Discussion Paper No. 1303

ISSN (Print) 0473-453X
ISSN (Online) 2435-0982

REVISITING THAILAND'S PHILLIPS CURVES: A GRANULAR PANEL DATA APPROACH

Arisa Chantaraboontha

February 2026

The Institute of Social and Economic Research
The University of Osaka
6-1 Mihogaoka, Ibaraki, Osaka 567-0047, Japan

Revisiting Thailand's Phillips Curves: A Granular Panel Data Approach

Arisa Chantaraboontha*

February 13, 2026

Abstract

This paper employs disaggregated panel data to examine the evolution of Thailand's Phillips Curve (PC) before and during the pandemic, providing empirical evidence on the nature of Thai inflation dynamics and their implications for optimal monetary policy formulation. Utilizing the real output gap derived from various methodologies, the findings reveal a relatively flat PC for Thailand, with a slightly steeper curve after COVID-19. In addition to domestic demand, external demand—reflected through global energy prices and food prices—played a significant role in Thailand's inflation dynamics. The Thai PC exhibits both backward-looking and forward-looking behavior, with a more weight on inertia parts. In addition to the price PC, the empirical evidence supports the presence of a wage PC, with coefficients comparable in magnitude to those for non-tradable inflation, suggesting that wage dynamics constitute a driver of non-tradable price developments. Meanwhile, staggered real wage setting is found to contribute to the backward-looking component of Thai inflation. Under an optimal inflation-targeting monetary policy, greater weight is placed on closing the inflation gap during normal periods, with even more emphasis during high-inflation episodes. This result, however, does not hold when the output gap is measured using the HP filter in the policy optimization.

Keywords: Optimal monetary policy, Phillips curve, Thailand's inflation, Pandemic crisis, tradable inflation, non-tradable inflation, disaggregated data, Bank of Thailand

*Graduate School of Economics, The University of Osaka, Email: u444398i@ecs.osaka-u.ac.jp

1 Introduction

Since the introduction of the traditional Phillips Curve by Phillips (1958), economists have continued to engage in an ongoing theoretical debate. The New Keynesian Phillips Curve (NKPC) [1], based on the early contributions of Taylor (1980), Calvo (1983), and Fischer (1997), has remained a central framework to modern monetary policy, though key empirical issues remain to be examined.

Given the historical sensitivity of the Phillips Curve to economic disruptions, its true shape remains controversial—whether it flattened during the 1990s (Kuttner and Robinson, 2010; Szafranek, 2017) [2] or has steepened in the aftermath of the COVID-19 pandemic, potentially exhibiting kinks or non-linearities (Hobijn et al., 2023; Gudmundsson et al., 2024; Benigno et al., 2023).[3] For Thailand, Bhanthumnavin (2002), Press (2009) and Sakurai (2016) found that the Phillips curve statistically emerged in Thailand only after the onset of the Asian crisis in 1997, with a relatively flat slope (Bhanthumnavin, 2002).[4] The evolving slope of the Phillips Curve complicates optimal monetary policy. Studying EU and US data, Smith et al. (2023) found that a kink in the Phillips Curve led central banks to react more aggressively due to uncertainty from steepening price developments.

Regarding data granularity, prior studies on the Phillips Curve have largely relied on aggregated data, with limited use of disaggregated or panel data, which can reveal heterogeneity[5] often overlooked in aggregate analyses. The regional or local panel data also enables

[1]The main features of the New Keynesian Phillips Curve (NKPC) assume that agents are rational when optimizing their wage and price adjustments. However, nominal rigidities in the economy prevent agents from adjusting wages and prices instantaneously in response to shocks, creating a short-run tradeoff between inflation and overall demand.

[2]attributing this trend to factors such as globalization (Kuttner and Robinson, 2010), well anchored inflation expectations (Williams, 2006) and increased goods competition from China (Smith et al, 2023)

[3]Explanations for this shift vary, ranging from delays in goods restocking (Alessandria et al., 2023), supply constraints (Gudmundsson et al., 2024; Comin et al., 2023) to a tight labor market (Benigno et al., 2023) and the impact of massive fiscal stimulus (Di Giovanni et al.,2023; de Soirees et al., 2024)

[4]In terms of contributing factors, import prices (Bhanthumnavin, 2002), energy prices (Nookhwun and Manopimoke, 2023) as well as global output gap (Manopimoke, 2015) have all been found to significantly influence Thailand's inflation dynamics.

[5]Regional disparities in both inflation and output are driven by factors such as regional industrial struc-

us to conduct a more plausible and timely empirical assessment with short period of the samples (Kishaba and Okuda, 2023). Smith et al. (2023), Kumar and Orrenius (2016), as well as Kishaba and Okuda (2023) confirms the kinked or nonlinearity of Phillips Curve in the United States [6] , which cannot be evidently found in national-level data. In the literature on Thailand's Phillips Curve, studies using disaggregated data to derive policy implications remain a gap.

Based on this motivation, this paper aims to empirically investigate Thailand's evolving Phillips Curve before and during the pandemic, using disaggregated data to shed light on inflation dynamics and policy implications from a provincial perspective.

Regarding variation in estimation, measuring potential output with alternative of methodology significantly impacts the measurement of the Phillips Curve (Bhanthumnavin, 2002).[7] While traditional univariate methods, like the Hodrick-Prescott filter (HP) and the quadratic detrending (QT), impose prior smoothness on the cycle or trend of the underlying factors, the model-based univariate approaches, such as Beveridge-Nelson decomposition (BN), do not.[8] In addition, estimating tradable and non-tradable inflation separately can provide more meaningful insights into local inflation dynamics, their key determinants, and spillover responses. The use of granular wage inflation could also provide a broader perspective on the local transmission mechanism linking labor market dynamics to local price movements. These issues should be addressed in empirical literature.

---

tures, labor market conditions, local supply-demand dynamics, and localized economic policies.

[6]Smith et al. (2023), employed state-level data and Bayesian panel regression with breakpoints confirmed the presence of a kinked Phillips Curve in the United States under tight labor market conditions, which cannot be evidently found in national-level data. Likewise, Kumar and Orrenius (2016) uncovered nonlinearity and strong convexity in the United States' state-level wage-price Phillips Curve with significant variation in the slope and form of the curve across states. In Asia, Kishaba and Okuda (2023) used prefecture-level panel data on service prices in Japan, confirming a flattened Phillips Curve in the 2000s but cannot captured a structural change in the slope of the Phillips Curve during the pandemic.

[7]From a policy formulation perspective, failing to accurately detect or assess potential output in line with real-time economic conditions can be risky—especially during periods of significant changes in potential output. (Chuenchoksan et al., 2008).

[8]Zhang and Murasawa (2011) applied the BN decomposition method to estimate potential output for China. Their findings indicated that this approach statistically outperformed traditional measures and significantly improved the explanation of China's inflation dynamics.

The exploration of forward- and backward-looking inflation dynamics has yielded contrasting findings. For the US case, Gali and Gertler (1999) confirmed the presence of both forward- and backward-looking behavior, with the more statistically significant role of forward-looking components.[9] Likewise, Ikeda et al. (2022) highlighted the necessity of including sectoral price and nominal wage rigidities, as well as uncertainty in inflation expectations when discussing Japan's price developments. In contrast, other studies have empirically found a more statistically significance in backward-looking behavior in some emerging Asia economies (Bhanthumnavin, 2002; Kim and Lee, 2013; Taguchi and Sohn,2014). For the case of Thailand, while some empirical studies confirmed strongly backward-looking inflation dynamics (Bhanthumnavin, 2002; Press, 2009), another study found relatively more forward-looking behavior (Sakurai, 2016), warranting further investigation.

This paper contributes to the existing literature on Thailand's Phillips Curve by: 1) utilizing provincial-level panel data to reexamine Thai Phillips Curve across provinces, both before and after the pandemic, with multiple methodologies for output gap estimation as well as alternative inflation choices. 2) reexamining the behavior of inflation expectations in Thailand with provincial perspectives, and 3) highlighting how changes in the Phillips Curve's slope pose challenges for optimal monetary policy.

