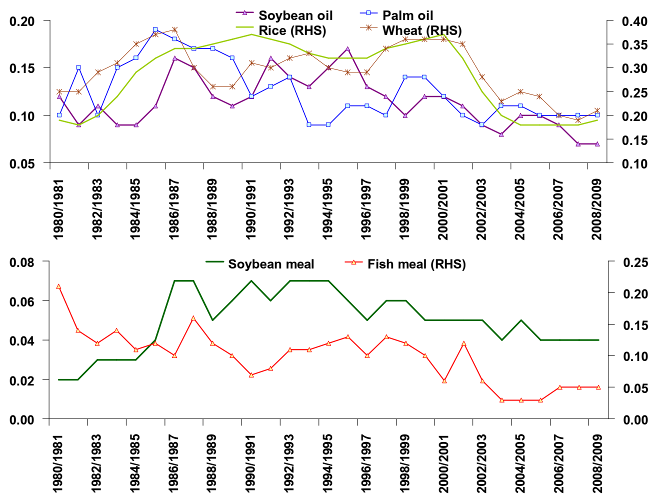
Figure 11 Lower surplus production capacity



Source: Energy Information Administration, *Short-term Energy Outlook June 2008*

With strong demand and limited supply, the world witnessed a reduction in world spare capacity for oil production and a decline in the ratio of stock to use of farm products. From Figure 11, it can be seen that during 2003 – 2007, world oil surplus capacity averaged at around 1.6 millions of barrels per day, less than half its average (1996 – 2002) of 3.9 millions of barrels per day. Moreover, this surplus capacity was concentrated in just a few countries, mainly in the Middle-east in the hands of NOCs whose motivation was not exclusively profit as mentioned earlier. (Interagency Task Force on Commodity Markets, 2008) In the case of farm products, despite once ample agricultural supply and thus relatively high ratios of world stock to use from the mid-1980s to early 2000s, Figure 12 shows that things turned around in 2003 or so, with the ratios of world stock to use dropping significantly since for many important agricultural products, both for human consumption and animal consumption.

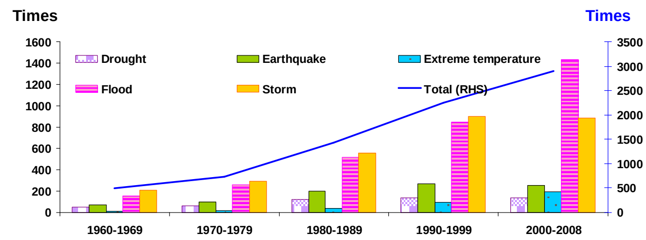
Figure 12: Ratios of world stock to use



Source: USDA (August 2008)

With already low investory levels, oil and farm products markets became much more sensitive to bad news. Meanwhile, bad news and natural disasters seemed to occur more frequently, partly as a result of worsening global environment. As shown in Figure 13, the number of natural disasters worldwide grew rapidly over the last five decades. Such supply disruptions contributed to episodes of panic and price jumps as well as higher price volatilities overall. One of the more recent examples is the case of rice. At the beginning of 2008, rice farms in two major rice exporting countries, India and Vietnam, were significantly hit by severe weather conditions. Initially, the countries raised their minimum export prices, but due to subsequent fears of domestic rice price increases and inflation, the governments later limited and then froze all rice exports. All over the world, panic regarding food security quickly surfaced. Rice importers such as the Philippines, Indonesia and China

Figure 13: Frequencies of natural disasters



	Drought	Earth-quake	Extreme Temp.	Flood	Storm	Total
1960-1969	48	74	9	152	211	494
1970-1979	63	101	15	261	290	730
1980-1989	121	196	38	515	557	1427
1990-1999	137	267	92	849	899	2244
2000-2008	140	251	190	1434	883	2898

Source: The International Emergency Disaster Database accelerated their purchases to safeguard against future price increases. Subsequently, world prices of rice soared to an unprecedented level in 2008Q2[14]. The impact of climate change on oil price is a similar story. Almost every time there was news about adverse weather conditions, e.g. Hurricane Katrina in 2005, market prices jumped in expectation of supply disruptions, thanks also to speculators in the financial markets.

In addition to climate change and natural disasters, shocks resulting from geopolitical uncertainties became major risks to oil supply. Again, given the already tight supply conditions relative to demand, geopolitical uncertainties, whether or not leading to actual supply disruptions, could send world oil price soaring more easily than ever. These conflicts were not confined to the Middle-east but extended to other regions as well, namely South America and Africa. Figure A.1 in Appendix A shows that these conflicts became more frequent around 2002, and the relationship between the Dubai oil price and the eruptions of conflict during 2002 – 2008 is quite obvious.

Finally, instead of alleviating pressures from these shocks, government reactions, while aiming to calm the market, could unintentionally exaggerate the impact on prices. Take for example the case of rice export quotas in India and Vietnam or the implementation of unsustainable fuel subsidies in various emerging countries. In general, given the temporary nature of these policies versus the protracted nature of oil and farm price increases, by delaying price adjustments (including those of related goods and services), anxiety could very well build up and prices as well as inflation could rise significantly due to pent-up pressures, down the road.

2.5 Lessons learned and future implications

From above, it should be clear that recent shocks to commodity prices were no longer purely driven by temporary supply disruptions but also motivated by the upwardly trending demand. As a result, these shocks would be more likely to linger compared to the case before the 1990s. While we might expect some short-term downward pressures on prices due to cyclical demand corrections as many major economies enter a period of slowdown at this juncture, it should be emphasized that demand and supply pressures we discuss in the previous sections are mostly structural and not cyclical in nature. Therefore, they are unlikely to go away so readily, and at the very least, prices should not be expected to go back down to their low levels. Realistically, we could even be faced with the return of soaring commodity prices once cyclical demand turns around. The implication of more persistent shocks is that inflation would be higher and, through expectation of continuous shocks, inflation persistence may also rise. Nevertheless, persistence in inflation may not be a result of shocks alone – a point that we further pursue in Parts 3 and 4.

Moreover, given that shocks from oil and farm prices are now more correlated as a result of growing competition for agricultural resources between consumption and bio-fuel production and also the fact that rising energy costs subsequently translate into rising costs of farming, the impact of oil and farm prices on inflation is likely to be compounding, as opposed to the experience of the past when shocks were uncorrelated. Inflation control is therefore likely to be all the more challenging under the circumstance.

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[14] Rice price in April 2008 reached 1,015.20 U.S. dollars per metric ton, equivalent to a 215 percent increase over the same period of the previous year.

3. Inflation dynamics in Thailand

In the previous part, we concentrate on qualitative analysis of supply side factors that are significant determinants of Thailand's inflation dynamics. Here, we proceed to quantitatively analyze the dynamics of Thailand's inflation process, drawing on our knowledge of major events in the past, in particular those related to the nature of oil and farm prices as described in Part 2. Our analysis entails three main sections. First, we measure inflation persistence through a univariate autoregressive (AR) model, allowing for shifts in the mean and persistence parameters. Evidence of a time-varying nature of our parameters of interest leads us to apply an unobserved components (UC) model to our inflation process in the next part, from which we obtain filtered series of inflation persistence and inflation trend. We close this part with a multivariate analysis of inflation, drawing on evidence from the hybrid New Keynesian Phillips Curve (NKPC), where we find supportive evidence for the impact of inflation expectation and hence the likely role of monetary policy in shaping the price setting behaviour and inflation dynamics in Thailand.

3.1 A simple univariate autoregressive model of inflation

3.1.1 Measures of inflation persistence and existing empirical findings

Existing literatures reveal four common proposals for measures of inflation persistence. Marques (2004) summarizes them into (i) the sum of autoregressive coefficients, (ii) the spectrum at zero frequency, (iii) the largest autoregressive root, and (iv) the half-life of a shock to the inflation process, vouching particular support for the first of the four measures.[15] This recommendation is also confirmed by Clark (2003). Accordingly, a relatively large amount of literatures on international evidences of inflation persistence can be found. These literatures usually employ a univariate approach in modeling inflation, assuming the existence of a constant long run equilibrium rate of inflation. The general findings as noted by authors such as Batani and Nelson (2001), Batani (2002), Levin and Piger (2004), and O'Reilly and Whelan (2005) are that the inflation process tends to be highly persistent. In other words, the AR coefficient is close to unity in a large number of countries.

3.1.2 Model specification and structural breaks identification

To investigate Thailand's inflation dynamics and measure their degree of persistence, we adopt the recommended simple AR(1) coefficient and the sum of the coefficients of an AR(4) process as our measures of inflation persistence, where the AR(1) and AR(4) specifications can be written as follows:

for AR(1):

$$\pi_t = \mu + \rho\pi_{t-1} + \varepsilon_t \qquad (1)$$

for AR(4), when K = 4:

$$\pi_t = \mu + \sum_{j=1}^{K} \alpha_j \pi_{t-j} + \varepsilon_t \qquad (2)$$

[15]The pros and cons of each measure are discussed in Marques (2004).

where μ is the mean of the process, π_t is the quarter-on-quarter inflation rate at time t, π_{t-j} is the quarter-on-quarter inflation rate at t-j, and ε_t is assumed to be a white noise disturbance term.

To measure inflation persistence in terms of the sum of AR coefficients as shown in equation (2), it is quite useful to consider the following equivalent representation:

$$\pi_t = \mu + \rho\,\pi_{t-1} + \sum_{j=1}^{K-1} \phi_j \Delta \pi_{t-j} + \varepsilon_t \qquad (3)$$

where the persistence parameter is given by $\rho \equiv \sum \alpha_j$, which according to Andrews and Chen (1994) is the best scalar measure of persistence. Moreover, in equation (3), the higher-order dynamic parameters ϕ_j are just simple transformations of the AR coefficients in equation (2) with $\phi_{K-1} = -\alpha_K$.

However, as demonstrated by Perron (1989), the estimates of the degree of persistence can be misleading if a structural break, i.e. an intercept or a mean shift, is not explicitly taken into account. On the other hand, if one allows for too many shifts in the intercept of the process, it could lead to an underestimation of the degree of persistence. Accordingly, the more recent literatures on inflation persistence[16] allow for at least one intercept shift in their estimations, giving rise to a lower estimated degree of persistence compared with the case of no shift. To proceed, we then reformulate equation (3) to:

$$\pi_t = \mu_0 + D_t\,\mu_1 + \rho\,\pi_{t-1} + \sum_{j=1}^{K-1} \phi_j \Delta \pi_{t-j} + \varepsilon_t \qquad (4)$$

where D_t is a dummy variable that takes the value of zero in periods t < *s* and one in all subsequent periods t ≥ *s*, with *s* denoting any potential structural break in the mean of the process.

The identification of shifts in the mean or structural breakpoints depends on whether we already have some priors about such points. If the breakpoint is known *a priori*, then Chow test can be applied.[17] In reality, an exact breakpoint may not be known in advance. Accordingly, there are many alternatives to define these unknown breakpoints such as the Quandt (1960) test or the application of Bayesian estimations, with the former being our chosen method to proceed. In essence, the Quandt test can be described as a process that identifies a solution taking the largest Chow statistic over all candidate breakpoints.[18] However, since the distribution of these test statistics is non-standard, their true distribution was later developed by Andrews (1993) with their approximate asymptotic *p*-values provided by Hansen (1997).

To estimate the persistence parameter, ρ, we employ the approach proposed by Bai (1997) and also used in Cecchetti and Debelle (2005). First, starting with the whole sample, we estimate equations (1) and (3) to obtain the values of ρ for both the AR(1)

[16] Levin and Piger (2003) and Cecchetti and Debelle (2005).
[17] Chow (1960) proposes the test by splitting the sample into two sub-samples before estimating the parameters for each sub-sample and testing the equality of the two sets of parameters using *F* statistics.
[18] This is the likelihood ratio test under normality.

and AR(4) processes. A Quandt-Andrews test is then applied. Once a possible and statistically significant breakpoint is determined, the sample is divided into two sub-samples at the identified breakpoint, and the same process is repeated to identify additional breakpoints for each sub-sample. The process stops when the test fails to reject the null hypothesis of no breakpoint.

In addition to the mean shift, we consider the possibility of potential breaks in the autoregressive parameter, ρ, such that equation (4) becomes:

$$\pi_t = \mu_0 + D_t\mu_1 + (\rho_0 + D_t\rho_1)\pi_{t-1} + \sum_{j=1}^{K-1}\phi_j\Delta\pi_{t-j} + \varepsilon_t \tag{5}$$

and $$\pi_t = \mu_0 + D_t\mu_1 + (\rho_0 + D_t\rho_1)\pi_{t-1} + \sum_{j=1}^{K-1}(\phi_{0j} + D_1\phi_{1j})\Delta\pi_{t-j} + \varepsilon_t \tag{6}$$

where structural changes are possible in all of the AR parameters. In the above, we constrain the break in the autoregressive parameters to occur at the same dates as the intercept.

3.1.3 Data description

Our analysis is performed on the quarterly consumer price index (CPI) and its highest-level disaggregated component series,[19] covering (1) food and beverages, (2) apparel and footwear, (3) housing and furnishing, (4) medical and personal care, (5) transportation and communication, (6) recreation and education, and (7) tobacco and alcoholic beverages, from 1964Q1 to 2008Q2. The series are treated for seasonal effects using the X12 quarterly seasonal adjustment method of the United States Census Bureau, with the inflation rate computed as $\pi_t^i = \ln(\text{CPIsa}_t^i / \text{CPIsa}_{t-1}^i) * 400$, where i denotes the aggregate and each of the seven disaggregated inflation series. The benefit of using disaggregated CPI series is that it provides us with a better understanding of the factors that underpin the inflation process and thus helps us to identify whether a particular factor is a common or idiosyncratic one. In particular, similarly dated breakpoints across CPI components would naturally suggest a factor with a pervasive effect on the general inflation level of the economy.

Before we proceed, it is worth noting that this is not the first attempt to study the inflation process in Thailand. Chantanahom *et al.* (2004) undertook a similar analysis using the AR(1) and AR(12) models and monthly data between January 1995 and June 2004. In their research, the degree of inflation persistence was found to be low and less than 0.5 for headline inflation[20], given no-break-point. When the financial crisis intercept dummy was introduced, an even lower degree of persistence in headline inflation was found. This breakpoint, however, was imposed arbitrarily from the argument that the financial crisis was a major shock to the economy. In contrast, our study does not impose a breakpoint unless it is confirmed by the Quandt-Andrews test. As a result, our results may differ from those presented by Chantanahom *et al.* (2004).

[19]Data are obtained from the Ministry of Commerce.

[20]They also tested for the persistence of other inflation series, including traded versus non-traded goods inflation, food versus non-food inflation, and goods versus services inflation.

3.1.4 Estimation procedure and results

The estimation procedure is performed in three steps. First, the AR(1) and AR(4) models are estimated without imposing any structural breaks. Next, the Quandt-Andrews test is used to find all possible breakpoints in our models. After having identified the breakpoints, we impose parameter breaks at those dates and re-estimate the degree of inflation persistence.

Results from the Quandt-Andrews test indicate that the first breakpoint in the CPI and its component series occurred sometime around the early 1970s, while the second breakpoint happened sometime during the late 1970s to early 1980s (Table 2). Though some of the breakpoints are not statistically significant at the 10 percent significance level, we still consider such breaks to be highly likely and thus incorporate them into our analysis.[21] Interestingly, we fail to reject the null hypothesis of no breakpoint at the time of the 1997 financial crisis, which is commonly assumed to bring about a structural break in the inflation process. As a result, our final model contains just two breakpoints. We then proceed to create two dummy variables that equal to one during the periods after each of the two break dates and re-estimate our parameters. However, we discover the coefficient in front of the second dummy to be insignificant, which effectively implies a reversion of the parameter to the value before the first break date. This allows us to consider only one dummy variable that equals to one between the two break dates and equals to zero otherwise in our final estimation.

Table 2 Testing for shifts in intercept at unknown break date in aggregate inflation and its disaggregated components

Items	First break date[1/]	Second break date[1/]
Headline	1970Q1 *	1983Q4 **
Food and beverages	1969Q4 **	1980Q3 **
Apparel and footwear	1972Q2 *	1980Q2
Housing and furnishing	1973Q1 **	1982Q1 **
Medical and personal care	1971Q1 *	1980Q1
Transportation and communication	1970Q3 **	1981Q2 **
Recreation and education	1970Q3 *	1982Q3
Tobacco and alcoholic beverages	1970Q3 *	1982Q3

[1/] Determined by the Quandt-Andrews test for individual series. * and ** denote significance at 10 and 5 percent, respectively. Rejection of the null hypothesis implies that there is a break point at the specified date.

[21] One possible explanation for not having found highly significant breakpoints for some of the CPI component series is the existence of administered prices. For example, the prices of school uniforms (in the apparel and footwear series), medicine (in the medical and personal care series), tuition fees (in the recreation and education series), and cigarettes (in the tobacco and alcoholic beverages series) were controlled by the government and thus might not have fully reflected adjustments according to market mechanism.

