It's baaack: The Inflation in the 2020s and the Return of the Non-Linear Phillips Curve

Pierpaolo Benigno (University of Bern)
Gauti Eggertsson (Brown University)

Bank of Spain

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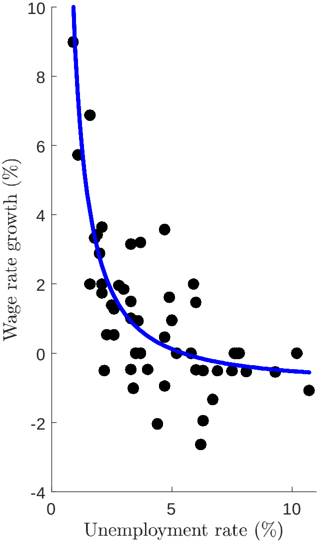
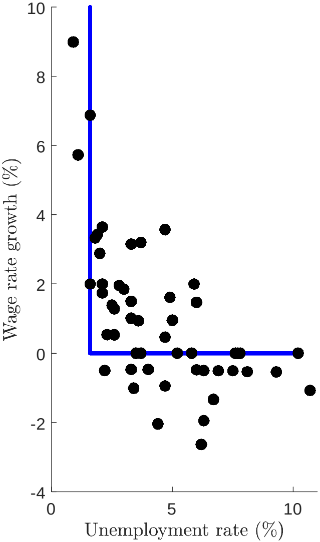
Main Summary

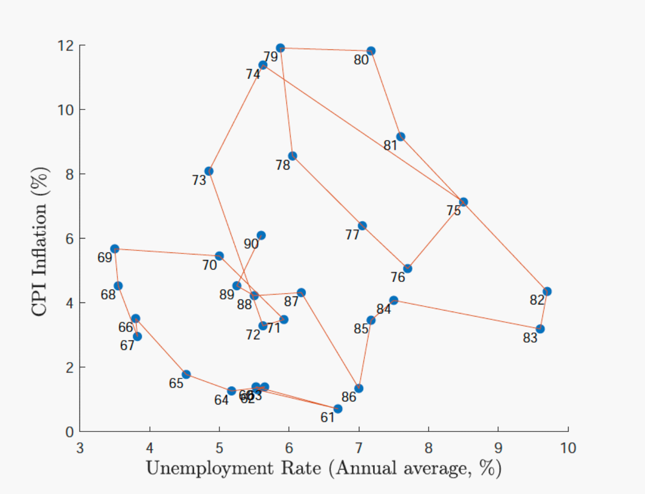
- Suggest that the Phillips Curve is non-linear (as in Phillips' work).
- Provide evidence for it.
- Provide a theory of an Inv-L NK Phillips Curve to replace the traditional NK equation.
- Draw policy implications for a soft landing.

The Original Phillips Curve





The Collapse of the Phillips Curve



$$\underbrace{\pi_t = \kappa x_t}_{\substack{\text{Keynesian} \\ \text{Phillips Curve}}} \quad + \quad \underbrace{\upsilon_t + \beta E_t \pi_{t+1}}_{\substack{\text{New Keynesian} \\ \text{Phillips Curve}}}$$

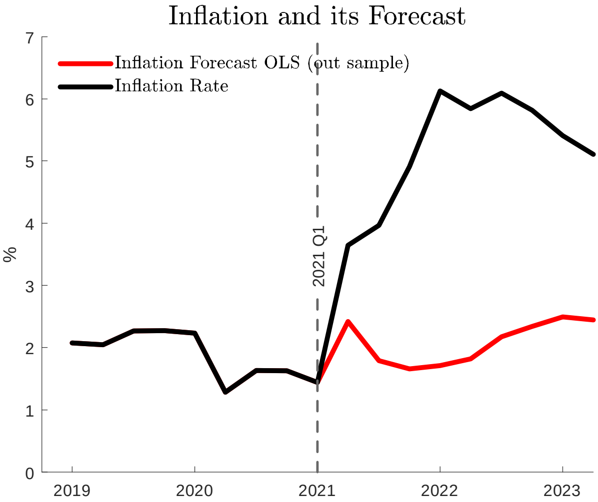
with

$$\begin{aligned} x_t &= \text{measure of economic slack} \\ \kappa &= \text{slope} \\ \upsilon_t &= \text{supply shock} \\ E_t \pi_{t+1} &= \text{expectations of inflation} \end{aligned}$$