The findings confirm a relatively flattened Phillips Curve for Thailand in terms of headline inflation and non-tradable inflation, but do not show a statistically significant relationship for a tradable inflation as similarly found in prior papers. External demand conditions, reflected in the dynamics of energy and food prices, play a significant role in shaping Thai inflation dynamic—consistent with findings of Nookhwun and Manopimoke (2023). After COVID-19, I find that the Thai Phillips Curve exhibits nonlinearity, represented by a mildly steepening slope driven by domestic demand and external prices, reflecting the rebound in global demand.

[9] Additionally, Choi (2021) discovered that the influence of forward-looking behavior diminishes as the inflation horizon lengthens.

In addition, the Thai Phillips Curve displays both backward-looking and forward-looking components, with inertia playing a dominant role. The estimated slopes of the non-tradable Phillips Curve are comparable to those derived from wage inflation specifications, indicating that wage dynamics constitute a primary driver of non-tradable inflation. The wage-price linkage is confirmed for Thailand. Under an optimal inflation-targeting mandate, the inflation gap is assigned relatively greater weight during stable periods and an even more weight during high-inflation episodes. However, this result in time of price crisis does not longer holds when the output gap is constructed using the HP filter.

The remainder of the paper is organized as follows: Section 2 provides details on the data and methodology employed in this study. Section 3 illustrates the Phillips Curve framework and the empirical findings. Section 4 conducts an empirical study of optimal monetary policy with diversified specification of output gap in Phillips curve. The final section concludes the paper.

2 Data and Methodology

2.1 Data

The granular-level panel data in this paper, shown in Table 1, consist of year-on-year figures measured at the end of each year. The data includes headline inflation, tradable inflation, non-tradable inflation, real GDP, and minimum wage, each representing 77 provinces in Thailand. The inflation data is sourced from Thailand's Ministry of Commerce, the real GDP is from the National Economic and Social Development Council (NESDC). The minimum wage data is derived from Ministry of Labor of Thailand and converted to real minimum wage. The timeframe spans from 2004 to 2022, falling entirely within the period after the Bank of Thailand adopted an explicit inflation target in 2000, eliminating the need to account for regime switching in the analysis.

[insert Table of Descriptive Statistics]

In addition, there are some selectively control variables representing external factors impacting Thailand's inflation dynamics: global energy prices and global food prices from the World Bank database, as well as the USDTHB exchange rate, all expressed as year-on-year changes on an annual basis. According to break point, the covid dummy is assigned from 2020 to 2022, indicating the accelerating inflation period since the onset of the pandemic. Lastly, the policy interest rate, taken from the Bank of Thailand database, is recorded at the end of each year.

2.2 Methodology

Regarding the choice of econometric methodology for the granular panel data, this study employs panel regressions with individual-specific fixed effects and time fixed effects, with standard errors clustered at the individual level, as the primary analytical framework.

For potential output estimation, various techniques exist, with the univariate approach being the most widely used, as it relies solely on information contained in the GDP time series (y_t). The common foundation of these methods is the decomposition of data into a trend component and a transitory or cyclical component. This paper focuses exclusively on the univariate approach, specifically the Hodrick- Prescott (HP) filter [10] , Quadratic detrending (QT) [11] and the Beveridge–Nelson decomposition (BN).[12]

[10] Hodrick- Prescott (HP) filter is the most common univariate approach, assuming that the underlying trend of output gap (τ_t^{HP}) evolves over time, controlled by a smoothing parameter (λ^{HP}), to minimize the loss between the fit to the data and the smoothness of the trend, as described in Hodrick and Prescott (1997). $\min \sum_{t=1}^{T} (y_t - \tau_t^{HP})^2 + \lambda^{HP} \sum_{t=1}^{T} \left[(\tau_{t+1}^{HP} - \tau_t^{HP}) - (\tau_t^{HP} - \tau_{t-1}^{HP}) \right]^2$

[11] Quadratic detrending (QT) assumes that the economy grows in a predictable and stable pattern such that the trend can be fitted in the following quadratic functional form: $\tau_t^{QT} = \alpha^{QT} + \beta^{QT} time + \gamma^{QT} (time)^2$. Given the rigid trend structure of quadratic detrending, the estimated trend is less responsive to shocks. For additional discussion on the use of deterministic polynomial trends in macroeconomic analysis, see Stock and Watson (1999).

[12] The Beveridge–Nelson (BN) decomposition assumes a stochastic trend that follows a unit root process, rooted in the ARIMA framework. Consequently, any shock becomes embedded in the estimated trend, making the BN trend well-suited to capturing permanent shocks. The output gap derived from BN decom-

The unconditional correlations of the real output gap derived from the three methodologies are as follows:

	HP	QT	BN
HP	1		
QT	0.98	1	
BN	0.83	0.84	1

Note: HP: Hodrick-Prescott filter, QT: Quadratic detrending, BN: Beveridge-Nelson decomposition

3 Theoretical Framework and Calibration

3.1 Price Phillips Curve Framework

Originally proposed by Phillips (1958), the traditional Phillips Curve posits a short-run relationship between the rate of wage inflation and the unemployment rate. It suggests that when the economy operates above its potential level, the unemployment rate falls below the Non-Accelerating Inflation Rate of Unemployment (NAIRU), exerting upward pressure on wages, which in turn feeds through to the overall price level in the economy. However, in the long run, economy and labor market will be at its potential level, indicating the Phillips Curve represents only a short run relationship of price dynamic and economic condition.

Due to lack of provincial unemployment rate, this paper optionally uses the real output gap as a measurement of domestic economic condition. [13] Using provincial-level panel data, I examine the evolving short-run relationship between Thailand's output gap and inflation through the lens of the traditional Phillips Curve as follows.

$$\pi_{pt} = \lambda \left(Y_{pt}^{m}\right) + \theta_p + \theta_t + \epsilon_{pt}$$

where π_{pt} is the year-on-year headline inflation of province p at time t. Next, Y_{pt} is the real

position therefore tends to convey richer information than those traditional method. For additional details, see Beveridge and Nelson (1981).

[13] One can apply Okun's law for Thailand, with an estimated coefficient ranging from –0.2 to –0.36. For additional details, see Kim et al. (2020) and Eyassu (2022).

output gap of province p at time t, which is constructed by method m: Hodrick-Prescott (HP) filter, Quadratic Detrending (QT) filter as well as Beveridge-Nelson (BN) decomposition. It should be noted that, in empirical analysis, the lagged real output gap at time $t-1$ is often used as an instrument variable for the real output gap at time t. Lastly, θ_p and θ_t represent a cross-sectional fixed effect as well as a time-fixed effect, and ϵ_{pt} is a cost push shock.

From a theoretical perspective, it is essential to strive for a deeper and more comprehensive understanding of the Phillips curve model, in accordance with the theoretical discussion in Hazell et al. (2022). Let's simply assume here that the transitory term of output gap, $\widetilde{y}_{pt}$,is computed as the deviation of domestic products, y_{pt}, from its permanent term of output, $\mathrm{E}_t\ \hat{y}_{t+\infty}$.

$$\widetilde{y}_{pt} = y_{pt} - E_t\left(\hat{y}_{t+\infty}\right)$$

The traditional Phillips curve, in iterative form, can therefore be rewritten as follows.

$$\pi_{pt} = \acute{\lambda} \sum_{i=0}^{\infty} \beta^i\ E_t\left(\widetilde{y}_{\ pt+i}\right) + \frac{\acute{\lambda}}{1-\beta} E_t\left(\hat{y}_{t+\infty}\right) + \theta_p + \theta_t + \omega_{pt}$$

Considering the above model, it becomes clear that current inflation is the result of an iterative process involving the discounted sum of expected future output gaps, where the discount factor is β. Also, long-run inflation expectations are equivalent to the discounted permanent component of output in long run such that $E_t(\ \pi_{t+\infty}) = \frac{\acute{\lambda}}{1-\beta} E_t(\ \hat{y}_{t+\infty})$. In this case the Phillips curve can be expressed as the follows.

$$\pi_{pt} = \acute{\lambda} \sum_{i=0}^{\infty} \beta^i\ E_t\left(\widetilde{y}_{\ pt+i}\right) + E_t\ (\ \pi_{t+\infty}\ ) + \theta_p + \theta_t + \omega_{pt}$$

For empirically identifying long-term inflation expectations, $E_t\left(\pi_{pt+\infty}\right)$, this term can be simply captured by time-fixed effects. This is because long-run inflation expectations are theoretically independent of current business cycles, being instead anchored to monetary policy commitments over the longer run, and are therefore constant across regions. Finally, let's assume for simplicity that $\widetilde{y}_{pt}$ follows an AR(1) process with autocorrelation coefficient equal to ρ_y. The summation term of output gap, $\sum_{i\,=\,0}^{\infty} \beta^i\, E_t\left(\widetilde{y}_{\,pt+i}\right)$, can be then expressed as $\varphi\ \left(\widetilde{y}_{\,pt}\right)$, providing that $\varphi\ = \frac{\acute{\lambda}}{1-\beta\rho_y}$.

$$\pi_{pt} = \varphi\ \left(\widetilde{y}_{\,pt}\right)\ +\ E_t(\ \pi_{t+\infty}) + \theta_p + \theta_t +\ \omega_{pt}$$

This proves that the estimated coefficient of λ in the reduced form of the first expression of the traditional Phillips curve is equivalent to φ. Based on this specification, the traditional Phillips Curve can be therefore interpreted as a special case of the New Keynesian Phillips Curve.