It can be seen from Tables 3 and 4 that once we allow for a break in the intercept of the process as mentioned above, the estimated degree of persistence was somewhat lower in every inflation series and in both model specifications. Moreover, in most cases once we introduce both the intercept and slope breaks into the equations, the estimated persistence parameter became even smaller than in the case with only an intercept shift.

Table 3 Estimates of persistence in aggregate inflation and its disaggregated components from the AR(1) specification

Items	Persistence parameter	Only intercept shift	Both intercept shift and slope change
		Two breaks	Two breaks
Headline	0.74 **	0.69 **	0.50 **
Food and beverages	0.63 **	0.59 **	0.37 **
Apparel and footwear	0.79 **	0.69 **	0.67 **
Housing and furnishing	0.67 *	0.49 **	0.45 **
Medical and personal care	0.56 **	0.50 **	0.40 **
Transportation and communication	0.40 *	0.30 **	0.20 **
Recreation and education	0.55 **	0.43 **	0.54 **
Tobacco and alcoholic beverages	0.21 **	0.20 *	0.20 **

* and ** denote significance at 10 and 5 percent, respectively

Table 4 Estimates of persistence in aggregate inflation and its disaggregated components from the AR(4) specification

Items	Persistence parameter	Only intercept shift	Both intercept shift and slope change
		Two breaks	Two breaks
Headline	0.73 **	0.65 **	0.49 **
Food and beverages	0.67 **	0.62 **	0.41 **
Apparel and footwear	0.79 **	0.69 **	0.71 **
Housing and furnishing	0.76 **	0.53 **	0.45 **
Medical and personal care	0.64 **	0.56 **	0.60 **
Transportation and communication	0.43 **	0.24 **	0.21 *
Recreation and education	0.64 **	0.47 **	0.54 **
Tobacco and alcoholic beverages	0.24 *	0.21	0.19 **

* and ** denote significance at 10 and 5 percent, respectively

One important point can be inferred from the results above. The similar dating in breaks across components of the CPI was likely a result of a *common factor*. Our preliminary hunch is that it was some kind of a demand pulled force rather than a supply shock, given our findings in Part 2 that shocks during the 1970s until the early 1980s, whether from oil or farm prices, were only short-lived and thus their direct impact on inflation should have been temporary, inducing no across-the-board change in the persistence parameter. We will return to this point in Part 4. To clearly see the direction of the impact of such factor on the inflation process during that period, Table 5 reports the intercept (μ) and the slope (ρ) values in front of the break period dummies. From that we learn that there was a significant upward shift in either the intercept term (μ) or the persistent parameter (ρ) of the CPI and each of its disaggregated series. Two important implications can be drawn from this: (1) both the intercept and the persistence parameter of the inflation process were not constant overtime, and (2) both the intercept and the persistence parameter in the aggregate CPI and its components were larger during the break period (1970-1980) than in other periods. These issues are investigated further in the next section where we attempt to model inflation as a time-varying process to filter out the changing trend inflation and inflation persistence over time.

Table 5 Intercept and slope values in front of the break period dummies obtained from the AR(1) and AR(4) specifications

Items	AR(1)		AR(4)	
	μ	ρ	μ	ρ
Headline	0.24	0.26 **	0.56	0.21 **
Food and beverages	-0.25	0.42 **	0.22	0.32 **
Apparel and footwear	2.58 **	0.03	2.68 **	-0.03
Housing and furnishing	3.42 **	0.06	3.87 **	0.00
Medical and personal care	0.41	0.47 **	2.97 *	-0.13
Transportation and communication	6.12 **	0.15	6.52 **	0.09
Recreation and education	4.02 **	-0.18	4.14 **	-0.20
Tobacco and alcoholic beverages	2.39	0.00	2.82	-0.10

* and ** denote significance at 10 and 5 percent, respectively

3.2 An unobserved components (UC) model of the inflation process

In this section, we would like to model the inflation path to better understand the evolution of inflation trend and persistence over time. From the previous section, we learn that the inflation process is likely to have a time-varying mean (μ_t) and also a time-varying autoregressive (AR) term. This implies that instead of estimating a univariate unobserved components (UC) model where inflation is just the sum of a stochastic trend and a serially uncorrelated disturbance component like the one adopted by Stock and Watson (2002, 2005) for their study of U.S. inflation,

$$\pi_t = \tau_t + \eta_t \qquad \text{with } \eta_t \text{ being serially uncorrelated } (0, \sigma_\eta^2) \qquad (7)$$

$$\tau_t = \tau_{t-1} + \varepsilon_t \qquad \text{with } \varepsilon_t \text{ being serially uncorrelated } (0, \sigma_\varepsilon^2) \qquad (8)$$

$\text{Cov}(\eta_t, \varepsilon_t) = 0$, we need to augment the above representation with an autoregressive term, as follows:

$$\pi_t = \mu_t + \rho_t \pi_{t-1} + \eta_t \quad \text{with } \eta_t \text{ being serially uncorrelated } (0, \sigma_\eta^2) \qquad (9)$$

$$\mu_t = \mu_{t-1} + \zeta_t \quad \text{with } \zeta_t \text{ being serially uncorrelated } (0, \sigma_\zeta^2) \qquad (10)$$

$$\rho_t = \rho_{t-1} + \nu_t \quad \text{with } \nu_t \text{ being serially uncorrelated } (0, \sigma_\nu^2) \qquad (11)$$

where η_t, ζ_t, and ν_t are mutually independent. Here, π_t is quarterly CPI inflation, seasonally adjusted and written in annualized rate: $\pi_t = \ln(CPIsa_t/CPIsa_{t-1})*400$. Equation (9) is the measurement equation, and equations (10) and (11) are the state equations for the unobserved mean of the inflation process and the autoregressive coefficient, respectively. Note that in this setup inflation trend is given by $\tau_t \cong \mu_t/(1-\rho_t)$. Persistence, or how protracted the impact of a shock to the price level on inflation is, can be measured by ρ_t.

The addition of an autoregressive term is supported by the significance of autocorrelations of $\Delta\pi_t$ at lags greater than one. To clarify this point, we note that the model which is characterized by (7) and (8) is well represented by an IMA(1,1) process:

$$\Delta\pi_t = (1-\theta B)a_t, \qquad (12)$$

where a_t is serially uncorrelated with mean zero and variance σ_a^2. It is then simple to see that the first-order autocorrelation of $\Delta\pi_t$ is negative, while all other autocorrelations should be zero. However, the latter is often not true for the inflation process in Thailand (see Table 6 below). For example, should we separate the data since 1964 into five non-overlapping periods of equal length[22], we observe that higher autocorrelations are statistically significant for some periods, e.g. 1982Q3 – 1991Q2. On the contrary, the UC model which is characterized by (9) – (11) is consistent with non-zero higher-order autocorrelations and thus seems to be a more appropriate representation of the inflation process in Thailand.

In addition to time-varying mean and autoregressive term, we explore the possibility that volatility of the disturbance terms σ_η^2, σ_ζ^2 and σ_ν^2 may also change over time. This is motivated by the observation that historically temporary disturbances, such as oil and farm price shocks, differed in size and in frequency over different periods of time. Moreover, there were shifts in the monetary policy regime or priority that could lead to different degrees of commitment to the price stability objective over time. Such shifts in monetary policy could cause varying degrees of change in inflation persistence, implying the possibility that σ_ν^2 could change over time.

[22] With the exception of the last period that is shorter than the others by 4 quarters.

Table 6: Autocorrelations of $\Delta\pi_t$

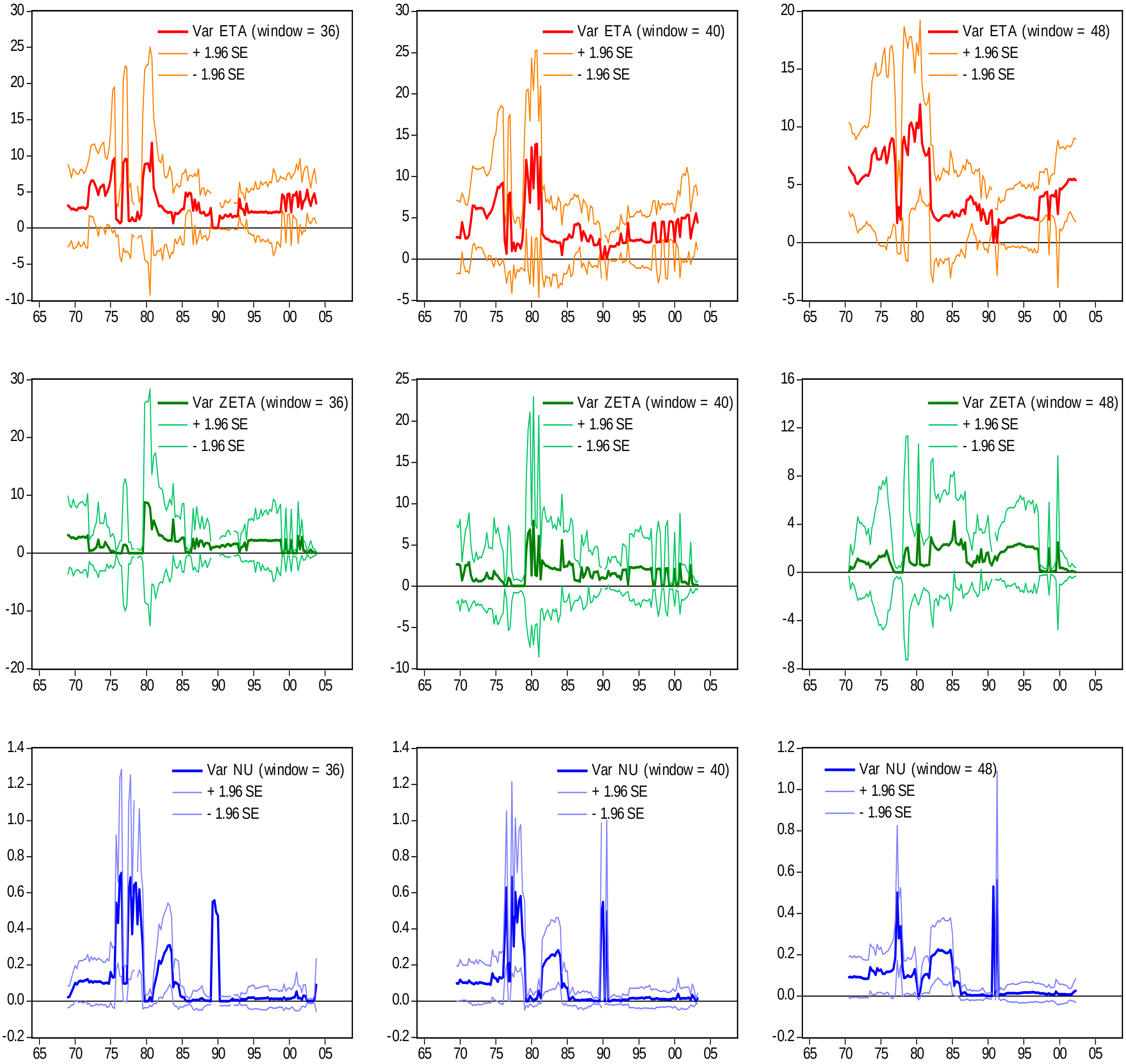
	1964Q3 – 2008Q2	**1964Q3 – 1973Q2**	**1973Q3 – 1982Q2**	**1982Q3 – 1991Q2**	**1991Q3 – 2000Q2**	**2000Q3 – 2008Q2**
Global environment	Whole sample	Pre-oil shocks	Oil shocks and lax monetary policy	The Great Stabilization	The Great Moderation	Concurrent rises in oil and farm prices
No. obs.	176	36	36	36	36	32
Autocorrelation of $\Delta\pi_t$ at lag:						
1	-0.182** (0.015)	-0.403** (0.012)	-0.008 (0.961)	-0.509** (0.001)	-0.155 (0.334)	-0.307 (0.069)
2	-0.064** (0.036)	0.179** (0.022)	-0.226 (0.358)	0.063** (0.006)	-0.020 (0.621)	0.008 (0.191)
3	0.035* (0.075)	0.036 * (0.053)	0.031 (0.553)	0.112** (0.013)	0.000 (0.813)	-0.012 (0.345)
4	-0.166** (0.018)	-0.109* (0.085)	-0.255 (0.302)	-0.304** (0.005)	-0.291 (0.335)	0.074 (0.473)

* and ** denote significance at 10 and 5 percent, respectively.

We use rolling estimations of the UC model with an autoregressive term, as in (9) – (11), to determine the nature of σ_η^2, σ_ζ^2 and σ_ν^2. Results[23] are shown in Figure 13. (See Appendix B for a comparison with the UC model without an autoregressive term.) For σ_ζ^2, or the variance of the disturbance term in the state equation for μ_t, we judge that it was fairly stable over time, and even though at certain dates, e.g. around the early 1990s, the estimated variance seemed larger than at other periods, it had a large standard error. Therefore, in the rest of the paper we impose no time variation on σ_ζ^2. On the contrary, the variations in σ_η^2 and σ_ν^2 appeared more distinct. In what follows we thus allow σ_η^2 and σ_ν^2 to change over time (Figures 14 and 15) in accordance with the patterns suggested by Figure 13, except for σ_η^2 from the period of the financial crisis onwards, which is towards the end of our sample and therefore the Hodrick-Prescott (HP) trend approximation, even when adjusted for end points, is likely to be less reliable. In particular, we impose a pattern that suggests greater volatility of temporary disturbances around 1997-1999 than that implied by the HP trend. Afterwards, we let σ_η^2 stay fairly low until late 2004, before picking up in tandem with the volatility of oil prices. This adjustment is justified by our understanding of the frequencies and sizes of temporary shocks, be it from extreme movements in the exchange rate in 1997-1999 or from the recent pickup in the volatility of oil prices as discussed in Part 2.

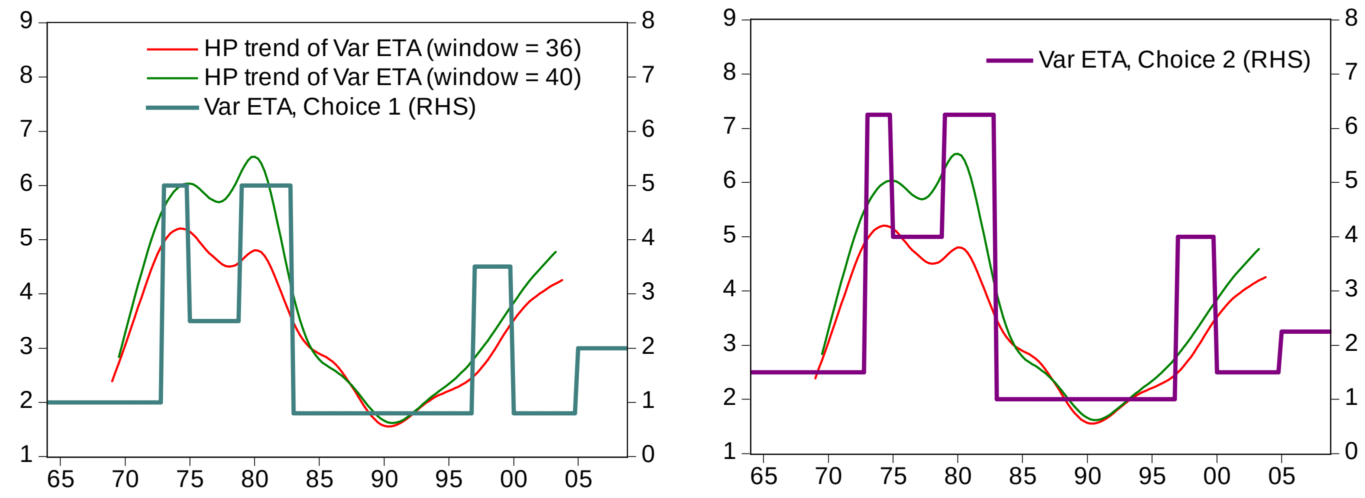
[23] Results in Figure 13 use a prior of 1.0 for all three variances. Implications on the time-varying nature of the variances are robust to changes in the prior.