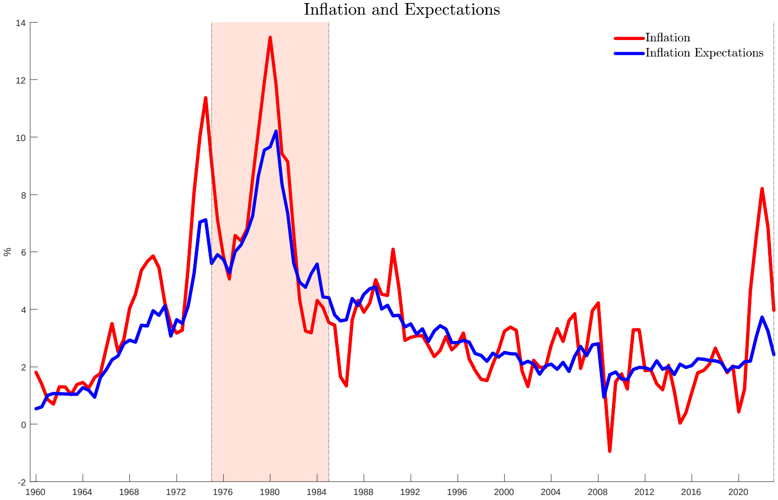
Flaws of the NK Phillips curve in predicting the 2020s inflationary surge

- Estimated slope is flat: a 1% fall in unemployment increases inflation by only 0.34 point, see Hazell et al. (2022).
- Supply shock has been moderate in magnitude and inflation expectations have remained anchored (unlike the 70s).
- Measure of economic slack: the unemployment rate might not capture all the significant pressures coming from the labor market, ...drop in the matching efficiency and...in labor-force participation.

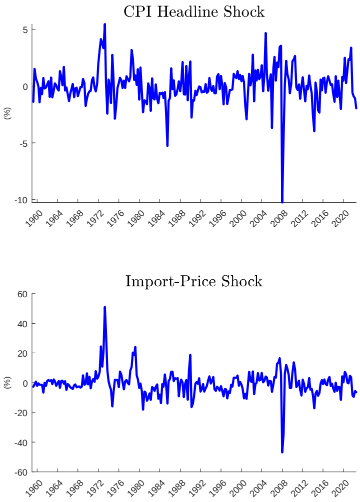
Predicting the 2020s inflation with pre-Covid estimates



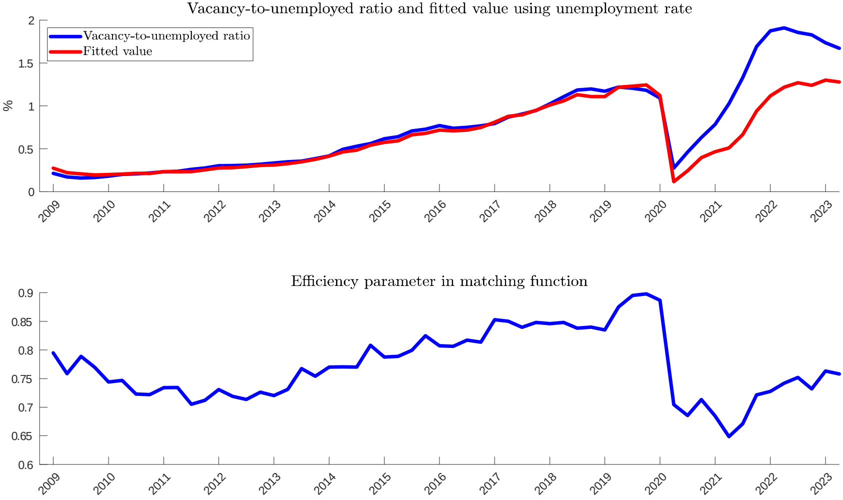
Anchored inflation expectations



Moderate supply shocks



Vacancy-to-unemployed ratio versus unemployment rate



An Inv-L New-Keynesian Phillips Curve

$$\pi_t = \begin{cases} \kappa^{tight}\hat{\theta}_t + \kappa_\upsilon^{tight}\hat{\upsilon}_t + \beta E_t \pi_{t+1} & \text{tight labor market} \\ \kappa_w \hat{w}_{t-1} + \kappa\hat{\theta}_t + \kappa_\upsilon \hat{\upsilon}_t + \kappa_\beta E_t \pi_{t+1} & \text{loose labor market} \end{cases}$$

New features:

1. Measure of economic slack:

$$\theta_t = \frac{\text{vacancy rate}}{\text{unemployment rate}}$$

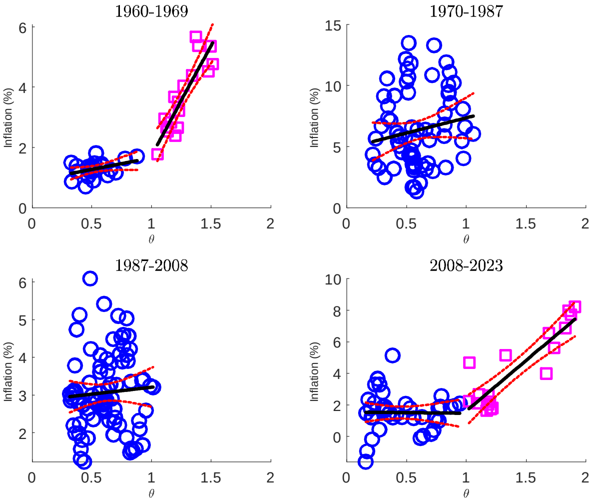
2. Non-linearities:

$$\kappa^{tight} > \kappa \qquad \kappa_\upsilon^{tight} > \kappa_\upsilon$$

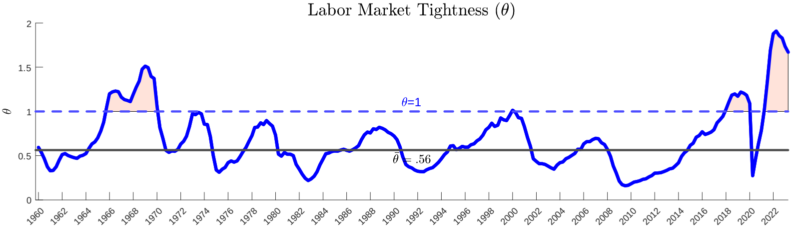
while κ_β can be higher or lower than β.

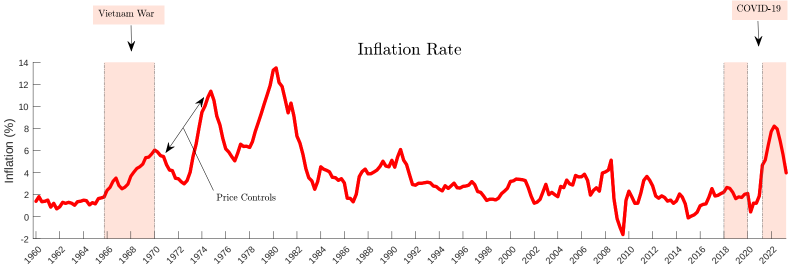
3. Various types of shifters: $\hat{\upsilon}_t$ includes oil, mark-up, productivity, participation rate and matching-efficiency shocks.

An Inv-L New-Keynesian Phillips Curve in the Data

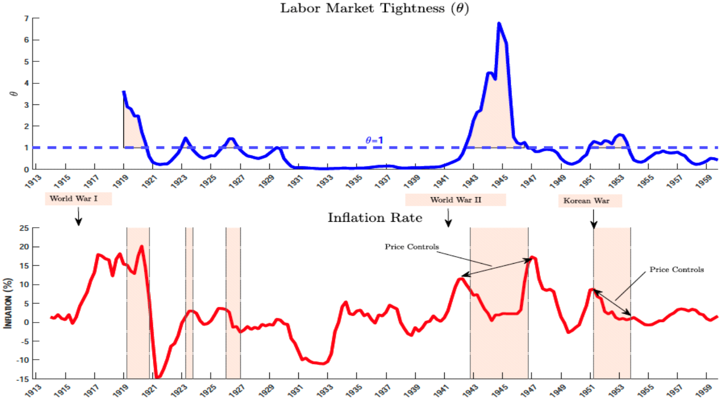


Inflation and Vacancy-to-Unemployed Ratio: 1960-2023





Inflation and Vacancy-to-Unemployed Ratio: 1919-1960



Estimation

$$\pi_t = \beta_c + \beta_\pi \pi_{t-1} + (\beta_\theta + \beta_{\theta_d} D_t) \ln \theta_t + (\beta_\upsilon + \beta_{\upsilon_d} D_t)\upsilon_t + \beta_{\pi^e} \pi_t^e + \varepsilon_t,$$