By incorporating a rational expectations term into the first model specification of the traditional Phillips Curve above, it yields the New Keynesian Phillips Curve as follows.

$$\pi_{pt} = \alpha_f\ E_t\left(\pi_{pt+1}\right)\ +\ \lambda\ \left(Y_{\ pt}^{\ m}\right)\ \ + \theta_p + \theta_t +\ \epsilon_{pt}$$

From theoretical perspective, this New Keynesian Phillips Curve can be shown as an iterative process involving the discounted sum of expected future output gaps, where the discount factor is β^i, as the following.

$$\pi_{pt} =\ E_t\left(\pi_{t+\infty}\right)\ + \lambda\ \sum_{i\,=\,0}^{\infty} \beta^i\ E_t\left(Y_{\ pt+i}^{\ m}\right)\ \ + \theta_p + \theta_t +\ \omega_{pt}$$

Referring to the literature that provides insights into the impact of long-run inflation on current inflation, Hazell et al. (2022) contributed part of the empirical work aimed at uncovering the reasons behind the disinflation during the Volcker era. They stated that the large change in inflation expectations was the primary cause of the rapid fall in inflation over this period, rather than higher unemployment working through a steep Phillips curve. Based on this, changes in beliefs about long-run monetary commitment, captured by time-fixed effects, can empirically have a significant impact on current inflation. Without controlling for such time-fixed effects, Hazell et al. (2022) find that a Phillips Curve specification misleadingly produces a 50–100 times steeper slope for the sample period in the 1990s.

3.2 Price Phillips Curve Calibration

Calibrating the slope of the Phillips curve remains a major technical challenge in the literature, particularly when inflation expectations co-move with the output gap. When using aggregate data, there is often insufficient variation to separately identify the coefficients on unemployment (or the output gap) and expected inflation (Mavroeidis et al., 2014). In such cases, employing disaggregated panel data, as done in this paper, can help mitigate this issue and enable a more reliable calibration of the Phillips curve slope.

Regarding fixed effects, beyond controlling for cross-sectional heterogeneity, accounting for time-fixed effects is also essential. While long-run inflation expectations tend to remain stable and anchored to monetary policy objectives across regions, absorbed by time-fixed effects, short-run expectations are more sensitive to localized shocks and current business cycle conditions. Incorporating an event-specific dummy can therefore provide more consistent and unbiased estimates when examining the impact of the output gap on inflation during the pandemic, as demonstrated in recent works by Ikeda et al. (2022) and Lasarte-Navamuel et al. (2025). Also, when time-fixed effects are controlled for, this paper finds a slightly higher Phillips Curve slope than in the case without such effects, consistent with Nishizaki and Watanabe (2000) as well as Hazell et al. (2022).

To construct a fully rational expectations model of Phillips Curve, this paper additionally incorporates an auxiliary COVID-19 dummy variable to examine whether a kink in the Phillips Curve emerges during the pandemic period in the case of Thailand, and to identify the potential underlying factors.

$$\pi_{pt} = \alpha_f \; E_t\left(\pi_{pt+1}\right) \; + \lambda \; \left(Y_{\;pt}^{\;m}\right) \; + \tau_y \; \left(D_t * Y_{\;pt}^{\;m}\right) + \tau_D \; \left(D_t * Z_t\right) \; + \zeta Z_t + \theta_p + \theta_t + \; \epsilon_{pt}$$

where D_t is a dummy variable for the COVID-19 period, with the starting point in 2020. Meantime, Z_t represents the external variables such as a global energy price index, a global food price index as well as the exchange rate movement of USDTHB. The time-specific effects, θ_t, collectively capture cross-sectionally invariant factors and major events, including the global oil price crisis of the 2000s, the 2007–2008 global financial crisis, Thailand's Great Flood in 2011 and Thailand's coup 2014. Importantly, during the simulation, time-specific effects can technically capture the impact of this isolated Z_t term.

Regarding the instrumental variable (IV) approach, $E_t(\pi_{p,t+1})$ denotes the expected headline inflation in province p at time $t + 1$. As this expectation is unobservable, it is proxied by the observable realized inflation rate, $\pi_{p,t+1}$. Both $\pi_{p,t+1}$ and the backward-looking component $\pi_{p,t-1}$ are treated as endogenous and instrumented using their own lagged values, which are predetermined and therefore known at time t. Similarly, the real output gap is instrumented by its lagged values, following standard practice in the literature.

Table 1 reports the first-stage regression results for all endogenous variables used in the empirical analysis. The Kleibergen–Paap rk Wald F-statistics indicate that the instruments are sufficiently strong. In addition, the Sargan overidentification test fails to reject the null hypothesis that the instruments are valid, providing further support for the IV specification.

[insert Table 1]

As shown in Table 2, the New Keynesian Phillips Curve with fully rational expectations is statistically valid for Thailand, exhibiting a relatively flat slope. The steepening of the curve during the pandemic is attributed to both domestic economic conditions and global energy prices.

[insert Table 2]

According to other empirical studies, particularly Gali and Gertler (1999), US inflation dynamics exhibit both a forward-looking expectations component and a significant inertial component. In contrast, prior studies on Thailand's inflation expectations report mixed findings, with some indicating strongly backward-looking behaviour and others suggesting forward-looking tendencies, highlighting the need for further investigation. To empirically address this issue, the inertia part (π_{pt-i}) was introduced into the simulation model. This formulation is known as the Hybrid New Keynesian Phillips Curve (HNKPC), serves as the main framework for the subsequent analysis of the Thai Phillips Curve in this paper.

$$\pi_{pt} = \alpha_f E_t\left(\pi_{pt+1}\right) + \alpha_b \pi_{\ pt-1} + \lambda\left(Y_{\ pt}^{\ m}\right) + \tau_y\left(D_t * Y_{\ pt}^{\ m}\right) + \tau_D\left(D_t * Z_t\right) + \zeta Z_t + \theta_p + \theta_t + \epsilon_{pt}$$

[insert Table 3]

According to Table 3, it is evident that both the rational expectation of future inflation and the inertial component played significant roles in shaping Thailand's inflation dynamics, with a stronger influence from the inertial (backward-looking) component. This finding aligns with some existing empirical literature on inflation behavior in Asian economies. The implication is that it remains challenging for the central bank of Thailand to anchor inflation expectations to some extent, given the persistent impact of past inflation among domestic optimizing agents. Furthermore, the significantly positive—though relatively flat—coefficient of the output gap, along with the COVID-19 interaction term, suggests the presence of a Phillips Curve in Thailand with a mild kink during the pandemic. The estimated magnitudes of the Phillips curve are consistent with the existing Thai literature (see Table 10), and the observed steepening of the Phillips curve during the pandemic aligns with empirical evidence from other countries. The primary factors contributing to the steepening of the Phillips Curve were the recovery in domestic and global demand during the post-COVID-19 period, particularly reflected in higher global energy prices.