Figure 13: σ_η^2, σ_ζ^2 and σ_ν^2 from rolling estimations of different window sizes



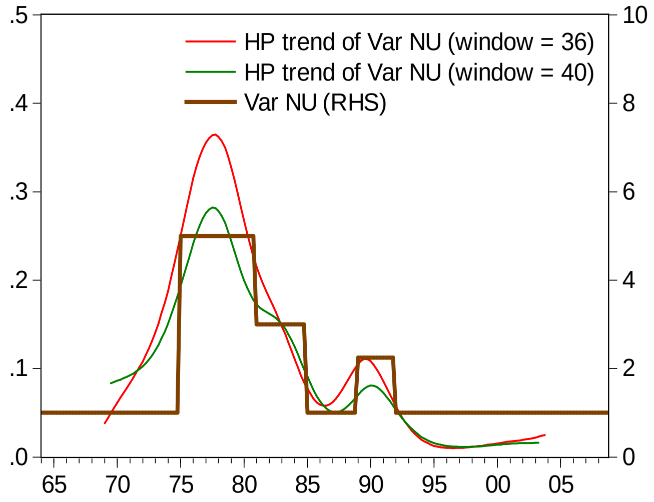
Source: Authors' calculations

Figure 14: Two choices of imposed pattern of σ_η^2



Source: Authors' calculations

Figure 15: Imposed pattern of σ_ν^2



Source: Authors' calculations

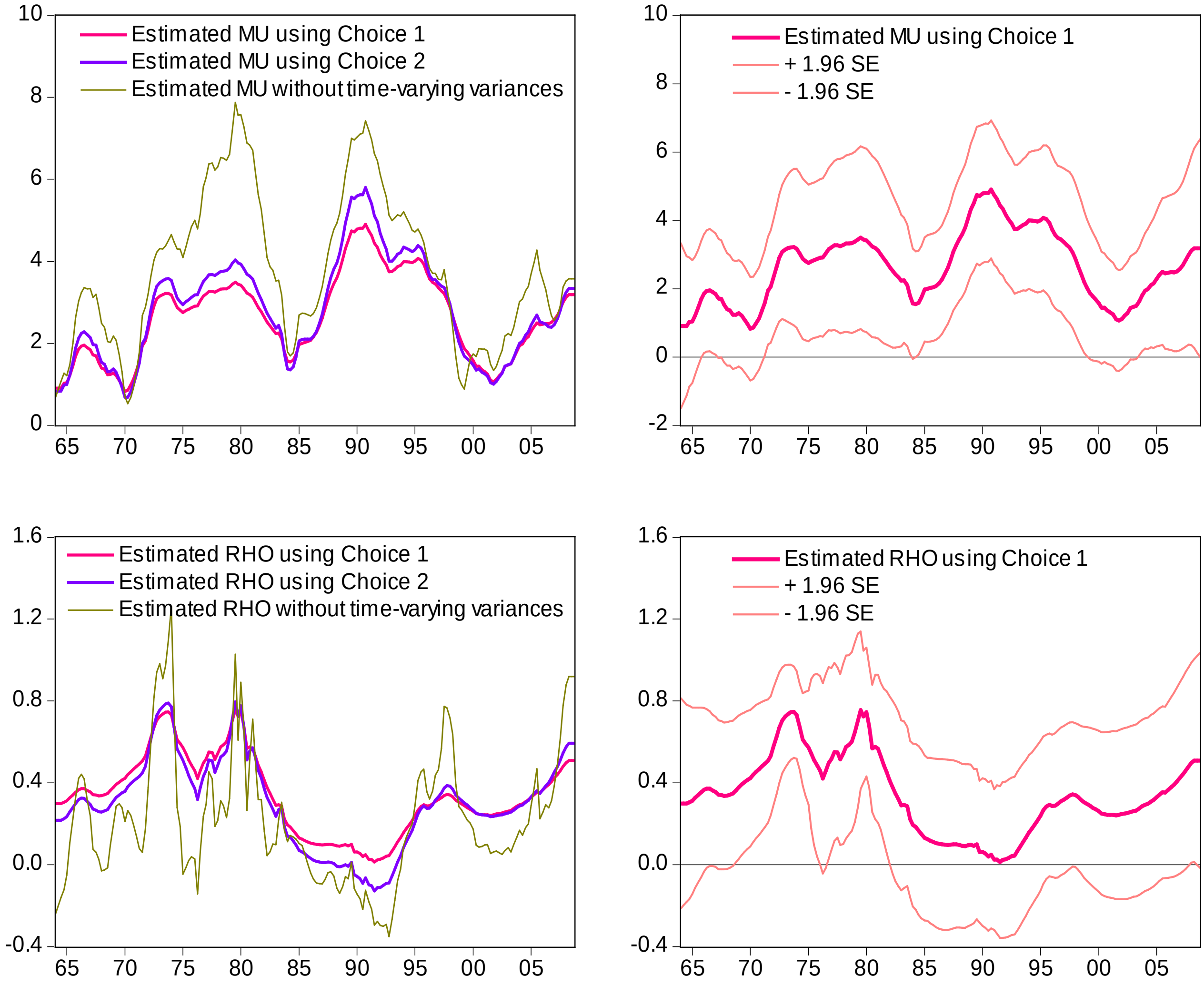
After imposing the patterns of σ_η^2 and σ_ν^2 as discussed above, we estimate the UC model with an autoregressive term for the entire sample period, 1964Q3 – 2008Q2. Key results are presented in Figure 16, along with the results from an estimation without the time-varying variance feature for comparison. As expected, time-varying variances allow μ_t and ρ_t to evolve more smoothly, as the variance terms now help absorb more of the short-term variation in inflation.

From Figure 16 below, it can be observed that inflation persistence was moderate in the 1960s, with ρ_t staying around 0.3 to 0.35. It evidently picked up in the early 1970s, peaking around 1973 with ρ_t nearly double the average value found for the 1960s. Although ρ_t edged down slightly and averaged around 0.5 in 1975-1978, it soon went back up around the second oil shock at the turn of the decade. Afterwards, ρ_t declined steadily, leveling off close to zero by 1985. It remained very low until the mid 1990s, when it increased to around 0.3 and remained close to that until 2004. Our estimates suggest that recently ρ_t went up further to around 0.45 to 0.5. This could partly reflect the persistence of oil and farm prices in recent years, as discussed in the previous part.[24]

[24] In our UC model, shocks to the inflation process are assumed to be serially *uncorrelated*. Therefore, when shocks tend to be serially *correlated* as in the recent years, in contrast to the past, the persistence

As for the mean of the inflation process, μ_t, it moved largely in line with actual inflation, except between 1973 and 1981 when ρ_t rose rather sharply, implying that during that period inflation was kept elevated not only from a higher mean of the inflation process but also from a stronger degree of inflation persistence. These results broadly confirm our findings from 3.1. In other words, even though shocks from oil prices were short-lived, their impact did not die down as rapidly as what we would have seen in the 1960s.

Figure 16: Estimated μ_t and ρ_t

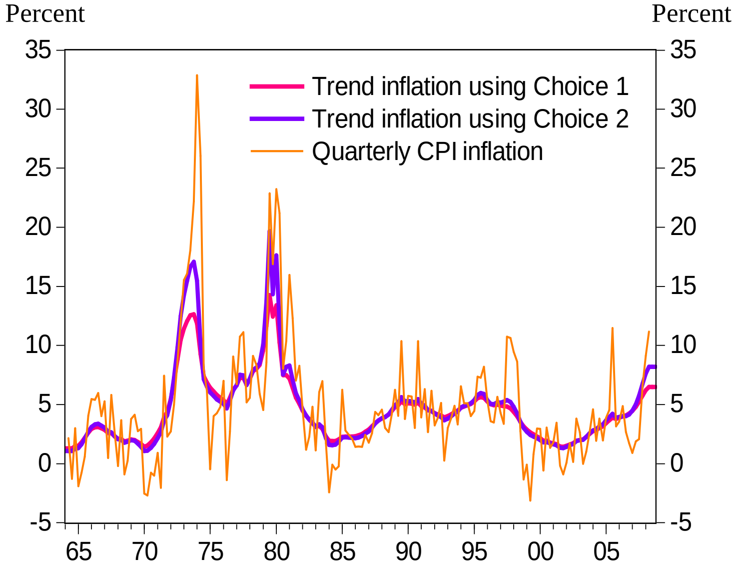


Source: Authors' calculations

The corresponding trend inflation (Figure 17) was low and fairly steady in the 1960s, rose sharply in the early 1970s, and attained twin peaks around the time of the two oil shocks, between which it stayed somewhat elevated. It fell markedly in the early 1980s and stabilized at around 5 percent during the ten years leading up to the 1997 financial crisis. Despite higher actual CPI inflation in 1997 and 1998 as a result of the

parameter is likely to end up capturing such persistence of the shocks in addition to capturing the persistence of the inflation process.

Figure 17: Trend inflation



Source: Authors' calculations

substantial currency depreciation, our estimated trend inflation was not noticeably affected. However, it declined around 2000 and hovered slightly below 2 percent for a few years before starting to pick up steadily since 2004.

It should be noted that our patterns of trend inflation and inflation persistence between mid-1960s and mid-1990s are similar to the patterns reported for the U.S. by Cogley, Primiceri and Sargent (2008). This is not at all surprising given that a pegged exchange rate throughout that period was likely to transmit the Fed's inflationary inclination to Thailand. The patterns of the two countries broke down around 1997, with inflation persistence remaining stable in the U.S. but rising in Thailand. The breakdown of the tight affiliation coincided with the abandonment of the U.S. dollar-dominated currency peg, offering yet another suggestion that monetary policy plays an important role in the determination of inflation persistence and, through that, of the inflation process. The issue is further pursued in Part 4.

So far, we have only concentrated our efforts on univariate inflation models without saying much about factors that govern the inflation process apart from the impact of various shocks. In the next section, we hope to apply the New-Keynesian economic theory to our analysis of inflation dynamics. Before moving forward, the final note to this section is that we could improve our estimation technique by using the unobserved components with stochastic volatility (UC-SV) model. This would allow us to do away with the imposition of variance patterns. Results from the UC-SV model could also be compared against our understanding of the nature of inflation disturbances over time. We thus intend to explore the UC-SV model in the future as an extension of our current research work.

3.3 Evidence from the hybrid New Keynesian Phillips curve (NKPC)

3.3.1 Concept

Next, we attempt to empirically measure the theoretical relationship between inflation, expected inflation, past inflation and some measure of overall real activity in the spirit of the hybrid NKPC, which has been popularized by Gali and Gertler (1999) and Gali *et al.* (2005). We prefer this version of the NKPC because not only that it is grounded on microeconomic foundations, namely the theory of staggered price adjustments by forward looking firms and individuals à la Calvo (1983), it also captures the reality that inflation tends to exhibit a certain degree of inertia since a subset of firms simply prefer to use a backward looking rule of thumb to set prices.[25]

Let π_t denote the inflation rate at time t and lower-case rmc_t the percentage deviation of firms' real marginal cost from its steady state value. While traditional empirical work on the Phillips curve often use some output gap measure as an indicator of real economic activity, the micro-economic based NKPC argues for the use of real marginal cost as a relevant measure given that (1) firms mark up price over marginal costs and (2) it directly accounts for the impact of productivity gains on inflation. To see the relationship between real marginal cost and the output gap, however, one ought to think about the concept of demand pulled inflationary pressure where the degree of such pressure is determined by the degree of resource utilization in the economy. In the short run where capital is fixed, an increase in demand signified by a positive output gap (i.e. level of actual output is above potential output) will exert pressure on resources and cause real marginal cost to rise above its steady state level. Thus, we choose to employ real marginal cost as our measure of overall real activity, though as a robustness check other possible candidates including the output gap and the capacity utilization rate will also be used. A reduced form inflation equation can be written as:

$$\pi_t = \omega_1 E_t(\pi_{t+1}) + \omega_2 \pi_{t-1} + \lambda rmc_t \tag{13}$$

Iterating equation (13) forward yields:

$$\pi_t = \lambda \sum_{k=0}^{\infty} \omega_1^{\,k} E_t\{rmc_{t+k}\} + \omega_2 \pi_{t-1} \tag{14}$$

The interpretation of equation (14) is quite intuitive. Given that firms (a) set price as a mark up over marginal costs, (b) cannot adjust price every period, and (c) make decisions based on both the expectation of future outcomes and historical experiences, their pricing decision hinges on both expected real marginal costs (infinitely into the future) as well as past information. As a result, one can see that firms' anticipation of future directions of oil and farm prices described in Part 2 will have relevant implications on the shaping of inflation dynamics, going forward.

Estimation of the parameters ω_1, ω_2 and λ will allow us to answer three questions of interest:

1. Does expectation play a role in governing the inflation process? If so, by how much?

2. How persistent is inflation in Thailand? Here the degree of persistence is governed by how backward looking firms are in their price setting behaviour.

3. How much is the impact of overall real activity on inflation?

To avoid potential problems associating with simultaneity, we employ the Generalized Method of Moments (GMM) estimation procedure in our analysis.

[25] More details can be found in Gali and Gertler (1999).

3.3.2 The relationship between real marginal cost and the labour share

Before we proceed to the empirical estimation, it is worthwhile to say a few words about how we obtain a measure of real marginal cost. For simplicity, we follow the approach taken by Gali and Gertler (1999), which is based on the assumption of a Cobb-Douglas (CD) technology:

$$Y_t = A_t K_t^{\alpha_k} N_t^{\alpha_n} \tag{15}$$

where $\alpha_k + \alpha_n = 1$; $\alpha_k, \alpha_n > 0$; Y_t = real output; A_t = exogenous productivity index; K_t = capital and N_t = labour, all at time t. Assuming that capital is fixed, real marginal cost can be approximated by the ratio of the real wage rate to the marginal product of labour, i.e. $RMC_t = W_t / P_t * (1/(\partial Y_t / \partial N_t))$. Differentiating and rearranging equation (15) give $\partial Y_t / \partial N_t = \alpha_n Y_t / N_t$, which when substituted into the RMC expression yields $RMC_t = W_t N_t / \alpha_n P_t Y_t = S_t / \alpha_n$, where S_t denotes the labour income share at time t. Given the proportionality between RMC_t and S_t, we can approximate real marginal cost by the labour income share, where the percentage deviations from their respective steady state values are given by the lower-case variables:

$$rmc_t = s_t . \tag{16}$$

In the existing NKPC literatures, it is a standard practice to calculate the labour income share of only the non-farm business sector. Due to revisions in the concept and definition of Thailand's labour force survey in 2001[26], we feel that it may not be entirely appropriate to merge the non-farm business series before and after the change. However, since the labour income series for the manufacturing business sector are comparable before and after the change, we proceed to merge them to calculate the labour income share in the manufacturing sector, instead. This approximation also helps weed out the impact of the government sector in our calculation of the labour income share given possible differences in productivity of the public and private sectors.

Furthermore, given that Thailand is a small open economy, we feel that our measure of real marginal cost needs to be adjusted for the degree of openness. According to Barkbu and Batini (2005) and Batini *et al.* (2005), openness can affect inflation through the relative price of inputs, which include imported content. With imported inputs, in the short run – i.e. when capital is fixed – the cost of production can be written as a function of labour costs and of the imported input costs. At the margin, this will be a function of the share of labour given above, the price of imported materials, firms' demand for imported materials, and the elasticity of material input with respect to output. Since value added, Y, is already defined as the value of output minus the value of imported inputs, it simply follows that the real marginal cost in this setup depends on just the labour share and the relative price of imported materials to that of value added.[27] Thus, we proceed to adjust our measure of real marginal cost for the role of imports by

[26] This includes the re-classification of non-farm business sectors into lower levels of disaggregation. For more details, please refer to http://web.nso.go.th/eng/stat/lfs/lfse.htm.

[27] Under this setup, relative price shocks, e.g. oil price shocks, enter the inflation equation positively through real marginal cost. The impact is not so clear cut when the output gap is employed as it affects output negatively. As a result, when output gap is used, supply shocks are usually incorporated into the model as a separate variable.

adding to the log of real marginal cost, the log of import price relative to the GDP deflator, weighted by the volume of trade relative to output, i.e. a measure of degree of openness.[28]

Although the import price variable should already incorporate the impact of rising world oil and farm prices, given our special interest on oil and farm prices, it may be useful to see their individual results separately. Thus, we create two additional measures of adjusted marginal costs, one adjusted for the role of Dubai oil price and another for the role of non-fuel commodity prices. As a result, we have altogether three measures of adjusted real marginal cost, namely import-adjusted, oil-adjusted, and non-oil adjusted real marginal costs.

3.3.3 Data and model specification

Real marginal cost measured as a percentage deviation from its steady state level, which is approximated by its sample mean (the approach normally employed in the existing literatures) is not a stationary process. We have two options: (a) express the series in its first difference[29] or (b) allow for a time-varying steady state approximated using a Hodrick-Prescott (HP) filter. For the sake of robustness, we decide to employ both methods. Other real activity variables used in the estimation include the popular HP trend output gap and the capacity utilization rate.[30]

Concerning our measures of inflation expectation, we employ two alternatives. In the first case, we employ the method used by Orphanides and Williams (2003) and estimate an inflation expectation series of the form:

$$E_t(\pi_{t+1}) = \alpha\pi_t + (1-\alpha)\overline{\pi} \qquad (17)$$

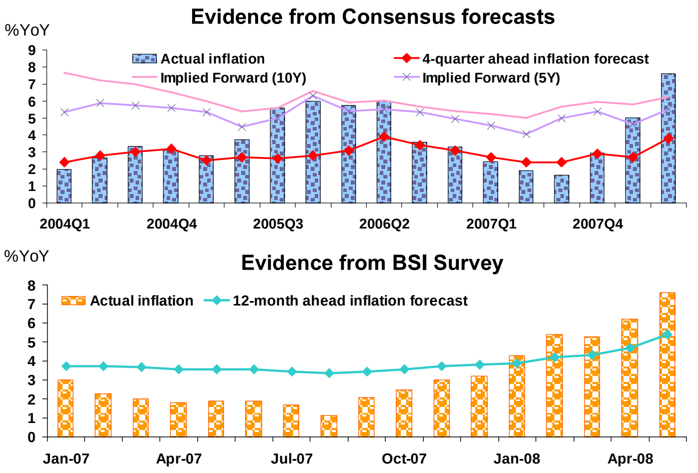
where expected inflation is assumed to be governed by this period's inflation and also some sort of anchor, for example the inflation target.