Apart from HNKPC model calibration, performing a structural analysis can shed light on the underlying mechanisms of Thai inflation dynamics. To this end, I follow Gali and Gertler (1999), who offer a calibrated model of the Modified Hybrid New Keynesian Phillips Curve as the follows.

$$mc_{pt} = \kappa^* x_{pt} \quad (1)$$

$$\pi_{pt} = \lambda^* \, mc_{pt} + \gamma_f E_t\{\pi_{pt+1}\} + \gamma_b \pi_{pt-1} \quad (2)$$

$$\pi_{pt} = \lambda^* \kappa^* x_{pt} + \gamma_f E_t\{\pi_{pt+1}\} + \gamma_b \pi_{pt-1} \quad (3)$$

$$\text{where} \lambda^* = \frac{(1-\omega)(1-\theta)(1-\beta\theta)}{\phi},$$

$$\gamma_f = \frac{\beta\theta}{\phi},$$

$$\gamma_b = \frac{\omega}{\phi},$$

$$\phi = \theta + \omega\,[1 - \theta(1-\beta)]$$

where mc_{pt} is a marginal cost of province p at time t, x_{pt} is a real output gap of province p at time t, β is household discount factor (given 0.99), θ is Calvo probability of not changing prices in a given period, ω is a fraction of firms which is a backward-looking, ϕ is composite term, λ^* is marginal cost elasticity of inflation, κ^* is output gap–marginal cost elasticity.

[insert Table 4]

From Table 4, the calibrated parameters confirm that inertia in inflation (γ_b) carries greater weight than the expectations component (γ_f) in Thailand's inflation dynamics. When marginal cost—assuming labor is the sole factor of production—is converted to the real output gap, the calibrated impact of the output gap on marginal cost (κ^*) is found to be larger than the transmission of marginal cost to price changes (λ^*). This implies that wages, as the sole production cost, respond significantly to economic conditions, while price levels cannot adjust promptly to such evolving cost pressures due to price-setting behaviour. Specifically, the estimates suggest more than 0.5 Calvo price stickiness (θ) and a large share of firms with backward-looking behaviour (ω). On average, prices remain fixed for about two years in Thailand's inflation dynamics. This is similar to Apaitan et al. (2018), who found that the median duration of Thai prices ranged from one to two years depending on the inflation category.

3.3 Tradable vs Non-tradable inflation

Since aggregate prices comprise both tradable and non-tradable inflation, it is worthwhile to explore the use of different data for Phillips Curve calibration. Tradable goods prices are often set at the national level and adjusted infrequently, indicating little variation in prices despite fluctuations in the output gap across the business cycle and across provinces. When I calibrated the model using tradable inflation against various measures of the output gap, I found an insignificant coefficient, which aligns with economic intuition and literature.

a) Lagged real output gap as an instrument for real output gap

For non-tradable inflation, price movements are theoretically determined by local agents and are likely to exhibit substantial cross-province variation. Utilizing non-tradable price data, I found statistically significant coefficients on the expectation term, the lagged non-tradable inflation, and the lagged output gap along with its interaction term with the pandemic dummy, as shown in Table 5. Taken together, the statistical insignificance of domestic demand effects on tradable inflation and the robust results for non-tradable inflation support the interpretation that non-tradable prices constitute the primary channel through which demand shocks are transmitted to aggregate price dynamics.

[insert Table 5]

One should observe that both headline inflation and non-tradable inflation were similarly driven more by lagged components than by forward-looking components. During the pandemic, in addition to domestic demand conditions, foreign demand reflected in global food prices also played a significant role in steepening the slope of Thailand's non-tradable inflation across provinces. Using Thailand's Okun's law, the estimated Phillips curve slope of non-tradable inflation in this paper relatively matches the U.S. estimate by Hazell et al. (2022).

b) Bartik instrument for an output gap

Apart from using the lagged output gap as an instrumental variable, there is an alternative Bartik instrument, or shift-share instrument, based on Bartik (1991), which can be used to replace the lagged output gap for calibrating the slope of the Phillips Curve in the non-tradable inflation model.

The underlying assumption is that a similar exogenous impact—such as a national-level economic boom or bust (a shift)—would have different local effects (a share) depending on each region's exposure to such shock. The Bartik instrument is accordingly constructed by weighting the national shock with the localized share of that factor in a specific local economy.

Next, relying on the economic theory of the Balassa-Samuelson effect [14], Bartik (1991) and Hazell et al. (2022) use employment data and wages to construct a tradable-demand spillover instrument. A higher national demand shock in tradable goods leads to wage increases not only in the tradable sector but also in the non-tradable sector, as firms compete to retain labour in the non-tradable sector within a given region. Ultimately, the overall increase in wages feeds through to demand and the general price level of that a particular region.

Due to limitations in cross-provincial labour market data, I construct the Bartik instrument by using a 2-year growth rate of tradable GDP of each province, excluding province

[14] The Balassa-Samuelson effect refers to the phenomenon where countries with higher productivity growth in the tradable goods sector tend to experience higher overall price levels due to increased wages that spill over into the non-tradable sector, which does not experience the same productivity gains. This leads to real exchange rate appreciation in fast-growing economies, even in the absence of nominal exchange rate movements.

p, at time t instead. This exclusion offers the advantage of mitigating reverse causality, such as the possibility that a local economic boom could lead to higher local wages within the model specification. Accordingly, the shock from the national tradable sector would pass through to each local province unequally, depending on the weight structure of the tradable sectors in that province as previously mentioned.

$$TradableIV = \sum_T \bar{S}_{Tp} \times \Delta_{2Y} logT_{-p,t}$$

where $\bar{S}_{Tp}$ is an average share of all tradable sectors (T) of province p over time, and $\Delta_{2Y} logT_{-p,t}$ is a 2-year growth rate of tradable sector excluding province p at time t.

In Table 6, the Bartik instrument or Tradable-Spillover instrument is positively significant for non-tradable inflation, confirming that national tradable sector shocks pass through to provincial non-tradable sector and associated inflation in Thailand. This finding is consistent with existing literature from other countries and supports the underlying economic theory.

[insert Table 6]

3.4 Wage Phillips Curve Framework

The primary link between domestic demand—represented by the output gap—and overall headline inflation lies in the response of wages to changes in labour demand driven by economic conditions. While the price Phillips Curve has shown a weakening response to labour market and economic conditions in recent decades, wage dynamics remain more closely tied to domestic labour market condition, offering a more stable indicator for policymakers (Knotek and Zaman,2014). Adapting the model from Phillips (1958) and Galí (2011) due to lack of provincial unemployment data in Thailand, this section explores whether the rate of change of real wage can be explained by domestic demand pressure for the case of Thailand, and whether it provides a better measure of responsiveness to demand compared to prices.

This is given that π^w_{pt} is the rate of change of real wage of province p at time t.

$$\pi^w_{pt} = \alpha_f \; E_t \left(\pi^w_{pt+1}\right) + \; \alpha_b \pi^w_{pt-1} \; + \; \lambda \; \left(Y \; {}^m_{pt}\right) \; + \theta_p + \theta_t + \; \epsilon_{pt}$$

[insert Table 7]

From Table 7, real wages in Thailand responded positively and significantly to domestic demand, as measured by the output gap, with a steeper slope compared to that of the Price Phillips Curve—particularly when the output gap is derived from the BN decomposition. This suggests that wages serve as a more sensitive measure of demand conditions than prices, consistent with the findings of Phillips (1958) and Galí (2011), who also documented a strong link between wage dynamics and labour market conditions. More specifically, general prices are often influenced more by external factors than by domestic demand, thereby reducing the responsiveness of the Phillips curve slope to demand fluctuations.

Moreover, the estimated wage coefficients are comparable in magnitude to those associated with non-tradable inflation. Given that wages constitute a major component of operating costs in the services sector, this finding confirms that wage developments play a central role in non-tradable price formation in Thailand. Furthermore, the results indicate that wage dynamics place greater weight on past wage realizations than on forward-looking expectations, reflecting a high degree of inertia in wage adjustment.

3.5 Wage-linked and Augmented Hybrid NKPC

While wages respond well to labour market and domestic economic conditions, their linkage to inflation remains uncertain. Gordon (1997) claimed that the relation of wages to prices has changed over time. . . the Fed's goal is to control inflation, not wage growth. Similarly, Knotek and Zaman (2014) noted that wages and prices in the U.S. tend to move together, but they found that wages have limited ability to predict inflation. This section aims to empirically examine wage transmission to prices in Thailand using the Wage-linked

NKPC framework. In addition, it investigates whether the output gap–inflation relationship remains valid once the model is augmented with a wage factor.

a) Wage-linked NKPC

$$\pi_{pt} = \alpha_f \; E_t \left(\pi_{pt+1}\right) + \; \alpha_b \pi_{\; pt-1} \; + \; \alpha_w \; \pi^w_{pt-1} + \tau_y \; \left(D_t * \pi^w_{pt}\right) \; + \theta_p + \theta_t + \; \epsilon_{pt}$$

b) Augmented Hybrid NKPC

$$\pi_{pt} = \alpha_f \; E_t \left(\pi_{pt+1}\right) + \; \alpha_b \pi_{\; pt-1} + \alpha_w \; \pi^w_{pt-1} + \tau_y \; \left(D_t * \pi^w_{pt}\right) \; + \lambda \; \left(Y^{\;m}_{\;pt}\right) \; + \theta_p + \theta_t + \; \epsilon_{pt}$$

[insert Table 8]

The results in Table 8 confirm that real wages are statistically significant in explaining Thailand's wage–price dynamics, albeit with only a modest effect. This finding is consistent with structural analyses indicating that increases in real wages are only limitedly transmitted to the general price level, owing to factors such as menu costs, contractual rigidities, and market competition. However, the interaction term between real wages and the pandemic period is statistically insignificant, suggesting that real wages did not exert a distinct impact on inflation during the pandemic era.

Regarding the output–inflation relationship through the Phillips curve, the model is augmented with real wages, and the relationship is found to hold. The real wage factor itself exerts only a modest but significant effect on inflation. This highlights the important role of staggered wages in driving the backward-looking behaviour of Thai inflation. Overall, the empirical evidence confirms the existence of a consistent relationship between real wages and price dynamics, with wage inertia significantly contributing to the persistence of backward-looking inflation in Thailand.

4 Implication for Optimal Monetary Policy

"A key implication of the weakening in the relationship between inflation and employment, then, is that we should not assume monetary policy will act to restrain the financial cycle as much as previously."

Governor Lael Brainard (May 16, 2019)

For more than a decade, central banks have recognized the weakening relationship between inflation and domestic economic activity, as reflected by the flattening of the Phillips Curve. This concern was highlighted in a speech by Fed Governor Lael Brainard in May 2019. Given this weakened relationship, monetary policy should not logically focus solely on either inflation or the output gap. Instead, a more nuanced approach that considers both variables when formulating monetary policy is crucial.

However, after the pandemic crisis, the Phillips Curve globally reemerged with a steeper slope, reflected in output recovery accompanied by a sharp rise in inflation. This marked shift in the Phillips Curve underscores the importance of studying the stability of a nuanced approach to formulating optimal monetary policy across different inflation dynamics.

Accordingly, this optimal monetary policy exercise aims to test whether changes in the Phillips curve relationship led to significant shifts in the relative weights assigned to policy target variables. I have assigned two tasks to the model, given diversified output gap. The first task involves running a regression using the data period from 2004 to 2019. For the second task, I will run a regression using only the data period during COVID-19, specifically the 2020-2022 timeframe.

Adapting the model from Smith et al. (2023), I employ the following small-scale macroeconomic model consisting of a Hybrid New Keysian Phillips Curve, an IS curve, and a modified Taylor rule for the optimal policy analysis, as follows:

According to, a Central Bank Objective:

$$\min E[Y_{pt}^2 + (\pi_{pt} - 0.02)^2]$$

$$i_t = \rho_y Y_{pt-1} + \rho_\pi(\pi_{pt-1}) \qquad \text{(1 - Taylor's rule)}$$

$$Y_{pt} = \beta_y Y_{pt-1} + \beta_i i_{pt-1} + \epsilon_{pt,y} \qquad \text{(2 - IS curve)}$$

$$\pi_{pt} = \gamma_0 \pi_{pt+1} + \gamma_1 \pi_{pt-1} + \gamma_y Y_{pt} + \gamma_D(D_t \cdot Y_{pt}) + \epsilon_{pt,\pi} \qquad \text{(3 - Phillips curve)}$$

where Y_{pt} stands for real output gap, which is constructed using three alternative methodologies mentioned in the previous section. i_t is the nominal policy rate at time t, formulated by allocating weights to policy focus on the real output gap and the inflation gap. The inflation gap is the recent inflation deviation from the inflation target of the central bank, here denoted 2 percent for the midpoint of Thailand's policy range.

Functionally, the optimal monetary policy rule i_t can be derived from the model by calibrating the coefficients of the structural equations so as to satisfy the constraints of minimizing the output gap while keeping inflation close to the central bank's target (2 percent, the midpoint of Thailand's target range), as specified in the policy objective. Under these conditions, the combined weights (ρ_y, ρ_π) in the nominal policy rate equation are obtained as the structurally optimal policy parameters. After employing disaggregated data in the model, the optimized outputs of the allocated weight on the output gap (ρ_y) and the weight on the inflation gap (ρ_π) are as the following.

[insert Table 9]

According to Table 9, different measures of the economic gap yield different policy weightings for optimal monetary policy. A consistent finding is that, under an inflation-targeting mandate, when the sample covers normal periods characterized by a flattened

Phillips curve, optimal policy places greater weight on closing the inflation gap. When the sample is restricted to the pandemic period associated with a steepened Phillips curve, optimal policy should place even additional policy weights on closing the inflation gap, compared to normal time. However, a Phillips curve based on the HP-filtered output gap may constrain policy flexibility in responding to evolving price developments, as it places greater emphasis on closing the output gap during crisis periods, thereby increasing the risk of a "behind-the-curve" policy response.

Therefore, even when using the same Phillips curve specification for Thailand, optimal monetary policy proves to be sensitive to prevailing economic and inflationary conditions, as well as to the methodology used for estimating the output gap. Given that central banks worldwide may adopt different Phillips curve specifications tailored to the structure of their respective inflation–economic dynamics, formulating a unified recommendation for optimal policy weights under similar business cycle conditions becomes even more challenging.

5 Conclusion

Proving the existence of the Phillips Curve (PC) is a delicate task that depends on model selection and the choice of data. Utilizing the real output gap derived from three selected methodologies as well as nominal wage gap, the results consistently confirm existence of the Thai PC with clear wage-price linkage. In addition, this paper found a relatively flattened slope of PC, with a slightly steepening of Thai inflation following the pandemic crisis. This flattened feature of the Thai Phillips Curve aligns with findings from the existing literature, as shown in Table 10.

[insert Table 10]

One notable finding is that the output gap derived from the Beveridge-Nelson (BN) decomposition yields a larger Phillips Curve slope compared to those obtained using the

Hodrick-Prescott (HP) filter and the Quadratic detrending (QT). At the provincial level, Thai inflation is primarily driven by the dynamics of non-tradable prices, which are determined locally and influenced by regional economic conditions.

Regarding underlying factors of headline inflation, both domestic demand and external influences—particularly global energy and food prices—play a significant role in shaping Thai inflation, consistent with the existing literature. Additionally, the Thai Phillips curve exhibits both backward-looking and forward-looking behaviour, with a greater weight on the inertial component. Structural analysis of inflation dynamics confirms that Thai firms place more emphasis on lagged inflation than on future inflation expectations when setting optimal prices. Additionally, it reveals that most domestic firms in Thailand are backward-looking. This explains the pronounced backward-looking behaviour of Thai inflation, reflected in an average Calvo price duration of two years. Furthermore, real wages are found to be closely aligned with non-tradable inflation, indicating that they are a key driver of non-tradable price developments. Staggered real wage adjustments are identified as an important factor contributing to the inertial component of inflation.

For monetary policy optimization, the outcome is sensitive to prevailing economic and inflationary conditions, as well as to the methodology used for estimating the output gap. The evidence consistently indicates that even in normal time, the inflation-targeted central bank should place primary emphasis on closing the inflation gap. During periods of elevated inflation, additionally greater weight should be placed on narrowing the inflation gap, consistent with the findings of Smith et al. (2023). However, reliance on the HP-filtered output gap in the Phillips curve may limit policymakers' ability to flexibly balance output stabilization and inflation control during periods of elevated inflation.

Future research on Thai inflation should further investigate the factors driving the pronounced backward-looking behaviour of inflation dynamics. This includes examining how individuals and firms, across time and provinces, incorporate past wage movements and unemployment into their pricing decisions using alternative structural models of inflation dynamics. Additionally, alternative approaches to identifying potential output in Phillips curve—such as multivariate models—and their implications for optimal monetary policy also merit further study. Since this study is limited to minimum wage data, it would be worthwhile to reexamine the wage Phillips curve if provincial wage data become available in the future. Finally, the finding that the HP filter may constrain optimal policy responses to changing economic and price conditions during abnormal periods warrants further empirical investigation in other contexts. Alternative approaches, such as DSGE models and production-side frameworks, should also be employed in future studies on optimal monetary policy formulation.