[28] We choose to weight the relative price of import to GDP deflator by trade share rather than by import share on the grounds that there exists competition between domestic-oriented and export-oriented firms for imported resources.

[29] Although the traditional way of expressing activity gap variables is in their levels, arguments for the relevance of changes in activity gap variables to inflation can also be found in the existing literatures. See Mehra (2004) for more information on this.

[30] Our CAPU series as a percentage deviation from its sample mean is also a non-stationary process. As a result, we proceed to adjust the series in the same manner as our real marginal cost.

Figure 18: Evidence of expectation formation in Thailand



Sources: Bank of Thailand's BSI Survey and Consensus Economics Inc. forecasts

To see whether this approximation mimics the true expectation formation process in Thailand, we plot actual inflation against two series of 1-year-ahead inflation expectation. The first series is constructed from 1-year-ahead Consensus inflation forecasts. The second series is obtained from the Bank of Thailand's Business Sentiment Index (BSI) survey where businesses are asked to give their estimates of inflation 1 year from today. [31] (Figure 18) Unfortunately, both series do not extend very far back, with the Consensus series going back to 2004Q1 and the BSI series going back only to January 2007. Nevertheless, graphical examination of both series reveals the following messages. From the Consensus series, it can be observed that the inflation expectation path exhibits both an adaptive element, i.e. following current inflation quite closely, but is generally flatter, suggesting some degree of expectation anchoring. This anchoring in inflation expectation is also broadly reflected from the shorter BSI series where inflation expectation of businesses is rather stable except during the most recent months. From this, one clear theme emerges – embedded within Thailand's inflation expectation formation process are both the element of backward lookingness and an inflation anchor. Thus, we assess that it is quite likely that the above approximation of inflation expectation will, to some extent, be valid for Thailand. Ordinary Least Square estimation of equation (17) using quarterly data from 1993Q1 to 2008Q1 yields:

$$E_t(\pi_{t+1}) = 0.60\pi_t + 0.40\bar{\pi}\,, \tag{18}$$

where $\bar{\pi}$ is assumed to be the average annualized headline inflation rate during 1993Q1 – 2008Q1 of 3.6 percent. [32]

In the second case, we assume that inflation expectation is perfectly anchored in the long run and thus can be denoted by a constant equal to $\bar{\pi}$ above.[33] Going forward, we would like to encourage researchers to employ observed series of inflation expectation in their future studies once longer series become available.

[31] Shown also in Figure 18 is another measure of inflation expectation extracted from bond yield data. However, such measure is more applicable for the longer-run and thus not used in this analysis.

[32] Given that Thailand's inflation target of 0-3.5 percent is for core inflation and not headline inflation, we assume that using the implied target mid-point of 1.75 percent may not be appropriate in this exercise.

[33] There is some evidence from Consensus inflation forecasts that in the long-run inflation expectation generally reverts to around 3 percent.

Given the limitation on the availability of quarterly GDP, the sample period included in our estimation spans from 1993Q1 to 2008Q1. In cases of missing variables, as in the case of the labour force survey data due to some non-survey rounds, we resort to a simple linear interpolation technique. Our list of instruments is in line with those of the existing literatures, including three lags each of expected inflation[34], real marginal cost, HP-trend output gap, Dubai oil price, non-farm commodity price and wage inflation. All variables are seasonally adjusted, stationary and expressed in the first difference of their logarithmic forms unless specified otherwise.

3.3.4 Results from the NKPC

Tables 7 and 8 present the results from our estimation of the NKPC for the two cases of inflation expectation formation process: (1) adaptive expectation with a perceived anchor and (2) constant inflation expectation. For technical robustness, we employ both the Newey-West (1994) and Andrews (1991)-recommended kernel and band-width selection methods in our GMM estimations. The results from Newey-West regressions are reported here and those from Andrews are reported in Appendix C.

Table 7: Estimation of the NKPC under adaptive expectation with perceived anchor

No.	Choice of real marginal cost (RMC)	ω_1	ω_2	λ	Adjusted R^2	Hansen-J(1)
1	PM adjusted RMC from mean	0.46 **	0.58 **	0.08 **	0.27	0.86
2	PM adjusted RMC from HP trend	0.42 **	0.61 **	-0.00	0.31	0.87
3	NONF adjusted RMC from mean	0.15 **	0.70 **	0.06 **	0.31	0.88
4	NONF adjusted RMC from HP trend	0.27 **	0.67 **	-0.03 **	0.19	0.89
5	Dubai adjusted RMC from mean	0.17 **	0.81 **	0.02 **	0.42	0.92
6	Dubai adjusted RMC from HP trend	0.36 **	0.69 **	0.01	0.35	0.88
7	HP output gap	0.43 **	0.59 **	0.05 **	0.36	0.83
8	CAPU from mean	0.16 *	0.82	0.00	0.28	0.78
9	CAPU from HP trend	0.26 **	0.85 **	0.00**	0.19	0.87

* and ** denote significance at 10 and 5 percent, respectively; (1) displays the *p*-values for the Hansen J-statistic test of over-identification where acceptance of the null hypothesis indicates that the equation is over-identified; list of instruments include 3 lags of HP trend output gap, marginal cost, Dubai oil price, non-fuel commodity price, wage and expected inflation. All variables are in log-difference except those calculated as the percentage deviation from the HP trend; PM, NONF and CAPU stand for import price, non-fuel commodity price, and capacity utilization rate, respectively.

[34] However, when a constant inflation expectation is assumed, only the second and third lags of inflation are included in the instruments to ensure correctness of model specification.

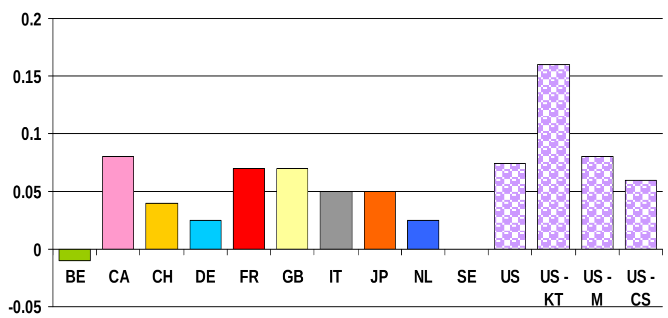
Table 8: Estimation of the NKPC under constant inflation expectation						
No.	Choice of real marginal cost (RMC)	ω_1	ω_2	λ	Adjusted R^2	Hansen-J(1)
1	PM adjusted RMC from mean	0.37 **	0.68 **	0.08 **	0.25	0.72
2	PM adjusted RMC from HP trend	0.43 **	0.58 **	-0.00	0.31	0.74
3	NONF adjusted RMC from mean	0.16 **	0.77 **	0.02	0.35	0.73
4	NONF adjusted RMC from HP trend	0.49 **	0.36 **	-0.03 **	0.04	0.79
5	Dubai adjusted RMC from mean	0.14 **	0.80 **	0.02 **	0.40	0.82
6	Dubai adjusted RMC from HP trend	0.32 **	0.71 **	0.00	0.33	0.80
7	HP output gap	0.39 **	0.69 **	0.06 **	0.32	0.72
8	CAPU from mean	0.10	0.96 **	0.00	0.15	0.82
9	CAPU from HP trend	0.12 *	0.88 **	0.00 **	0.26	0.84

* and ** denote significance at 10 and 5 percent, respectively; (1) displays the *p*-values for the Hansen J-statistic test of over-identification where acceptance of the null hypothesis indicates that the equation is over-identified; list of instruments include 3 lags of HP trend output gap, marginal cost, Dubai oil price, non-fuel commodity price, wage and 2 lags of past inflation. All variables are in log-difference except those calculated as the percentage deviation from the HP trend; PM, NONF and CAPU stand for import price, non-fuel commodity price, and capacity utilization rate, respectively.

From above, it can be observed that during 1993 - 2008, the effect of inflation expectation denoted by ω_1 played an important role in determining inflation, though to a lesser extent compared to the purely backward looking rule of thumb behaviour. In other words, we could say that firms in the Thai economy exhibited some degree of expectation induced price setting behaviour. Nevertheless, our inflation process remained governed to a larger extent by past information, i.e. backward lookingness. Recall that in the previous sections, inflation persistence or ρ decreased during the 1980s until around the mid 1990s (while rising again during the most recent periods), unfortunately due to the short GDP, CAPU and employment series, we are not able to use this multivariate method to confirm such findings. It is interesting to note that even though we do not restrict the sum of ω_1 and ω_2 to equal to one, i.e. the superneutrality assumption, the estimated coefficient values generally sum to one anyway.

Real marginal cost and other activity gap measures are found to be only marginally significant determinants of current inflation. This result may surprise some, but it is actually consistent with international findings. Figure 19 summarizes a collection of international findings on the size of λ. Popular explanations that have been cited in the literatures, e.g. by Borio

Figure 19: Evidence on the size of λ

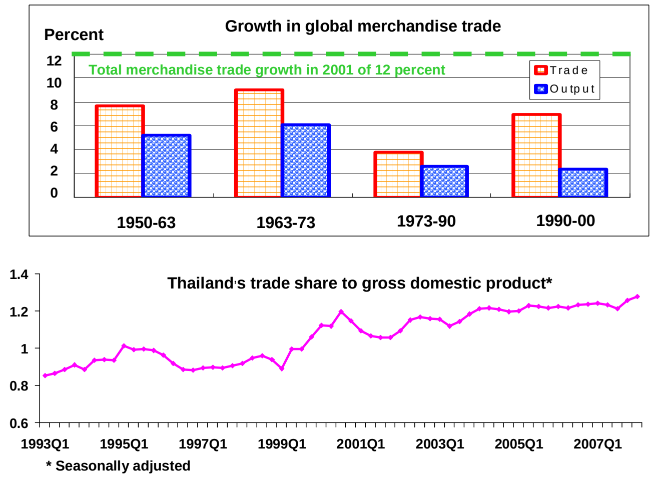


BE = Belgium, CA = Canada, CH = Switzerland, DE = Germany, FR = France, GB = United Kingdom, IT = Italy, JP = Japan, NL = the Netherlands, SE = Sweden, US = United States

Sources: All estimations are from White (2008) during 1993-2005 except US-KT (Kozichi and Tinsley [2002] during 1947-2001), US-M (Mehra [2004] during 1997-2003) and US-CS (Cogley and Sbordon [2002] during 1962-2002) and Filardo (2007) and White (2008), include the impact of globalization that has affected domestic inflation through a flattening of the Phillips curve since the early 1990s. This amounts to a reduction in the second round effect as a result of downward pressures on inflation from foreign competition. In our attempt to measure the impact of globalization, we introduce an interactive dummy variable for globalization, D_{globe}, which takes the value of one between 2000Q1 to 2008Q1 and zero otherwise.

Although, it is very difficult to justify the beginning of globalization, we choose 2000Q1 as the beginning of a structural shift in global trade for three important reasons. First, 2000 marked the year of a significant increase in global merchandise trade. According to the World Trade Organization (WTO)'s *International Trade Statistics 2001*, total merchandise trade increased by 12 percent – almost matching the highest annual growth rate over the previous five decades (Figure 20). Secondly, also from Figure 20, there seemed to be a shift in the degree of Thailand's openness to foreign trade, measured by the share of trade to GDP, around that time.[35] Finally, introducing D_{globe} in 2000 would allow for the coverage of China's preparatory period prior to its accession to the WTO in December 2001.

Figure 20: Global trade and Thailand's openness



Sources: WTO International Trade Statistics (2001) , NESDB and authors' calculations

The introduction of D_{globe} yields:

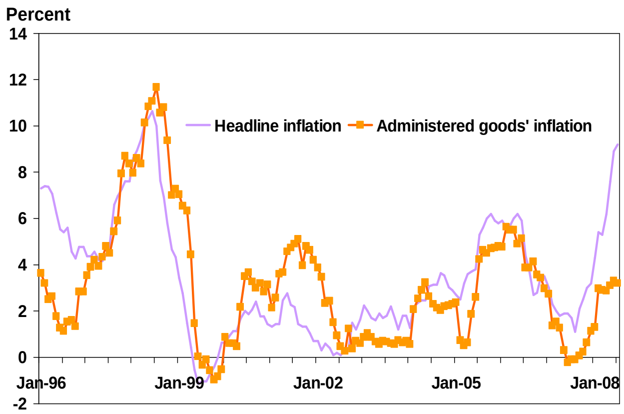
$$\pi_t = \omega_1 E_t(\pi_{t+1}) + \omega_2 \pi_{t-1} + \lambda_1 rmc_t + \lambda_2 D_{globe,t} rmc_t \qquad (19)$$

Estimation of equation (19) reveals some evidence of the impact of globalization as λ_2 is found to be negative and significant at the five percent significance level. That is, there was a reduction in the slope of the NKPC under the period 2000Q1-2008Q1, which worked to limit the second round effect of demand pressure from rising resource utilization. Interestingly, the size of λ_2 is found to be more or less equal to that of λ_1, suggesting that globalization may have (almost) completely limited the impact of demand-pulled pressure on Thai inflation in this period. (see Appendix D for estimates and tests of equality) However, this must be considered together with the fact that supply shocks that entered real marginal cost directly through our adjustment for imports were also rather benign for most of the period investigated. As global demand began to exert pressure on resources and play a more important role in dictating the future of commodity

[35] By regressing the share of trade to GDP on its own lag and a constant, we find that a Chow test for break point at 2000Q1 rejects the null hypothesis of coefficient stability at that point.

prices such as oil and farm prices discussed in Part 2, we must be mindful that the favourable impact of globalization in the past may diminish, going forward. In other words, the on-going changes could potentially raise the size of λ through economic agents' expectations of a persistent acceleration in real marginal cost, especially once recoveries in global growth as well as our own domestic demand take place.

Figure 21: Administered goods' inflation



Note: Administered goods include those items whose prices are formally administered by law. They amount to around 30 percent of the CPI weight.
Source: Ministry of Commerce and authors' calculations

For Thailand, an additional factor underpinning the small magnitude of λ may be domestic price administration measures, which in effect distorted the pass-through of costs to retail prices, as mentioned by Buddhari and Chensawasdijai (2003) and Chantanahom *et al.* (2004). We also attempt to capture the effect of price administration in our hybrid NKPC but find it to be insignificant. Nevertheless, we can still see the impact of price administration by observing the relationship between general inflation and administered goods' inflation in Figure 21.

In summary, one key message emerges from our analysis of the hybrid NKPC, that is, to a certain extent, inflation expectation played a role in shaping Thailand's inflation dynamics during 1993Q1 – 2008Q1. Such findings are in accordance with the spirit of the NKPC and also in support of the role of monetary policy. Our tests of robustness are presented in Appendix E.

Overall, Part 3 reveals several key important messages regarding the dynamics of Thai inflation. In particular, we find evidence to suggest that the parameters governing our inflation process were time-varying in nature and closely mimicked important events and/or shocks experienced in the past. However, these events and/or shocks could not fully account for all the changes observed. This suggests that a more common factor, likely to be demand driven (or closely associated with it – e.g. monetary policy), might have been at play. Moreover, in an attempt to explore the appropriateness of the New Keynesian economic theory in explaining Thailand's inflation process, we find that inflation expectation was a significant factor that governed the inflation process. Together, these findings lend support to the role of monetary policy, which sets forth our analysis in the next part.

4. Monetary policy and the evolving inflation process

In the previous part, we establish that changes in the inflation process of the CPI and its components came around the same time, suggesting that the breaks in the process were not driven by some sector-specific factor. In other words, we should look for a factor that would have a pervasive impact on the price-setting behaviour of the entire economy. In addition, the degree of inflation persistence in Thailand coincided with the patterns observed in the U.S. during the time when we were under the U.S. dollar-dominated exchange rate peg. The resemblance ended around 1997, when Thailand abandoned the exchange rate peg and her monetary policy no longer had to follow that of the U.S.

These two important observations, along with the theoretical suggestion that monetary policy should play an important role in steering inflation expectation and thus the inflation process, lead us to investigate further the evidence to support the proposition that changes in the inflation process, especially inflation persistence, were the result of shifts in monetary policy.