Acknowledgements

I would like to express my sincere gratitude for the support and invaluable research guidance provided by Professor Takayuki Tsuruga of the University of Osaka. I gratefully acknowledge the financial support of Grants-in-Aid for Scientific Research (JP25H00544). The views expressed in this paper are exclusively those of the author.

References

Alessandria, G., Khan, S.Y., Khederlarian, A., Mix, C. and Ruhl, K.J., 2023. The aggregate effects of global and local supply chain disruptions: 2020–2022. Journal of international Economics, 146, p.103788.

Apaitan, T., Disyatat, P. and Manopimoke, P., 2018. Thai inflation dynamics: a view from micro CPI data. Puey Ungphakorn Institute for Economic Research Discussion Papers, (85).

Barattieri, A., Basu, S. and Gottschalk, P., 2014. Some evidence on the importance of sticky wages. American Economic Journal: Macroeconomics, 6(1), pp.70-101.

Bartik, T.J., 1991. Who benefits from state and local economic development policies?.

Benigno, P. and Eggertsson, G.B., 2023. It's baaack: The surge in inflation in the 2020s and the return of the non-linear phillips curve (No. w31197). National Bureau of

Economic Research.

Bernanke, B. and Blanchard, O., 2023. What caused the US pandemic-era inflation?. Peterson Institute for International Economics Working Paper, (23-4).

Beveridge, S. and Nelson, C.R., 1981. A new approach to decomposition of economic time series into permanent and transitory components with particular attention to measurement of the 'business cycle'. Journal of Monetary economics, 7(2), pp.151-174.

Bhanthumnavin, K., 2002, June. The phillips curve in Thailand. In A paper presented at the Gorman Workshop Series. Department of Economics, University of Oxford.

Blanchard, O.J. and Bernanke, B.S., 2023. What caused the US pandemic-era inflation? (No. w31417). National Bureau of Economic Research.

Brainard, L., 2019. The Disconnect between Inflation and Employment in the New Normal" speech delivered at National Tax Association 49th Annual Spring Symposium, Washington, D.C., May 2019.

Calvo, G.A., 1983. Staggered prices in a utility-maximizing framework. Journal of monetary Economics, 12(3), pp.383-398.

Chuenchoksan, S., Nakornthab, D. and Tanboon, S., 2008. Uncertainty in the Estimation of Potential Output and Implications for the Conduct of Monetary Policy (No. 2008-04).

Choi, Y., 2021. Inflation dynamics, the role of inflation at different horizons and inflation uncertainty. International Review of Economics Finance, 71, pp.649-662.

Clarida, R., Gali, J. and Gertler, M., 1999. The science of monetary policy: a new Keynesian perspective. Journal of economic literature, 37(4), pp.1661-1707.

Comin, D.A., Johnson, R.C. and Jones, C.J., 2023. Supply chain constraints and inflation (No. w31179). National Bureau of Economic Research.

de Soyres, F., Gaillard, A., Santacreu, A.M. and Moore, D., 2024, May. Supply Disruptions and Fiscal Stimulus: Transmission through Global Value Chains. In AEA Papers and Proceedings (Vol. 114, pp. 112-117). 2014 Broadway, Suite 305, Nashville, TN 37203: American Economic Association.

Di Giovanni, J., Kalemli-Özcan, Ş., Silva, A. and Yıldırım, M.A., 2023, May. Quantifying the inflationary impact of fiscal stimulus under supply constraints. In AEA Papers and Proceedings (Vol. 113, pp. 76-80). 2014 Broadway, Suite 305, Nashville, TN 37203: American Economic Association.

Eyassu, S., 2022. Okun's law applied to different countries in different continents: Does the method of estimation affect Okun's coefficient?.

Fischer, S., 1977. Long-term contracts, rational expectations, and the optimal money supply rule. Journal of political economy, 85(1), pp.191-205.

Furuoka, F. and Munir, Q., 2009. Phillips Curve in selected ASEAN countries: new evidence from panel data analysis. Sunway Academic Journal, 6, pp.89-102.

Galí, J. and Gertler, M., 1999. Inflation dynamics: A structural econometric analysis. Journal of monetary Economics, 44(2), pp.195-222.

Galí, J., 2011. The return of the wage Phillips curve. Journal of the European Economic Association, 9(3), pp.436-461.

Gitti, G., 2024. Nonlinearities in the regional phillips curve with labor market tightness. Collegio Carlo Alberto Turin, mimeo.

Gordon, R.J., 1997. The time-varying NAIRU and its implications for economic policy. Journal of economic Perspectives, 11(1), pp.11-32.

Gudmundsson, T., Jackson, C. and Portillo, R, 2024. The Shifting and Steepening of Phillips Curves During the Pandemic Recovery: International Evidence and Some Theory. IMF Working Paper, 24/7.

Hobijn, B., Miles, R., Royal, J. and Zhang, J., 2023. The recent steepening of Phillips curves. Chicago Fed Letter, 475.

Hodrick, R.J. and Prescott, E.C., 1997. Postwar US business cycles: an empirical investigation. Journal of Money, credit, and Banking, pp.1-16.

Ikeda, S., Inatsugu, H., Kishaba, Y., Kondo, T., Sakura, K., Takatomi, K., Nakazawa, T. and Yamada, K., 2022. Inflation in Japan: Changes during the Pandemic and Issues for the Future (No. 22-E-18). Bank of Japan.

Kim, J.I. and Lee, J., 2013. How important are inflation expectations in driving Asian inflation. Bank for International Settlements Papers, (70), pp.41-63.

Kim, J., Yoon, J.C. and Jei, S.Y., 2020. An empirical analysis of Okun's laws in ASEAN using time-varying parameter model. Physica A: Statistical Mechanics and its Applications, 540, p.123068.

Kishaba, Y. and Okuda, T., 2023. The slope of the Phillips curve for service prices in Japan: Regional panel data approach (No. 23-E-8). Bank of Japan.

Kittisowan, C., Piboonthanakiat, N. and Orutsahakij, S., 2011. AEC Implication: Effect towards Thailand's unemployment rate.

Knotek, E.S. and Zaman, S., 2014. On the relationships between wages, prices, and economic activity. Economic Commentary, (2014-14).

Kumar, A. and Orrenius, P.M. 2016. A closer look at the Phillips curve using state-level data. Journal of Macroeconomics, 47, pp.84-102.

Kuttner, K. and Robinson, T., 2010. Understanding the flattening Phillips curve. The North American Journal of Economics and Finance, 21(2), pp.110-125.

Lasarte-Navamuel, E., Pérez-Rivero, J.L. and Montania, C., 2025. An empirical analysis of regional phillips curve with spatial dependence. Regional Science Policy Practice, 17(2), p.100162.

Manopimoke, P., 2015. Globalization and international inflation dynamics: the role of the global output gap. Puey Ungphakorn Institute for Economic Research, (2008).

Manopimoke, P., 2018. Thai inflation dynamics in a globalized economy. Journal of the Asia Pacific Economy, 23(3), pp.465-495.

Mavroeidis, S., Plagborg-Møller, M. and Stock, J.H., 2014. Empirical evidence on inflation expectations in the New Keynesian Phillips Curve. American Economic Journal: Journal of Economic Literature, 52(1), pp.124-188.

Nishizaki, K. and Watanabe, T., 2000. Output-inflation trade-off at near-zero inflation rates. Journal of the Japanese and International Economies, 14(4), pp.304-326.

Nookhwun, N. and Manopimoke, P., 2023. Disaggregated Inflation Dynamics in Thailand: Which Shocks Matter? (No. 211). Puey Ungphakorn Institute for Economic Research.

Phillips, A.W., 1958. The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861-1957. economica, 25(100), pp.283-299.

Press, M., 2009. The inflation dynamics of the ASEAN-4: A case study of the Phillips curve relationship. The Journal of American Science, 1545(1), pp.55-57.

Sakurai, H., 2016. The new Keynesian Phillips curve in Thailand through two financial crises. Asian Economic and Financial Review, 6(4), p.190.