4.1 Approximations of the monetary policy stance

In order to do so, we look for periods when the monetary policy stance was likely to differ substantially from those implied by standard policy rules, such as the Taylor rule and the optimal policy rule as suggested by Ball (1998) for an open economy, and see whether or not the degree of inflation persistence tended to change following sustained deviations from the rules. In particular, we expect to see a rise (fall) in inflation persistence when monetary policy was too accommodative (restrictive) compared to the stance suggested by the rules. The approach follows the spirit of Cecchetti *et al.* (2007).

4.1.1 Simple monetary policy rules

We begin with the construction of a number of simple rules or benchmarks, against which actual interest rate or monetary conditions will subsequently be compared. Three types of rules/benchmarks are considered, as follows:

(1) Taylor rule, which defines optimal policy interest rate as the one that minimizes a weighted sum of the output gap and inflation deviation from its target rate. The rule takes the following form:

$$i_t = c + \pi_t + 0.5\ (\pi_t - \pi^*) + 0.5\ y_t \qquad (20)$$

where i_t is the interest rate at time t, π_t is the inflation rate, π^* is target inflation, y_t is the output gap, and the constant term, c, is taken to be the level of the long-run equilibrium real interest rate. Here we keep the original weights of 0.5 and 0.5 in front of the inflation deviation and the output gap terms, respectively. The formal derivation of the Taylor rule can be found in Svensson (1996).

(2) Optimal policy rule for an open economy, which recognizes the importance of the exchange rate channel and modifies the Taylor rule above to explicitly incorporate the exchange rate, as follows:

$$\omega r_t + (1-\omega)e_t = c + \alpha\ [(\pi_t - \pi^*) + \gamma e_{t-1}] + \beta y_t \qquad (21)$$

where c is a constant term that depends in part on the long-run equilibrium real interest rate, e_t is the real exchange rate at time t (with a higher value suggesting a stronger domestic currency), ω governs the relative importance of real interest rate and real exchange rate, and γ captures the impact of the exchange rate appreciation on inflation through import prices. The left-hand side is the prevailing monetary conditions that should be equated to the right-hand side to attain the optimal level.

In what follows we adopt two choices of ω, namely 0.5 and 0.66, with the latter being consistent with the weight used by the Bank of Thailand in the construction of its regularly published monetary conditions index (MCI). The value of 0.66 for ω suggests that the impact of a one percentage point increase in the real interest rate has about twice as large an impact as that of a one percentage increase in the real exchange rate, a relative magnitude that is by and large consistent with empirical results. The values of α and β are set to equal to 0.5 and thus are consistent with the weights used in the Taylor rule discussed above. We assume $\gamma = 0.2$, which implies that a one percent appreciation in the real exchange rate would directly reduce inflation by two tenths of a point.[36] The value is comparable to the estimated share of imports in the CPI basket. The addition of γe_{t-1} to the right side of the rule filters out the transitory effects of exchange rate movements on inflation. Ball (1997) interprets this modification as equivalent to the use of core or underlying inflation by central banks, which allows policymakers to concentrate on underlying inflation and ignoring transitory fluctuations like the ones arising from temporary exchange rate movements. At the bottom line, this rule implies that the appropriate measure of the policy stance for an open economy is an MCI that is a weighted average of the real interest rate and the real exchange rate.[37]

Both optimal MCI and actual MCI[38], which is just the left-hand side of (21), are normalized such that they average to 100 over 1979Q1-2008Q1. That is to say, we take the view that on average actual monetary conditions were neutral, and thus deviations of actual MCI from optimal MCI over the long horizon averaged to zero.

(3) A modified MCI, which extends the conventional MCI to include a quantity variable to capture the credit availability effect:

$$\omega_1 r_t \ + \ \omega_2 e_t \ - \ \omega_3 g^{credit} \ = \ c \ + \ \alpha \ [(\pi_t - \pi^*) + \gamma e_{t-1}] \ + \ \beta y_t \qquad (22)$$

where $\omega_1 + \omega_2 - \omega_3 = 1$, and g^{credit} is real credit growth. This modification is intended to allow for the impact of financial market liberalization over time, e.g. the introduction of BIBFs in the late 1980s that led to large foreign capital inflows and credit boom in the early 1990s. In what follows we explore two sets of (ω_1,

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[36] In the model setup in Ball (1997), γ enters into the open-economy Phillips curve as follows:
$\pi_t = \pi_{t-1} + \alpha\, y_{t-1} - \gamma(e_{t-1} - e_{t-2}) + \eta_t$, where η is the disturbance term. The change in the real exchange rate affects inflation indirectly via the output gap and also directly through import prices.

[37] This, however, does not necessarily lead to the conclusion that the MCI should be used as the policy target. See Freedman (2000) and Hong Kong Monetary Authority (2000) for discussions of the limitations of the MCI in policy implementation.

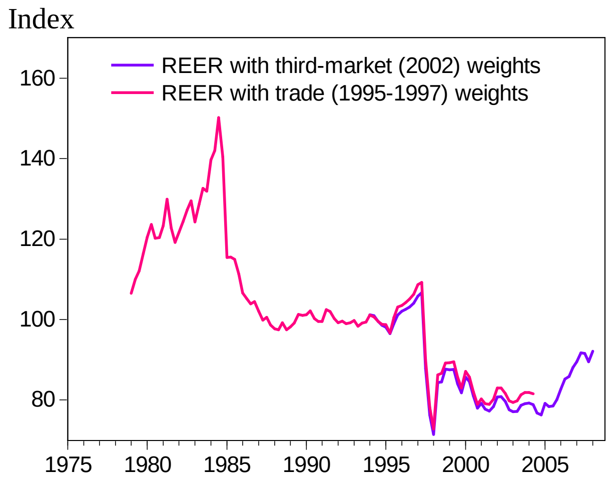
[38] Actual (standard) MCI = $\omega\, r_t + (1 - \omega)\, e_t$.

ω_2, ω_3), namely (0.6, 0.6, 0.2) and (0.8, 0.4, 0.2)[39]. The conclusions are robust to a reasonable variation of the choice of weights. Like the standard MCI discussed above, the modified MCI[40] is normalized so that the long-run average equals 100.

As all the rules/benchmarks use the interest rate as a measure of the monetary policy stance, whether alone or in conjunction with other financial variables, we need an interest rate variable that has the following properties: (1) it serves as the policy interest rate or at least is closely linked to the interest rate controlled by the central bank, and (2) quarterly data are available back to the 1960s so that we could construct a fairly good measure of the monetary policy stance back to that period. The best candidate in view of the two criteria is the interbank rate.

Another important information is the real exchange rate. Here we use the real effective exchange rate index (REER), with direct trade weights based on the trade structure over 1995-1997 to construct the index from 1979 to 1994, and with direct and indirect (third-market) trade weights based on the trade structure in 2002 to construct the index from 1995 onwards. The choice of weights reflects the evolution of the REER construction adopted by the Bank of Thailand, with the weights broadened to incorporate competition in third markets as globalization intensified. Figure 22 suggests, however, that the choice of weights is unlikely to matter significantly to our calculation of the monetary policy stance as the indices using different sets of weights still moved in line with each other.

Figure 22: REERs with different weights



Source: Bank of Thailand

The variable that is far more difficult to obtain is the quarterly output gap for the years preceding the mid-1990s. That is because the quarterly GDP data are available back to only 1993, while other variables that could help indicate the intensity of resource utilization in the economy, such as the capacity utilization rate (CAPU) and unemployment rate, fare no better. We thus resort to the use of real bank credits, letting the deviation of real bank credit from its Hodrick-Prescott (HP) trend[41] approximate the

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[39] Also referred to as (3, 3, 1) and (4, 2, 1), respectively.

[40] Actual (modified) MCI is represented by the left-hand side of (22), $\omega_1 r_t + \omega_2 e_t - \omega_3 g^{credit}_t$.

[41] The HP trend is known to be more sensitive at end points where data available for the approximation are limited. In our estimate of the output gap, whether using GDP or real credit data, the gap in the most recent period is slightly above zero, suggesting that the economy is operating close to potential. While this may differ from the views of many people, we judge from circumstantial evidence that it is plausible. In particular, the capacity utilization rate is high, and the unemployment rate is extremely low, both indicating a high degree of resource utilization at present. In other words, potential growth of the Thai economy may be lower than many hoped for, and there are a couple of reasons in support of this view. First, higher oil price is likely to dent the growth potential of an economy like Thailand where energy efficiency is low by international comparison. Second, despite a fairly high rate of capacity utilization, the ratio of investment

output gap or the deviation of GDP from its trend. Obviously, our choice is not ideal, for it is possible that real activities and credit expansion may not move in synchronization at all times. For example, real activities plunged abruptly in the wake of the 1997 financial crisis, but bank credits took some time to adjust. However, the event in 1997 was a shock of exceptional magnitude to the economy, so the discrepancy between the real credit cycle and GDP cycle is expected to be much smaller under normal circumstances.

4.1.2 Deviations from monetary policy rules and benchmarks

Figure 23 (top row) illustrates that, from 1993 to the present, deviations from the Taylor rule do not differ much whether GDP or real bank credits are used to approximate the output gap, except during 1997-1999 as expected from the discussion above. Here we may vary the parameters in the Taylor rule. For instance, Taylor rule 1 assigns c = 2.25 and $\pi^* = 3$, while Taylor rule 2 assigns c = 3.25 and $\pi^* = 5$. The value of 2.25 to 3.25 for the term that is meant to be the long-run equilibrium real interest rate is broadly consistent with the long-term average value of real interbank rate of approximately 3.15 percent over the past forty years. The value of 3 for the inflation target is close to the average headline inflation rate since 2000 and is also consistent with the Bank of Thailand's current core inflation target range of 0-3.5 percent, while the value of 5 for the inflation target is close to the average value of quarterly inflation over the past forty years and thus may better represent the policy target for the period of interest as a whole. The combination of parameters in each rule also leads to the average deviation from rule of roughly zero and is thus consistent with our view that in the long-term monetary policy is neutral on average. Note, however, that by invoking the assumption of zero average deviation from rule over time, Taylor rules 1 and 2 are a transformation of each other, and thus deviations from the two rules are the same. Variation of the parameter values within reasonable bounds, not necessarily forcing the average deviations over time to equal zero, does not suggest significant differences in the estimates of the monetary policy stance.

The monetary policy stance is calculated as the difference between the rate implied by the Taylor rule in (20) and actual interest rate, or in the case of the MCI as the difference between that implied by (21) or (22) and actual MCI. When actual interest rate or actual MCI is above the level suggested by the rule/benchmark (deviation is -), the monetary policy stance or monetary conditions are likely to be restrictive. Likewise, when actual interest rate or actual MCI falls below the level suggested by the rule/benchmark (deviation is +), the monetary policy stance or monetary conditions are likely to be accommodative. Figure 23 shows deviations from the rule/benchmark in various cases. While the top figures apply to the (equivalent) Taylor rules discussed earlier, the bottom figures apply to the MCI[42] while setting $\pi^* = 5$, with the left using a combination of the real interest rate and the real exchange rate and the right incorporating real credit growth into the monetary conditions measure.

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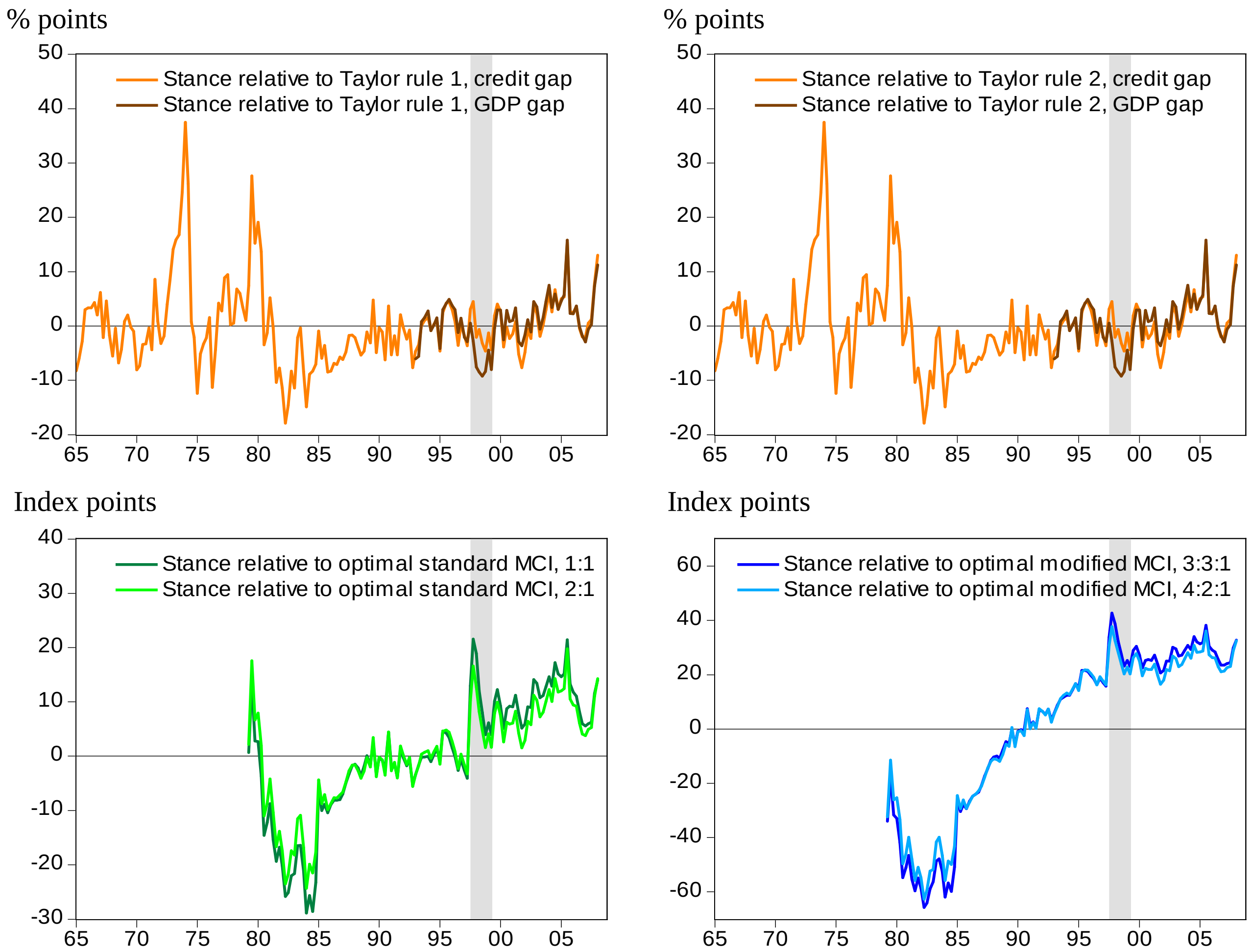
to GDP has been consistently low for the past several years, implying limited capacity expansion that is crucial for the maintenance of growth potential.

[42] For the standard MCI, the relative weights of 1:1 and 2:1 correspond to the cases of $\omega = 0.5$ and $\omega = 0.66$, respectively. For the modified MCI, as said before, the relative weights of 3:3:1 and 4:2:1 correspond to the cases with (ω_1, ω_2, ω_3) equal to (0.6, 0.6, 0.2) and (0.8, 0.4, 0.2), respectively.

Figure 23: Deviations from various policy rules/benchmarks



Source: Authors' calculations

We do not attempt to suggest which indicator is best in gauging Thailand's monetary policy stance or monetary conditions at each point in time. After all, suitability may change over time, depending on the degree of market liberalization and policy regime. However, no matter which is used, monetary policy is suggested to be highly accommodative on average in the 1970s and quite restrictive in the 1980s. Table 9 provides a summary of the average deviations from rules/benchmarks at different periods. It could be seen that large and positive deviations, consistent with a highly accommodative monetary stance, prevailed around 1973Q1-1980Q4. The stance reversed to restrictive in the 1980s, as indicated by large and negative deviations.

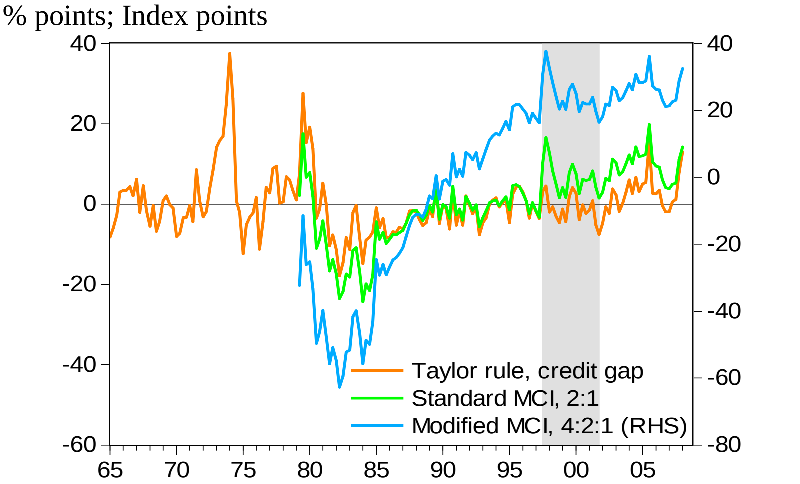
Implications on the monetary policy stance or monetary conditions vary slightly from the 1990 onwards, and Figure 24 clearly points it out. The differences emerge from two key factors, namely the financial liberalization with the introduction of BIBFs around 1989 and the 1997 financial crisis that saw a sharp depreciation of the exchange rate as well as severe credit conditions as a result of extreme risk aversion in the subsequent period.