Sekine, A. and Tsuruga, T., 2018. Effects of commodity price shocks on inflation: A cross-country analysis. Oxford Economic Papers, 70(4), pp.1108-1135.

Smith, S., Timmermann, A. and Wright, J.H., 2023. Breaks in the Phillips Curve: Evidence from Panel Data (No. w31153). National Bureau of Economic Research.

Stock, J.H. and Watson, M.W., 1999. Business cycle fluctuations in US macroeconomic time series. Handbook of macroeconomics, 1, pp.3-64.

Szafranek, K., 2017. Flattening of the New Keynesian Phillips curve: Evidence for an emerging, small open economy. Economic Modelling, 63, pp.334-348.

Taguchi, H. and Sohn, W.K., 2014. Inflation Targeting and the Pass-through Rate in East A sian Economies. Asian Economic Journal, 28(2), pp.139-159.

Taylor, J.B., 1980. Aggregate dynamics and staggered contracts. Journal of political economy, 88(1), pp.1-23.

Williams, J.C., 2006, October. Inflation persistence in an era of well-anchored inflation expectations. Federal Reserve Bank of San Francisco.

Yang, T., Gallagher, C.M. and McMahan, C.S., 2019. A robust regression methodology via M-estimation. Communications in Statistics-Theory and Methods, 48(5), pp.1092-1107.

Zhang, C. and Murasawa, Y., 2011. Output gap measurement and the New Keynesian Phillips curve for China. Economic Modelling, 28(6), pp.2462-2468.

Tables

Table of Descriptive Statistics

CPI Baskets (Across Provinces,YoY)	**Weight**	**Max**	**Min**	**Average**	**Stdev**	**Within-group Stdev**	**Between-group Stdev**
HCPI (Allitems)	100	11.5	-2.2	2.9	2.6	2.6	1.4
Food and Non-Alcoholic Beverages	39.0	27.2	-4.3	4.6	4.8		
Apparel and Footwear	2.1	11.2	-13.8	0.2	2.2		
Tobacco and Alcoholic Beverages	1.2	29.9	-5.4	3.8	5.2		
Tradable inflation group	42.0	25.1	-3.8	4.3	4.4	4.3	2.4
Housing and Furnishing	24.7	28.7	-18.2	0.8	3.2		
Medical and Health Care	6.4	19.9	-16.4	0.96	1.8		
Transportation and Communication	22.6	43.3	-22.1	2.8	8.3		
Recreation and Education	4.0	34.5	-46.6	-0.6	6.3		
Non-tradable inflation group	58.0	11.4	-8.9	1.7	3.2	3.2	1.4
Fresh Food and Energy	29.9	20.1	-8.4	4.7	5.5	5.5	2.7
Core Inflation	70.1	14.0	-7.6	1.5	1.7	1.6	1.4
Real GDP growth		46.9	-38.8	2.7	6.2	5.6	5.7
Minimum Wage growth		39.8	0	5.2	9.8	9.9	2.5

Source: Author's calculations

Table 1: First-Stage Panel Regressions for Endogenous Variables

	Endogenous Variables								
	π_{pt+1}	π_{pt-1}	$Nontrade_{pt+1}$	$Nontrade_{pt-1}$	π^w_{pt+1}	π^w_{pt-1}	Y^{HP}_{pt}	Y^{QT}_{pt}	Y^{BN}_{pt}
π_{pt-2}	0.129***								
	(0.0290)								
π_{pt-3}	0.089**	0.129***							
	(0.0287)	(0.0290)							
π_{pt-4}		0.089***							
		(0.0287)							
$Nontrade_{pt-2}$			0.014						
			(0.0224)						
$Nontrade_{pt-3}$			0.057***	0.125***					
			(0.0175)	(0.0166)					
$Nontrade_{pt-4}$				0.057***					
				(0.0173)					
π^w_{pt-2}					0.155***				
					(0.0317)				
π^w_{pt-3}					0.100***	0.089***			
					(0.0310)	(0.0318)			
π^w_{pt-4}						0.147***			
						(0.0311)			
Y^{HP}_{pt-1}							0.382***		
							(0.0279)		
Y^{HP}_{pt-2}							0.333***		
							(0.0280)		
Y^{QT}_{pt-1}								0.231***	
								(0.0290)	
Y^{QT}_{pt-2}								0.239***	
								(0.0290)	
Y^{BN}_{pt-1}									0.053**
									(0.0250)
Y^{BN}_{pt-2}									0.316***
									(0.0275)
KP test (F-value)	22.2***	91.9***	6.1***	21.5***	27.8***	24.1***	38.8***	60.3***	58.3***
Sargan test (F-value)	1.19	1.17	3.05	1.47	3.03	3.07	0.43	0.42	0.44
Adjusted R^2	0.205	0.205	0.150	0.190	0.222	0.241	0.222	0.256	0.240

Note: 1) This table reports first-stage regressions for endogenous variables used in the 2SLS estimation. 2) Robust standard errors are shown in parentheses. 3) The Kleibergen–Paap rk Wald F-statistic is reported to test the null hypothesis that the instrument is weak. 4) The Sargan test examines the null hypothesis that all instruments are valid. and 5) ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Source: Author's calculations

Table 2: New Keynesian Phillips Curve: π_{pt}

	Full Panel		
	HP	QT	BN
π_{pt+1}	0.465 ***	0.465 ***	0.462 ***
	(0.0216)	(0.0217)	(0.0216)
Y_{pt}	0.041 ***	0.107 ***	0.395
	(0.0038)	(0.0314)	(0.6462)
$Dummycovid{*}Y_{pt}$	0.022 ***	0.019 ***	0.148 ***
	(0.0056)	(0.0053)	(0.0352)
$Dummycovid{*}GEnergy_{pt}$	0.019 ***	0.019 ***	0.019 ***
	(0.0012)	(0.0012)	(0.0012)
individual fixed effect	yes	yes	yes
time fixed effect	yes	yes	yes
Pseudo R-square	0.3448	0.3447	0.3465

Note: 1) ***, ** and * represent 1, 5, and 10 percentage of significance level respectively. 2) Numbers in parentheses are clustered standard errors. 3) HP: Hodrick-Prescott filter, QT: Quadratic detrending, BN: Beveridge-Nelson decomposition 4) Y_{pt} represents real output gap, which is instrumented by its period lags. Meanwhile, inflation at time $t+1$ is instrumented by its own period lags that are known at time t.
Source: Author's calculations

Table 3: Hybrid New Keynesian Phillips Curve: π_{pt}

	Full Panel		
	HP	QT	BN
π_{pt+1}	0.481***	0.485***	0.489***
	(0.0992)	(0.0991)	(0.0988)
π_{pt-1}	0.519***	0.515***	0.511***
	(0.0992)	(0.0991)	(0.0989)
Y_{pt}	0.075***	0.148***	0.181**
	(0.0044)	(0.0300)	(0.0635)
$Dummycovid*Y_{pt}$	0.021***	0.021***	0.165***
	(0.0063)	(0.0061)	(0.0453)
$Dummycovid*GEnergy_{pt}$	0.021***	0.021***	0.021***
	(0.0010)	(0.0010)	(0.0010)
individual fixed effect	yes	yes	yes
time fixed effect	yes	yes	yes
Pseudo R-square	0.3610	0.3620	0.3629

Note: 1) ***, ** and * represent 1, 5, and 10 percentage of significance level respectively. 2) Numbers in parentheses are clustered standard errors. 3) HP: Hodrick-Prescott filter, QT: Quadratic detrending, BN: Beveridge-Nelson decomposition 4) Y_{pt} represents real output gap, which is instrumented by its period lags. Meanwhile, inflations at time $t+1$ and $t-1$ are instrumented by its own lags that are known at time t.
Source: Author's calculations

Table 4: A Structural analysis of Thai inflation dynamics
Calibrated Parameters of Hybrid New Keynesian Phillips curve

Parameter	HP	QT	BN
β	0.99	0.99	0.99
θ	0.50	0.54	0.54
ω	0.92	0.92	0.90
ϕ	1.41	1.54	1.54
λ^*	0.02	0.04	0.06
κ^*	1.48	1.61	1.82
γ_f	0.351	0.349	0.350
γ_b	0.649	0.651	0.650
$\lambda^*\kappa^*$	0.022	0.064	0.116
$CalvoPriceDuration$	2.00	2.18	2.19