Table 9 Average deviations from rules/benchmarks at different periods

	1965.1 – 1972.4	1973.1 – 1980.4	1981.1 – 1989.4	1990.1 – 1996.4	1997.1 – 1999.4	2000.1 – 2003.4	2004.1 – 2008.1
Real interbank rate	2.771	-0.212	7.728	4.366	6.074	0.327	-0.960
Deviations from rule/benchmark, using real credit cycle to approximate the output gap							
Taylor rule	-0.601	6.833	-5.785	-0.830	-0.659	-1.104	4.187
Standard MCI, $\omega = 0.5$, $\pi^* = 5$	na	na	-12.005	-0.290	8.593	9.493	12.042
Standard MCI, $\omega = 0.66$, $\pi^* = 5$	na	na	-9.906	0.004	6.064	6.522	10.072
Estimated degree of inflation persistence							
ρ_t, Estimate 1	0.423	0.604	0.203	0.137	0.313	0.255	0.379
ρ_t, Estimate 2	0.367	0.5740	0.139	0.056	0.337	0.249	0.396

Without taking into account the financial liberalization, both the Taylor rule and standard MCI suggest that the policy stance was generally neutral during 1990-1996, with deviations being small in absolute value compared to other periods (see also Table 9). The Taylor rule indicates that monetary policy continued to be neutral up to early 2003, before turning accommodative from late 2003 onwards and remaining fairly accommodative in 2008Q1, though less so than the average stance in the 1970s. The MCI, however, suggests that monetary conditions since 1997 were more lax than that implied by the Taylor rule, which considers only the real interest rate, as meanwhile the real exchange rate stayed weaker compared to the period before the crisis. Nonetheless, like the Taylor rule, the standard MCI indicates that monetary conditions became somewhat more accommodative around 2003.

Figure 24 Deviations from selected rules/benchmarks



Source: Authors' calculations

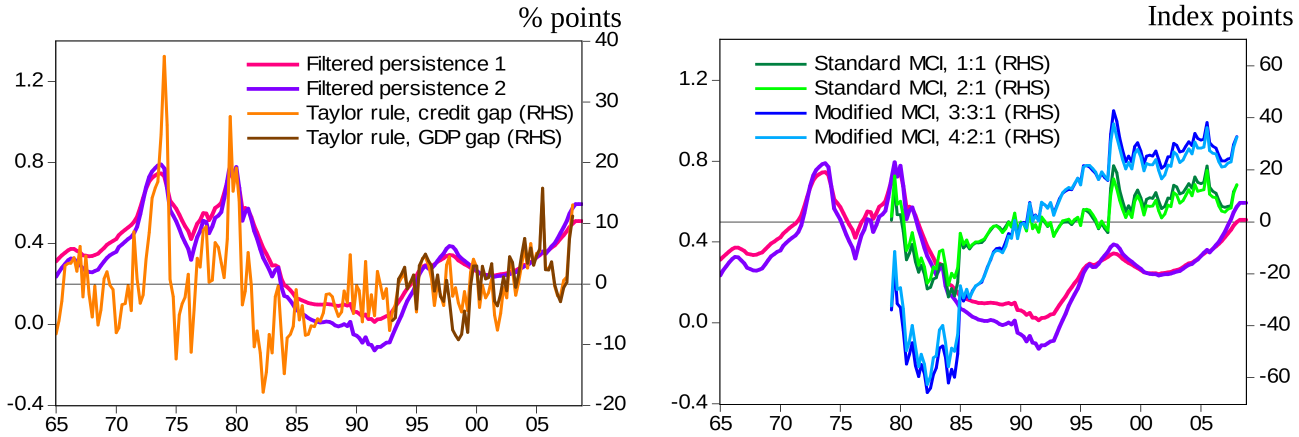
When financial liberalization is accounted for, monetary conditions were implied to be looser than that suggested by the Taylor rule and standard MCI. In particular, between the onset of the 1989 financial liberalization and the 1997 financial crisis, monetary conditions were likely to ease as foreign capital flows flooded in and supported a strong credit boom. The stance during this period was nonetheless closest to neutral compared to other periods between 1979 and 2008. From 1997 onwards, tightened credit conditions offset part of the real exchange rate depreciation. Thus, when compared to the period right before the financial crisis, monetary conditions stayed comparable rather than eased as suggested by the standard MCI. However, the modified MCI suggests that overall monetary conditions became more accommodative after 2003, which is consistent with the implication drawn from both the Taylor rule and the standard MCI.

Before we go on to the next section and compare changes in the inflation process against changes in the monetary policy stance, one important point should be highlighted. That is, the calculation of optimal monetary policy depends crucially on the accurate assessment of the output gap. With the benefit of hindsight and data that were not available real-time to policymakers when they were contemplating their decisions, we recognize that it is highly plausible that our output gap estimates are different from what the policymakers assessed back then. Thus, even though it looks as if monetary policy was overly accommodative from time to time, policymakers might not have intended for it to be so. In particular, policymakers working with limited real-time information might judge that the economy's output potential was higher and thus unknowingly accommodated the demand-side pressure. This highlights the importance of an accurate real-time assessment of the output potential and output gap.

4.2 The effect of monetary policy on inflation persistence

As economic theory suggests that monetary policy should have an important role in steering inflation expectation and by doing so should affect the persistence of the inflation process that leads in turn to trend inflation, in this section we concentrate on establishing a linkage between the monetary policy stance and inflation persistence. In Table 9 where we present average deviations from the monetary policy rules/benchmarks over different sub-periods, it is evident that positive (negative) deviations, indicating accommodative (restrictive) monetary policy, tend to be associated with high (low) inflation persistence, ρ_t. Figure 25 provides a visual representation of the same relationship. Overall, it is suggested that deviations from the simple policy rules/benchmarks during the 1970s and 1980s were very much consistent with the timing of the structural breaks in the inflation process found in Section 3.1 and the timing of the increases and declines in inflation persistence estimated from the UC model in Section 3.2. Moreover, the fairly neutral policy stance during the first half of the 1990s was associated with the maintenance of low inflation persistence, and the more accommodative monetary policy stance in the recent few years seemed to be coinciding with some pickup in inflation persistence. On the whole, from the Taylor rule's point of view there is only one period, 1997-1999, where the rise in inflation persistence seemed at odd with the neutral policy stance. However, the discrepancy can be reconciled when we look at the MCI. When the weaker exchange rate was incorporated, the monetary policy stance was likely to be more accommodative than that suggested by the real interest rate alone, at least before credit conditions became restrictive. This offers a preliminary confirmation that shifts in monetary policy should be responsible in part for changes in the inflation dynamics.

Figure 25: Inflation persistence and shifts in monetary policy



Source: Authors' calculations

Next we look for econometric evidence in support of our argument. In particular, we test for the significance of the relationship between $\Delta_n\rho_t$ or the change in ρ_t from its value n periods ago, and the average deviation from the policy rule/benchmark over the past n periods:

$$\Delta_n \rho_t = \beta_0 + \beta_1 \frac{1}{n}\sum_{i=0}^{n-1}\delta_{t-i} + u_t \tag{23}$$

where δ_{t-i} denotes deviation from policy rule/benchmark at time t-i, and u_t is the disturbance term. A summation of deviations is used because prolonged, not temporary, deviations from policy rule/benchmark are expected to influence the inflation process. It should be noted that although ρ_t has a unit root, its difference terms, $\Delta_n\rho_t$ with n>1, do not. Deviations from the Taylor rule and the optimal standard MCI are also stationary, so we could run regressions of $\Delta_n\rho_t$ on deviations from these rules/benchmarks. However, deviation from the modified MCI is found to be non-stationary at the five percent significance level. We therefore regress instead $\Delta_n\rho_t$ on $\Delta_n\delta_t$, with $\Delta_n\delta_t$ that is positive (negative) denoting more accommodative (restrictive) monetary conditions compared to n periods ago:

$$\Delta_n \rho_t = \gamma_0 + \gamma_1 \, \Delta_n \delta_t + v_t \tag{24}$$

where v_t is the disturbance term. Significant and positive β_1 and γ_1 would then be consistent with the significant influence of shifts in monetary policy on inflation persistence. Results are shown in Table 10 for n = 4 and 6. The lags are chosen to be consistent with our understanding of the monetary policy transmission time lag.

Additionally, as Part 2 presents evidence that oil and farm prices have become more persistent themselves in recent years, we expect that this factor may in part explain the contemporaneous rise in inflation persistence.[43] Moreover, the government's price

[43] Recall that ρ_t is the filtered measure of inflation persistence from our UC model in Section 3.2. In that setup, shocks to inflation or π_t in equation (9) are assumed to be serially uncorrelated. While the model is consistent with the nature of oil and farm price shocks in the past as demonstrated in Part 2, it may not

administration measures have also become more stringent, which could in effect mitigate hikes in inflation but at the same time prolong the price adjustment process. A clear example is the domestic oil price subsidy in 2004-2005. While inflation in late 2004 was kept below what should be had domestic oil prices been allowed to reflect movements in the world market, Thailand's inflation remained elevated in 2005Q3 – 2006Q3 due to the lift of the subsidy even though by that time pressure from global oil prices had already diminished. In addition, in an attempt to further alleviate the burden of higher costs of living on consumers, the government stepped up its price administration measures of various necessary goods and services at the beginning of 2005. These measures are still ongoing. Thus, price administration could also make the inflation process seem more persistent. To capture these effects, we introduce an interactive dummy, D, to equations (23) and (24), respectively:

$$\Delta_n \rho_t = \beta_0 + \beta_1 \frac{1}{n}\sum_{i=0}^{n-1}\delta_{t-1} + \beta_2 D \frac{1}{n}\sum_{i=0}^{n-1}\delta_{t-1} + u_t \text{, and} \quad (25)$$

$$\Delta_n \rho_t = \gamma_0 + \gamma_1 \Delta_n \delta_t + \gamma_2 D \Delta_n \delta_t + v_t \quad (26)$$

where D takes the value of one since 2004Q1, and zero otherwise. Significant and positive β_2 and γ_2 would then suggest that the rise in inflation persistence since 2004 was by more that the part that could normally be explained by shifts in monetary policy.

Two important implications are evident from the results. First, the coefficients which capture the effect of monetary policy on inflation persistence are always significant and positive. In addition, variation in the policy rule/benchmark used does not affect this conclusion. This is not surprising given that (a) differences in the implied monetary stance from the rules/benchmarks used are not that significant and (b) the rules/benchmarks capture similarly all major movements in monetary policy, namely the first break around 1970, the second break around 1980, the fairly neutral stance in the 1990s, and the more accommodative trend since late 2003. Second, a plausible break in the relationship between monetary policy and inflation persistence around late 2003 or early 2004 is not statistically significant.

The latter point is significant to us in yet another way. In the previous section, we raise the issue of output gap estimation, mentioning in particular that the HP trend which is used to estimate the output gap may be less reliable at end points and thus our estimates of the output gap for the most recent years could be inaccurate. Equations (25) and (26) can be regarded as using information up to 2003 to estimate β_1 and γ_1, and the results indicate that the above conclusions are not sensitive to the possible error in the estimates of output gap for the most recent years.

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capture well the recent situation. Therefore, the pickup in ρ_t since 2004 may reflect in part the more persistent nature of oil shocks and thus cannot be attributed entirely to the changing nature of the CPI inflation process.

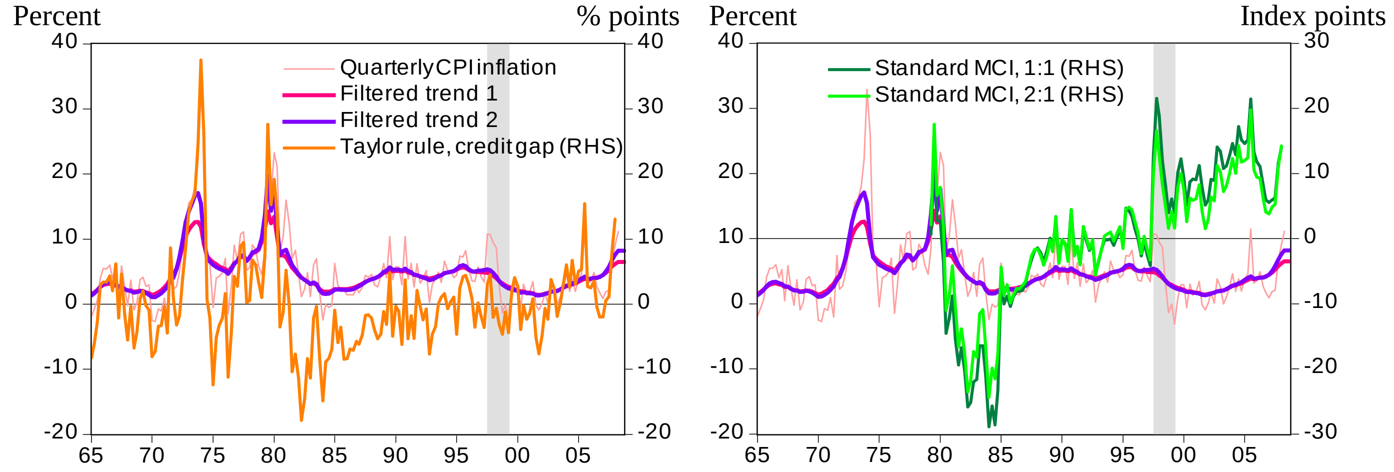
Table 10 Estimated impact of shifts in monetary policy on inflation persistence#

	Taylor rule		Standard MCI $\omega = 0.66$, $\pi^* = 5$		Modified MCI, $\omega_1 = 0.8$, $\omega_2 = 0.4$, $\pi^* = 5$	
n = 6						
β_0	-0.004 (0.007)	0.001 (0.008)	-0.012* (0.006)	-0.011 ** (0.007)		
β_1	0.005 ** (0.001)	0.005 ** (0.001)	0.007 ** (0.001)	0.007 ** (0.001)		
β_2		0.005 (0.004)		-0.000 (0.002)		
γ_0					-0.022 ** (0.009)	-0.023 ** (0.009)
γ_1					0.003 ** (0.001)	0.003 ** (0.001)
γ_2						-0.003 (0.003)
n = 4						
β_0	0.003 (0.005)	0.002 (0.006)	-0.008 (0.005)	-0.008 ** (0.005)		
β_1	0.003 ** (0.001)	0.003 ** (0.001)	0.005 ** (0.001)	0.005 ** (0.001)		
β_2		0.005 (0.004)		0.000 (0.001)		
γ_0					-0.014 ** (0.006)	-0.014 ** (0.006)
γ_1					0.003 ** (0.001)	0.003 ** (0.001)
γ_2						-0.001 (0.003)

Results shown are for our filtered inflation persistence 1. Using the alternative series (2) produces very similar results. Standard errors are provided in parentheses; * and ** denote significance at 10 and 5 percent, respectively.

Together, we take these implications as a strong and robust confirmation of the proposition that monetary policy has a role in governing inflation persistence and hence the inflation process, regardless of the initial cause of inflation. In particular, the role of monetary policy is not restricted to periods where inflation arises from domestically driven demand pressure. The early 1970s and early 1980s both saw large but temporary disturbances from oil prices. However, the inflation dynamics following the two oil shocks were different. While trend inflation stayed somewhat high in the late 1970s despite the absence of adverse supply shocks, there was a sharp fall in trend inflation following the second oil shock, after which it remained moderate for the rest of the decade (Figure 26). The key difference between the two periods was the stance of monetary policy. In particular, monetary policy was accommodative in the 1970s, whereas it was restrictive in the latter period. As for the 1990s and early 2000s, globalization might have helped exert downward pressure on inflation as discussed in Section 3.3, but the generally disciplined monetary policy also played a role in keeping trend inflation moderate and well anchored, as seen by no observable break in the inflation process and no change in trend inflation around the time of the 1997 financial crisis despite a sharp rise in actual inflation as a result of severe exchange rate depreciation.

Figure 26: Inflation trend and shifts in monetary policy based on selected rules/benchmarks



Source: Authors' calculations

Therefore, while we do not suggest that monetary policy is the only factor that drives changes in inflation persistence, we are convinced that monetary policy has an important role in the determination of inflation persistence. Most importantly, the lack of monetary discipline will make the inflation process prone to becoming more persistent. That is, monetary policy that is more accommodative than what is suggested to be appropriate by a policy rule or an optimal benchmark (which already takes into consideration the output gap) would work to sustain inflation and could protract the effect of temporary shocks, whether from the supply or demand side, for several years to come.