Note: 1) Model refers to Gali and Gertler (1999). 2) β = household discount factor, given as 0.99. θ = Calvo probability of not changing prices in a given period, ω = a fraction of firms which is a backward-looking, ϕ = composite term, λ^* = marginal cost elasticity of inflation, κ^* = output gap–marginal cost elasticity, γ_f = forward-looking coefficients in Hybrid NKPC, γ_b = backward-looking coefficients in Hybrid NKPC, 3) Calvo Average Price Duration is calculated by 1/(1-θ)
Source: Author's calculations

Table 5: Hybrid New Keynesian Phillips Curve: $Nontrade_{pt}$

	Full Panel		
	HP	QT	BN
$Nontrade_{pt+1}$	0.357**	0.347**	0.337**
	(0.1516)	(0.1521)	(0.1545)
$Nontrade_{pt-1}$	0.643***	0.653***	0.663***
	(0.1516)	(0.1521)	(0.1545)
Y_{pt}	0.165***	0.134***	0.881***
	(0.0508)	(0.0158)	(0.0996)
$Dummycovid{*}Y_{pt}$	0.073***	0.071***	0.371***
	(0.0139)	(0.0134)	(0.0869)
$Dummycovid{*}Food_{pt}$	0.167***	0.167***	0.168***
	(0.0060)	(0.0061)	(0.0059)
individual fixed effect	yes	yes	yes
time fixed effect	yes	yes	yes
Pseudo R-square	0.5238	0.5245	0.5176

Note: 1) ***, ** and * represent 1, 5, and 10 percentage of significance level respectively. 2) Numbers in parentheses are clustered standard errors. 3) HP: Hodrick-Prescott filter, QT: Quadratic detrending, BN: Beveridge-Nelson decomposition 4) Y_{pt} represents real output gap, which is instrumented by its period lags. $Nontrade_{pt+1}$ and $Nontrade_{pt-1}$ represent the inflation of non-tradable goods at time $t+1$ and $t-1$, instrumented by its own lags that are known at time t.
Source: Author's calculations

Table 6: Traditional Phillips Curve with Tradable-spillover instrumental variable (Bartik instrument): $Nontrade_{pt}$

	Full Panel
$Tradable - spilloverIV_{-pt}$	0.368 ***
	(0.0634)
individual fixed effect	yes
time fixed effect	yes
Pseudo R-square	0.2419

Note: 1) ***, ** and * represent 1, 5, and 10 percentage of significance level respectively. 2) Numbers in parentheses are clustered standard errors. 3) $Tradable - spilloverIV_{-pt}$ or Bartik instrument represents the instrumental variable of the shock of tradable inflation from all others provinces except the province p $(-p)$ at time t

Source: Author's calculations

Table 7: Wage Phillips Curve: π^w_{pt}

	Full Panel		
	HP	QT	BN
π^w_{pt+1}	0.478***	0.479***	0.481***
	(0.0187)	(0.0187)	(0.0189)
π^w_{pt-1}	0.522***	0.521***	0.519***
	(0.0198)	(0.0198)	(0.0211)
Y_{pt}	0.184***	0.169***	0.998***
	(0.0647)	(0.0594)	(0.3676)
individual fixed effect	yes	yes	yes
time fixed effect	yes	yes	yes
Pseudo R-square	0.3241	0.3237	0.3227

Note: 1) ***, ** and * represent 1, 5, and 10 percentage of significance level respectively. 2) Numbers in parentheses are clustered standard errors. 3) HP: Hodrick-Prescott filter, QT: Quadratic detrending, BN: Beveridge-Nelson decomposition 4) Y_{pt} represents real output gap, which is instrumented by its period lag. Meanwhile, π^w_{pt+1} aand π^w_{pt-1} reflect the year-on-year change in real wage at time $t+1$ and $t-1$, instrumented by its own lags known at time t.
Source: Author's calculations

Table 8: Wage-linked NKPC and Augmented Hybrid NKPC: π_{pt}

	Wage-linked NKPC	**Augmented Hybrid NKPC**		
		HP	**QT**	**BN**
π_{pt+1}	0.409***	0.335***	0.343***	0.406***
	(0.1246)	(0.1052)	(0.1056)	(0.1054)
π_{pt-1}	0.591***	0.665***	0.657***	0.594***
	(0.1026)	(0.1039)	(0.1040)	(0.1032)
π^{w}_{pt-1}	0.038***	0.043***	0.042***	0.038***
	(0.0064)	(0.0065)	(0.0065)	(0.0064)
$DummyCovid \times \pi^{w}_{pt}$	0.026	0.022	0.023	0.026
	(0.0272)	(0.0274)	(0.0274)	(0.0272)
Y_{pt}		0.098***	0.121***	0.204**
		(0.0210)	(0.0318)	(0.0881)
individual fixed effect	yes	yes	yes	yes
time fixed effect	yes	yes	yes	yes
Pseudo R-square	0.459	0.467	0.465	0.459

Note: 1) ***, ** and * represent 1, 5, and 10 percentage of significance level respectively. 2) Numbers in parentheses are clustered standard errors. 3) π^{w}_{pt-1} reflects the year-on-year change in real wage, whereas Y_{pt} represents real output gap, which is instrumented by its period lags. Meanwhile, inflation at time $t+1$ and $t-1$ are instrumented by its own lags known at time t.
Source: Author's calculations

Table 9: Implication for Optimal Monetary Policy

Gap Measures	**2004-2019**		**2020-2022**	
	ρ_y	ρ_π	ρ_y	ρ_π
Outputgap_HP	0.43	0.57	0.47	0.53
			(+0.04)	(-0.04)
Outputgap_QT	0.45	0.55	0.41	0.59
			(-0.04)	(+0.04)
Outputgap_BN	0.45	0.55	0.40	0.60
			(-0.05)	(+0.05)

Note: 1) ρ_y and ρ_π denote estimated weights on the output gap and inflation gap in Taylor's rule, respectively. 2) Pandemic period refers to 2020–2022 3) HP: Hodrick–Prescott filter, QT: Quadratic detrending, BN: Beveridge–Nelson decomposition 4) The numbers in parentheses indicate the unit difference in policy weight between elevated-inflation periods and normal periods.
Source: Author's calculations

Table 10: Summary of Empirical Estimates of the Slope of the Thai Phillips Curve

Study	**Periods**	**Dependent-Regressor**	**Backward-looking PC**	**Forward-looking NKPC**	**Hybrid NKPC**
Bhanthumnavin (2002)	1993–2001	π_{pt} and Y_{pt}	0.034–0.05		
	1993–1996		0.022		
	1997–2000		0.031		
Press (2009)	1980–2005	π_{pt} and U_{pt}	-0.944		
Sakurai (2016)	2009–2014	π_{pt} and Y_{pt}		0.304	0.361
	2000–2008			0.399	0.515
	2000–2014			0.409	0.516
Chuenchoksan et al. (2008)	2000–2007	π_{pt} and Y_{pt}			0.05
Hazell et al, (2022): US case	1990-2017	$Nontradable_{pt}$ and U_{pt}			-0.009
	1990-2017	$Nontradable_{pt}$ and $Tradable-SpilloverIV$			-0.332
Kishiba (2023): Japan case	Only 2000-2021	$Nontradable_{pt}$ and Y_{pt-1}			0.55
This paper	2004–2022	π_{pt} and Y_{pt}		0.041-0.395	0.075–0.181
	2020–2022	π_{pt} and Y_{pt}		0.063-0.148	0.096-0.346
	2004–2022	$Nontradable_{pt}$ and Y_{pt}			0.134–0.881
	2020–2022	$Nontradable_{pt}$ and Y_{pt}			0.205-1.253
	2004–2022	$Nontradable_{pt}$ and $Tradable-SpilloverIV$			0.368

Note: 1) NKPC refers to New Keynesian Phillips Curve. 2) π_{pt} is headline inflation, U_{pt} is unemployment rate, and Y_{pt} represents real output gap 3) One can convert the estimated coefficients between Y_{pt} and U_{pt} by applying Okun's law for Thailand, which is approximately $U_{pt} = -0.2\ Y_{pt}$, as found by Kittisowan et al.(2011) and Eyassu(2022)
Source: Author's compilation based on cited studies.