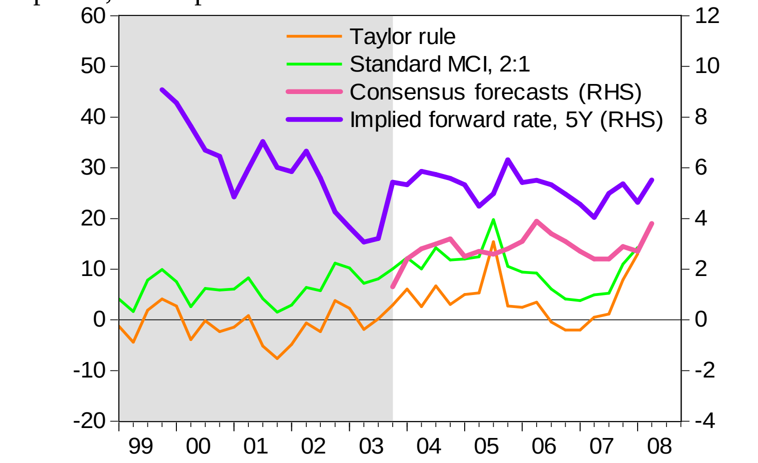
4.3 Inflation expectations and monetary policy

The results from section 4.2 leads naturally to the question of how monetary policy works to influence inflation persistence. Economic theory tells us that monetary policy can help anchor inflation expectations, and with well anchored expectations, the effect of temporary shocks are much less likely to become entrenched in the people's price setting behaviour. As a result, inflationary pressure will soon fade away as temporary shocks subside. On the contrary, when inflation expectations are easily influenced by current inflation, i.e. are poorly anchored, the impact of even one-time shocks that raise current inflation will tend to persist as people expect future inflation to stay just as high as today and thus bargain for higher wages, for instance, and tolerate high price increases in general. In addition, from Section 3.3, we learn that economic agents in Thailand are not entirely backward-looking, leaving room for monetary policy to influence their price setting behaviour through credibility of the central bank's inflation target, which would be maintained if and only if the central bank consistently demonstrates commitment to that target over time.

If monetary policy influences inflation persistence and trend inflation through inflation expectations, we would expect to observe rising (falling) inflation expectations and higher (lower) inflation persistence as monetary policy stays accommodative (restrictive). Unfortunately, data on inflation expectations are extremely limited in Thailand, as already mentioned in Section 3.3. Nonetheless, we plot the series together to get some idea whether or not they even seem to move in the expected manner.

Figure 27 shows selected inflation expectation indicators against measures of the monetary policy stance. Since 2004, inflation expectations appear to move consistently with what we expect; that is, inflation expectations tend to rise (fall) when monetary policy becomes more (less) accommodative. Such relationship, however, was not found prior to 2003, and that could be explained by a number of reasons, including the change in monetary policy regime to inflation targeting in May 2000, with the new regime taking time to gain credibility. Moreover, risk premium was likely to be high in the years shortly after the financial crisis. As the economy adjusted back to normal, risk premium fell, leading to the fall in the implied forward rate that was not attributable to falling inflation expectations. When we try to look for a statistical relationship between $\Delta_4\pi^e$ (the change in inflation expectation from four quarters ago) and average deviation from policy rule over the past four quarters, the relationship in 2004Q1-2008Q1 has the correct sign but is not significant at the five or ten percent significance level. It is occasionally significant at the fifteen percent significance level.

Figure 27 Inflation expectations and monetary policy



Source: Authors' calculations

Obviously, the issue of how monetary policy affects inflation expectations cannot be concluded by the evidence we offer at this stage. It thus remains an important research topic for the central bank and those who seek to understand inflation dynamics and their effective control.

To recap, in Part 4 we demonstrate that shifts in monetary policy do have a significant impact on inflation dynamics. In particular, if we have a simple monetary policy rule that takes into account both (1) deviation of inflation from its target level and (2) deviation of output from its potential level, substantial and prolonged divergences from the rule in the direction that indicates accommodative (restrictive) monetary policy tend to lead to higher (lower) inflation persistence. Moreover, there is some evidence in support of the proposition that monetary policy influences inflation dynamics in part through the formation of inflation expectations. In all, our findings are very much consistent with Milton Friedman's famous remark that *"inflation is always and everywhere a monetary phenomenon."*

The difficulty for policymakers, however, may not lie in whether or not they should strictly follow a monetary policy rule. There could be times when policymakers do not intend for monetary policy to be accommodative but end up otherwise. Factors that could lead to that are the inaccuracy in the real-time assessment of output gap and as discussed in Part 2, challenges in the assessment of the continuously changing nature of shocks entering our economy.

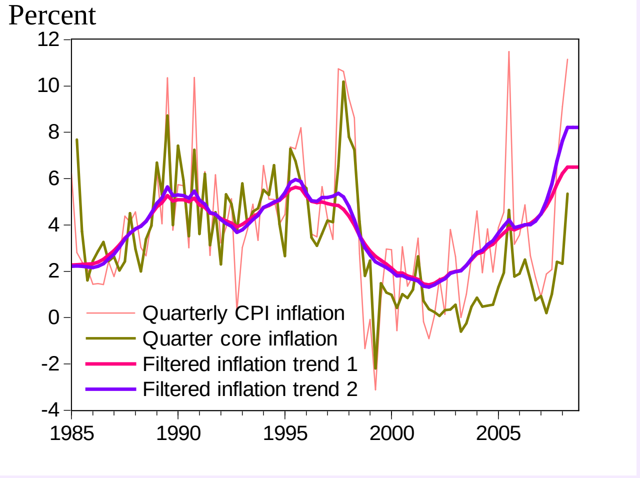
Box 1: Divergence between headline and core inflation

Thailand adopted the inflation targeting regime in May 2000. At the time, the target choice was core inflation, computed by subtracting prices of raw food and energy products known to be sensitive to temporary supply shocks away from the consumer price basket so that the target would reflect the underlying inflation trend and can be more effectively controlled by monetary policy. More importantly, core inflation demonstrated a close statistical relationship with headline inflation. Thus, it could be ascertained that monetary policy formulation under core inflation targeting would achieve price stability in the long-term and safeguard the cost of living that would normally be measured by headline inflation.

Since then, despite the fact that core, headline and trend inflation continue to move in the same direction, their statistical relationship has changed significantly. To be exact, **core inflation appears to be a lagging indicator of headline inflation and trend inflation at times. Moreover, it consistently remains below the other two measures, with no definite signs of convergence in the near term** (Figure 28). This phenomenon is mainly caused by structural changes in the dynamics of fresh food and energy prices during the last five years or so, as discussed in Part 2. It can also be seen that such changes have not been adequately reflected in core inflation, effectively removing its ability to accurately track the real cost of living measured by headline inflation and its trend inflation. (Figure 29) As a result, if the central bank continues to focus too much on core inflation, it could run the risk of moving too late.

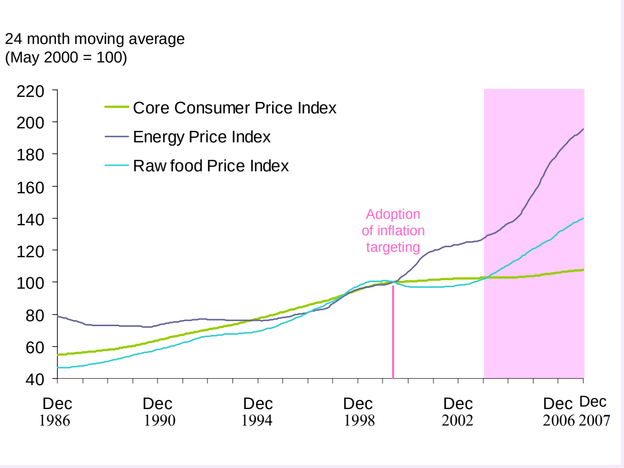
Under the outlook that structural changes in the dynamics of fresh food and energy prices may continue for more periods to come, we may very well continue to observe the prolonged divergence between headline and core inflation. As such, the challenge remains in rethinking the appropriateness of core inflation both as a measure of underlying inflation and as a meaningful inflation target for the Thai economy.

Figure 28
Core, CPI and trend inflation



Source: Minister of Commerce and authors' calculations

Figure 29 Breakdown of core, raw food and energy prices



Source: Minister of Commerce and authors' calculations

5. Conclusion

Our motivation for this paper originates from the currently divided public opinion regarding the present episode of inflation. On the one side, arguments rest on the fact that because current inflation arises from supply-side factors that are beyond the control of monetary policy, a tightening stance is therefore not needed. Rather, monetary policy should become more accommodative to alleviate the financial burden on businesses and consumers. On the other hand, the opposite side views that monetary policy must be tightened to relieve pressures from the continuously high resource utilization and gradually accelerating inflation expectations. Given these differences in opinion and that the understanding of inflation dynamics and their governing factors are of utmost importance to the conduct of monetary policy, our paper sets out to provide some clarifications and answers to the issues at hand.

We begin with an analysis of historical developments in Thailand's inflation where we find that global supply shocks, particularly oil and farm price shocks, greatly affected our past inflation movements. Up until the early 2000s, these shocks were mostly temporary in nature, implying only short-lived direct effects on inflation. Since 2003, however, the prices of oil and farm products rose continuously, with the volatility of oil in particular averaging much higher than historical records. Such developments stemmed from a combination of structural changes in the demand and supply of these commodities, resulting in market tightness that further gave rise to more exacerbated impacts of shocks. Overall, the findings tell us that recent shocks in commodity prices are driven no longer purely by supply disruptions but also by the upwardly trending demand. Given so, these shocks are unlikely to disappear so soon or on their own.

We proceed to empirically assess the dynamics of Thailand's inflation by employing two univariate inflation models, namely a simple autoregressive model and an unobserved component model, and one multivariate inflation model, namely the hybrid New Keynesian Phillips Curve model. Three important findings emerge from our study. First, there were two breaks in the inflation process, one occurring in the early 1970s and another towards the end the 1970s or the early 1980s. Further analysis of disaggregated CPI data reveals that these dates were common among all disaggregated series, suggesting a common pervasive cause. Secondly, inflation persistence is found to be higher between the two break dates no matter which univariate inflation model is used. Given that the short-lived supply shocks during this period could at best partly account for this observation, we find that an additional force, i.e. accommodative monetary policy, was likely to be responsible. Lastly, we also find that inflation expectation played a part in governing Thailand's inflation dynamics, thus providing support for the role of monetary policy.

We then take the investigation on the role of monetary policy further. Through estimations based on the concept of deviations of monetary policy stance from those implied by standard policy rules, e.g. the Taylor rule and the optimal policy rule for an open economy, we find convincing evidence to suggest that an accommodative (strict) monetary policy stance tended to coincide with an increase (decrease) in inflation persistence. Moreover, there is some evidence in support of the proposition that monetary policy influenced inflation dynamics in part through the formation of expectations.

In summary, our evidence seems to set a case that monetary policy matters regardless of the causes of inflation. We can see this even under a benign and supportive environment or the period of "good luck" of the past where monetary policy stance that was too loose alone could already affect inflation persistence. Now, faced with adverse shocks and increasing challenges, e.g. "bad luck", monetary policy will become all the more important as it must remain a strong pillar of strength and stability for the overall economy.

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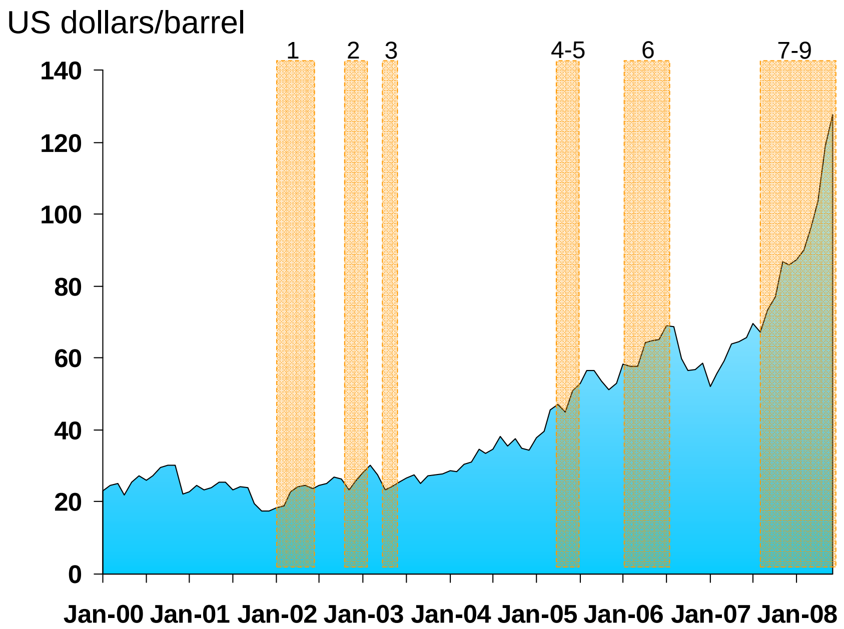
Appendix A Oil price and major geopolitical events between 2002-present

Figure A.1
Dubai oil price during 2002-2008



Major geopolitical events

Event	Brief description
1	Unrest in Venezuela and growing tensions in the Middle-east
2	Strike in Venezuela and continued conflict in Iraq
3	Military actions in Iraq
4	Continued supply disruptions in Iraq and Nigeria
5	Military attacks in Nigeria
6	Continued conflict in Iraq, North Korea missiles launch, war between Israel and Lebanon
7	Ongoing tensions in Eastern Turkey
8	Continued tensions in Nigeria
9	Growing tensions between Israel and Iran

Sources: Bloomberg, EIA Annual Oil Market Chronology 2007, http://www.en.wikipedia.org

Appendix B: The unobserved components (UC) model without an AR(1) term

Stock and Watson (2002, 2006) use the unobserved components (UC) model and the unobserved components with stochastic volatility (UC-SV) model to study the U.S. inflation process. Both are parsimonious models which decompose the univariate process of quarterly inflation into two components: (1) a random walk component that reflects the underlying trend, and (2) a serially uncorrelated shock component. The UC model can be written simply as follows:

$\pi_t = \tau_t + \eta_t$ with η_t being serially uncorrelated $(0, \sigma_\eta^2)$

$\tau_t = \tau_{t-1} + \varepsilon_t$ with ε_t being serially uncorrelated $(0, \sigma_\varepsilon^2)$

$Cov(\eta_t, \varepsilon_t) = 0$

The model allows one to look at the relative importance of the trend and random disturbances. Note first that disturbances to the random walk component, ε_t, persist indefinitely and thus affect the trend inflation rate going forward. On the other hand, the random disturbance η_t leads to only transitory fluctuations around the trend. Intuitively, when trend disturbances are important relative to temporary disturbances, inflation becomes highly persistent. That is because when inflation starts to go up, the trend component also goes up, and as a result inflation tends to stay up going forward. On the contrary, when temporary shocks are more important, a change in inflation tends to come from a change in the temporary component. In this case, the trend component is not affected and fluctuations in inflation soon fade away, implying a less persistent inflation process.

As it turns out, the relative importance of the trend and random disturbances in this setup depends on their respective variances, σ_ε^2 and σ_η^2. To see this, we allude to the derivation by Cecchetti *et al.* (2007). They first note that the first-difference of inflation can be written as:

$$\Delta\pi_t = \Delta\tau_t + \Delta\eta_t = \varepsilon_t + \eta_t - \eta_{t-1} \qquad \text{(B.1)}$$

The first-order autocorrelation of the *change* in inflation, $\rho_{\Delta\pi}$, can be thought of as a summary of the persistence of the inflation process, and it can be expressed as follows:

$$\rho_{\Delta\pi} = Cov(\Delta\pi_t \Delta\pi_{t-1}) / Var(\Delta\pi_t^2) = -\sigma_{\eta,t}^2 / [2\sigma_{\eta,t}^2 + \sigma_{\varepsilon,t}^2] \qquad \text{(B.2)}$$

The autocorrelation $\rho_{\Delta\pi}$ ranges between -0.5 and 0. When the permanent component is more important, σ_ε is large relative to σ_η, and the closer inflation is to a pure random walk with $\rho_{\Delta\pi}$ equal to 0. In other words, when σ_ε is large, the trend component moves around a lot, and thus trend inflation becomes unanchored, leading to high inflation persistence. In contrast, when the temporary component is more important, σ_ε is small relative to σ_η, and the closer inflation is to a stationary white noise process with $\rho_{\Delta\pi}$ approaching -0.5.

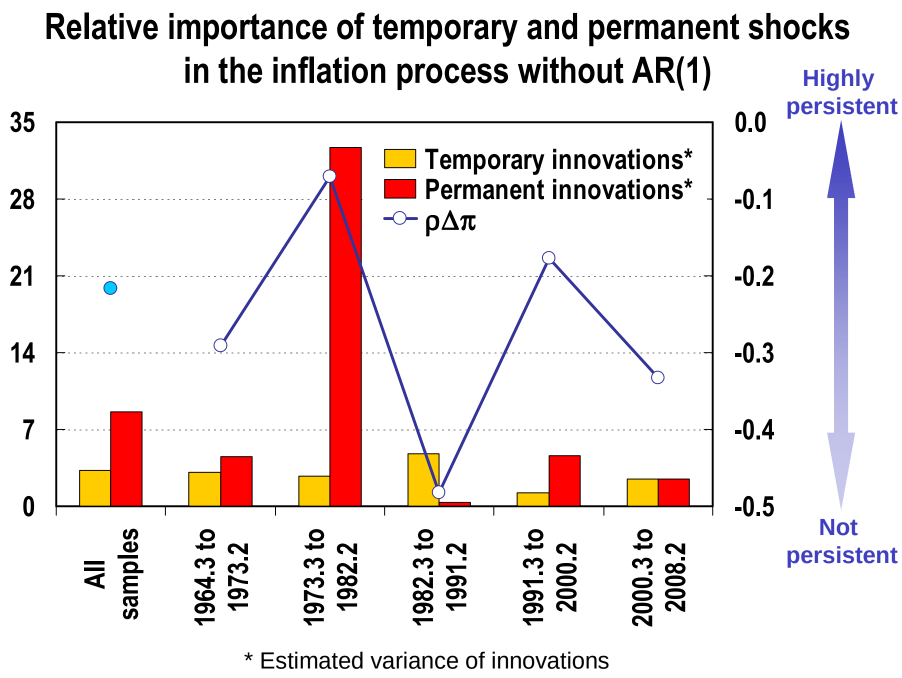
When we apply the model to Thailand's CPI data over five non-overlapping periods of equal length[44], we find that the relative importance of the trend and random disturbances does seem to vary over time. Table B.1 and Figure B.1 provide the estimated values of σ_ε^2 and σ_η^2 for each period, as well as the implied $\rho_{\Delta\pi}$ value which in turn suggests the degree of inflation persistence.

Table B.1 Estimated values of parameters of interest

Global environment	**1964.3 – 2008.2**	**1964.3 – 1973.2**	**1973.3 – 1982.2**	**1982.3 – 1991.2**	**1991.3 – 2000.2**	**2000.3 – 2008.2**
	Whole sample	Pre-oil shocks	Oil shocks and lax monetary policy	The Great Stabilization	The Great Moderation	Concurrent rises in oil and farm prices
No. obs.	176	36	36	36	36	32
UC parameters (Std. err.) using no priors:						
σ_η^2	3.268 ** (1.049)	3.135 (1.708)	2.814 (10.191)	4.778 ** (1.164)	1.270 (1.195)	2.497 ** (0.914)
σ_ε^2	8.592 ** (1.466)	4.487 (2.377)	32.494 ** (14.652)	0.359 (0.366)	4.557 ** (1.956)	2.498 ** (1.066)
$\rho_{\Delta\pi}$	-0.216	-0.291	-0.074	-0.482	-0.179	-0.333
Degree of persistence		Low	Very high	Very low	Somewhat	Low
P-values are reported in parentheses. * and ** denote significance at 10 and 5 percent, respectively. $\rho_{\Delta\pi}$ = $Cov(\Delta\pi_t,\Delta\pi_{t-1}) / Var(\Delta\pi_t^2)$, with a value closer to -0.5 implying less persistence.						

[44] With the exception of the last period that is shorter than the others by 4 quarters. We also experiment by varying the cutoff dates, and the results are fairly robust.

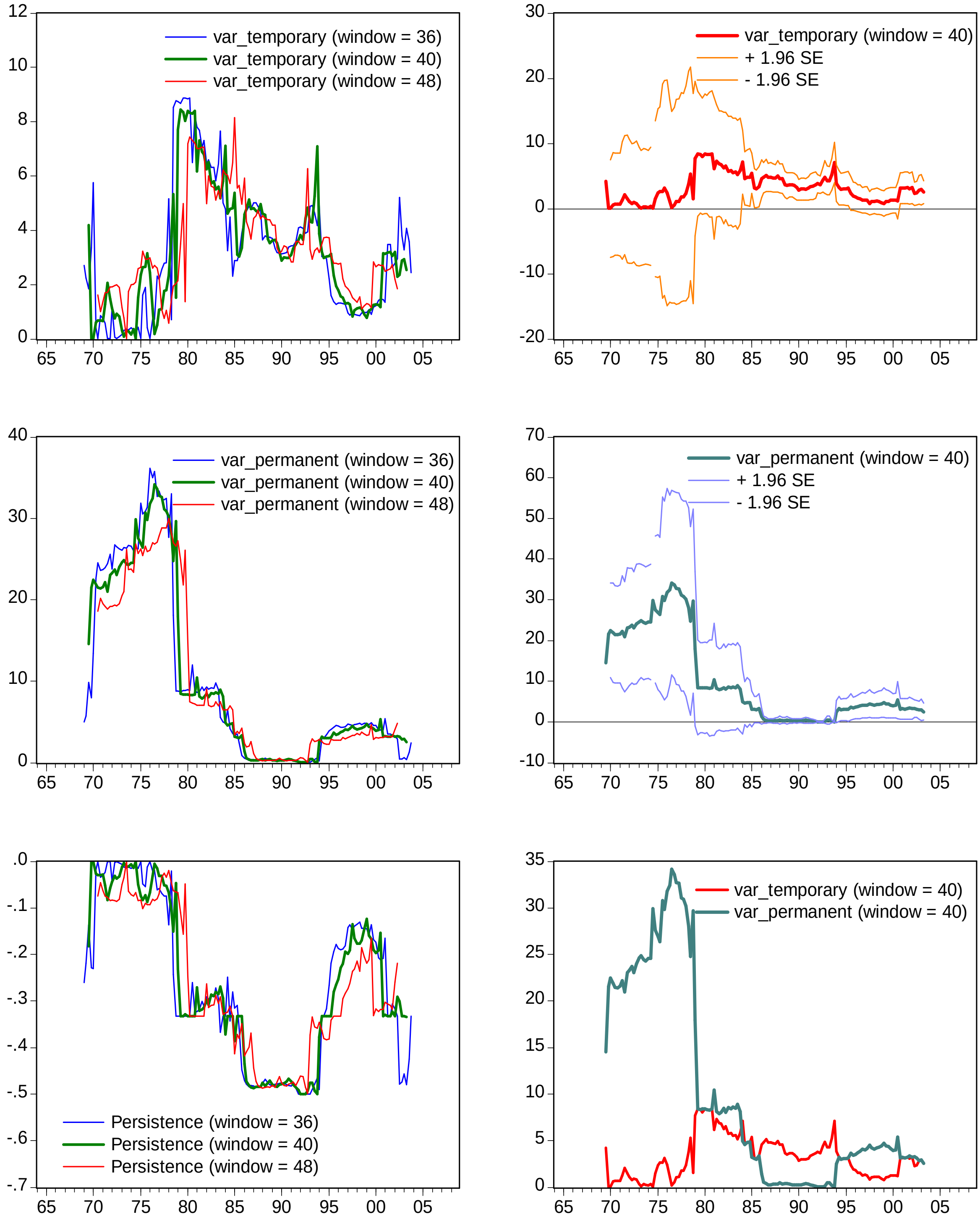
Figure B.1



Source: Authors' calculations

We also use rolling regressions, varying the window length between 36 and 48 periods, to capture the evolution of the relative importance of temporary and permanent disturbances. The results lead to a couple of interesting observations. First, while the variance of temporary disturbances evolved over time, its movements were far less pronounced compared to the changes in the variance of permanent disturbances (Figure B.2, bottom-right). This suggests that the drop in the variance of permanent disturbances contributed at least somewhat to the decline in inflation persistence around 1980.

Figure B.2



Source: Authors' calculations

Second, prominent changes in the variance of permanent disturbances coincided with the well-established dating of key monetary policy shifts. The variance was strikingly high throughout the 1970s and began to fall around 1980 with the start of the Great Stabilization, when major central banks around the world fought more vigorously against inflation. At the time, Thailand's monetary policy was tied to the U.S. monetary policy through the U.S. dollar-dominated pegged exchange rate, so our monetary policy stance was expected to be broadly in line with that of the U.S. The variance of permanent disturbances fell further in the late 1980s and stayed very, very low in the early 1990s. The pickup in the variance of permanent disturbances in the latter half of the 1990s was close to the time of the Asian financial crisis, when there was a switch in Thailand's monetary policy regime and central bank credibility was severely impaired. The evolution of the variance of permanent disturbances thus seem to track the evolution of monetary policy fairly well, and so there is some indication that monetary policy is a good candidate for the factor that is largely responsible for the changes in the variance of permanent disturbances and hence is likely to play a nontrivial role in governing the persistence of the inflation process.

Third, comparing the results from the UC model without AR(1) against the results from the UC model with AR(1), which should be a better representation of the inflation process in Thailand as argued in Part 3, we find that they are broadly consistent. The results here thus provide a useful affirmation of the robustness of our findings.

Appendix C: GMM Estimation of the hybrid NKPC using Andrews (1991)

Table C.1: Estimation of the NKPC under adaptive expectation with perceived anchor

No.	Choice of real marginal cost (RMC)	ω_1	ω_2	λ	Adjusted R^2	Hansen-$J^{(1)}$
1	PM adjusted RMC from mean	0.51 **	0.52 **	0.07 **	0.32	0.64
2	PM adjusted RMC from HP trend	0.33 **	0.72 **	-0.00	0.30	0.81
3	NONF adjusted RMC from mean	0.32 **	0.52 **	0.07 **	0.35	0.71
4	NONF adjusted RMC from HP trend	0.26 **	0.79 **	-0.01	0.27	0.85
5	Dubai adjusted RMC from mean	0.14 **	0.86 **	0.02 **	0.40	0.75
6	Dubai adjusted RMC from HP trend	0.24 **	0.78 **	-0.00	0.28	0.73
7	HP output gap	0.17 **	0.83 **	0.01	0.29	0.69
8	CAPU from mean	0.14	0.87 **	0.00	0.26	0.65
9	CAPU from HP trend	0.29 **	0.74 **	0.00 **	0.28	0.74

* and ** denote significance at 10 and 5 percent, respectively; (1) displays the p-values for the Hansen J-statistic test of over-identification; list of instruments include 3 lags of HP trend output gap, marginal cost, Dubai oil price, non-fuel commodity price, wage and expected inflation. All variables are in log-difference except those calculated as the percentage deviation from the HP trend

Table C.2: Estimation of the NKPC under constant inflation expectation

No.	Choice of real marginal cost (RMC)	ω_1	ω_2	λ	Adjusted R^2	Hansen-$J^{(1)}$
1	PM adjusted RMC from mean	0.28 **	0.70 **	0.06 **	0.36	0.59
2	PM adjusted RMC from HP trend	0.32 **	0.72 **	0.00	0.31	0.62
3	NONF adjusted RMC from mean	0.15 **	0.78 **	0.03 **	0.37	0.61
4	NONF adjusted RMC from HP trend	0.13	0.88 **	-0.02	0.21	0.69
5	Dubai adjusted RMC from mean	0.12 *	0.84 **	0.01 **	0.39	0.63
6	Dubai adjusted RMC from HP trend	0.24 **	0.79 **	-0.01	0.26	0.64
7	HP output gap	0.18 **	0.83 **	0.01	0.30	0.50
8	CAPU from mean	0.14	0.85 **	0.00	0.21	0.66
9	CAPU from HP trend	0.30 **	0.71 **	0.00 **	0.28	0.66

* and ** denote significance at 10 and 5 percent, respectively; (1) displays the p-values for the Hansen J-statistic test of over-identification; list of instruments include 3 lags of HP trend output gap, marginal cost, Dubai oil price, non-fuel commodity price, wage and 2 lags of past inflation. All variables are in log-difference except those calculated as the percentage deviation from the HP trend

Appendix D: The impact of globalization

Table D.1 Estimated impact of globalization (Newey-West)

No.	Choice of real marginal cost (RMC)	λ_1	λ_2	Wald tests of equality
1	PM adjusted RMC from mean	0.08 **	-0.11 **	0.36
2	PM adjusted RMC from HP trend	-0.00	-0.00	-
3	NONF adjusted RMC from mean	0.08 **	-0.07 **	0.50
4	NONF adjusted RMC from HP trend	-0.01	-0.03	-
5	Dubai adjusted RMC from mean	0.00	0.02 *	-
6	Dubai adjusted RMC from HP trend	0.03 **	-0.03 **	0.44
7	HP output gap	0.07 **	-0.11 **	0.19
8	CAPU from mean	-0.00	0.00	-
9	CAPU from HP trend	0.00 **	-0.00 **	0.59

* and ** denote significance at 10 and 5 percent levels, respectively. Figures in the column for the Wald tests of equality denote *p-values* where acceptance of the null hypothesis implies that $\lambda_1 = -\lambda_2$

Table D.2 Estimated impact of globalization (Andrews)

No.	Choice of real marginal cost (RMC)	λ_1	λ_2	Wald tests of equality
1	PM adjusted RMC from mean	0.09 **	-0.12 **	0.43
2	PM adjusted RMC from HP trend	-0.00	-0.00	-
3	NONF adjusted RMC from mean	0.08 **	-0.07 **	0.50
4	NONF adjusted RMC from HP trend	-0.01	-0.04	-
5	Dubai adjusted RMC from mean	0.01	0.01	-
6	Dubai adjusted RMC from HP trend	0.03 **	-0.03 **	0.44
7	HP output gap	0.08 **	-0.08 **	0.96
8	CAPU from mean	-0.00	0.00	-
9	CAPU from HP trend	0.00 **	-0.00	-

* and ** denote significance at 10 and 5 percent levels, respectively. Figures in the column for the Wald tests of equality denote *p-values* where acceptance of the null hypothesis implies that $\lambda_1 = -\lambda_2$

Appendix E: Robustness of the hybrid NKPC

E.1 Alternative specifications

To ensure the robustness of our results, we also employ an additional case of perfect foresight inflation expectation assumption, i.e. assuming that expected inflation in period t+1 is equal to actual inflation in the corresponding period. We find that the size of ω_1 varies between 0.40 – 0.45. However, we caution readers against taking these estimates at face value given that the estimations tend to over-estimate the extent of forward looking behaviour given that actual future inflation, our proxy for inflation expectation, is by construction highly correlated with current inflation. In the case of constant inflation expectation, we also employ an alternative constant of 2.5 as an additional test. The results are in line with the findings presented in Part 3 and thus are not reported here in details.

E.2 Instrument relevance

One potential weakness of GMM is the issue of instrument relevance, i.e. weak identification problem. If the instruments are only marginally relevant, or weak, the GMM estimators may be biased. Formal tests of instrument strength generally rely on the estimation of the first-stage *F-statistics* (Baum and Schaffer [2002]), which in essence identifies whether the instruments are statistically significant determinants of the GMM regressors. We use the same underlying concept to test the validity of our instruments by regressing:

$$Y_t = \sum_{i=0}^{n} \beta_i X_{it} + \varepsilon_t \qquad \text{(E.1)}$$

where Y and X denote our GMM regressors (various measures of real marginal cost, output gap, CAPU, expected inflation and lagged inflation) and our list of instruments, respectively. The results are presented in Table E.1 below.

Table E.1 Tests for instrument relevance

No	Choice of RMC	Dependent variables		
		Expected inflation	Inflation	RMC/HP Gap/CAPU
1	PM adjusted RMC from mean	3.35 ** (0.00)	8.44 ** (0.00)	0.78 (0.70)
2	PM adjusted RMC from HP trend	3.38 ** (0.00)	8.33 ** (0.00)	2.82 ** (0.00)
3	NONF adjusted RMC from mean	3.53 ** (0.00)	8.37 ** (0.00)	1.59 (0.11)
4	NONF adjusted RMC from HP trend	3.40 ** (0.00)	8.36 ** (0.00)	4.42 ** (0.00)
5	Dubai adjusted RMC from mean	2.98 ** (0.00)	8.50 ** (0.00)	1.96 ** (0.04)
6	Dubai adjusted RMC from HP trend	3.04 ** (0.00)	8.49 ** (0.00)	9.18 ** (0.00)
7	HP output gap	3.60 ** (0.00)	8.73 ** (0.00)	43.31 ** (0.00)
8	CAPU from mean	3.60 ** (0.00)	8.73 ** (0.00)	2.31 ** (0.00)
9	CAPU from HP trend	3.60 ** (0.00)	8.73 ** (0.00)	7.38 ** (0.00)
Figures in parentheses denote the p-values. GMM instruments are used as regressors.				

In general, we find that the instruments employed in our analysis of the NKPC are relevant determinants of our regressors although a few instances of potential weakness are present. Overall, we feel that our results remain reliable and robust given that whenever possible, alternative specifications and methodologies are explored. Nevertheless, as noted, we remain mindful of our analysis especially given data limitations and urge readers to do so as well. For future work, we encourage researchers to explore other estimation methodologies that can further improve the robustness of our analysis. In particular, following authors like Kurmann (2002), Bakrbu and Batini (2005) and Ma (2002), uses of limited or full information maximum likelihood (LIML/FIML) or continuous updating GMM may be worth exploring.