Table 1: Phillips Curve Estimates

	(1) 1960-2023	(2) 2008-2023	(3) 1960-2023	(4) 2008-2023
Inflation lag	0.3768*** (0.0946)	0.2765 (0.2465)	0.2601*** (0.0933)	−0.1355 (0.2052)
$\ln \theta$	0.6822*** (0.183)	0.7062* (0.3806)	0.2422 (0.1998)	0.5199 (0.3257)
$\theta \geq 1$			3.727*** (0.8346)	5.2042*** (0.9298)
μ *shock*	0.0372* (0.0192)	0.0101 (0.0379)	0.0444** (0.0204)	−0.0096 (0.0236)
$\theta \geq 1$			0.0831 (0.1073)	0.2771** (0.1385)
Inflation expectations	0.6524*** (0.106)	1.0613 (0.6352)	0.8033*** (0.1016)	0.5324 (0.5777)
Constant	0.5629*** (0.1585)	1.0303** (0.4621)	0.2046 (0.1679)	0.4072 (0.4037)
R^2 adjusted	0.816	0.530	0.828	0.663
Observations	254	60	254	60

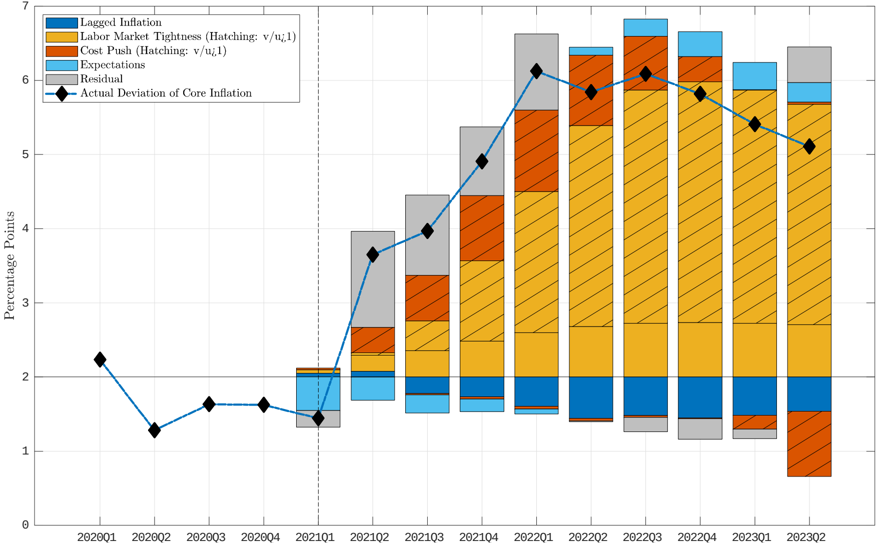
· ***,**,* denote statistical significance at the 1,5, and 10 percent level, respectively.

· Newey-West standard errors.

· (1) and (3): sample 1960 Q1 – 2022 Q3

· (2) and (4): sample 2008 Q3 – 2023 Q2

Prediction using the Inv-L NK Phillips Curve



- Household's utility flow:

$$U(C_t, F_t, \chi_t, \xi_t) = \xi_t \left(\frac{C_t - \chi_t \int_0^{F_t} f^\omega df}{1-\sigma} \right)^{1-\sigma}$$

C_t: consumption index; F_t: number of people that decides to participate in the labor market; each household member is indexed by f and has fixed disutility f^ω (see Galì, 2009), with $\omega > 0$:

$$\int_0^{F_t} f^\omega df = \frac{F_t^{1+\omega}}{1+\omega}.$$

- The household decides the labor force participation. The entire labor force is not going to be employed because of frictions in the labor market.

- The labor force is divided between employed and unemployed

$$F_t = N_t + U_t, \tag{1}$$

where N_t is people employed by firms and U_t is unemployed workers at the end of period t.

- At the beginning of each period a fraction $(1 - s)$ of the labor force is attached to firms.
- The remaining fraction of the labor force, s, is without work. Their ability to enter employment is determined by the matching function

$$M_t = m_t(U_t)^{\eta} V_t^{1-\eta} \tag{2}$$

where $m_t > 0$ is matching efficiency while V_t is vacancies posted by employment agencies; η is a parameter with $0 < \eta < 1$.

- Define the tightness of the market by $\theta_t \equiv V_t/U_t$, hiring rate is:

$$(H_t/sF_t) = (m_t U_t \theta_t^{1-\eta})/s,$$

Total employment and labor income are given by

$$N_t = (1-s)F_t + H_t = F_t(1 - s + m_t u_t \theta_t^{1-\eta}). \quad (3)$$

$$W_t N_t = W_t(1-s)F_t + W_t(1-\gamma_t^b)m_t u_t \theta_t^{1-\eta} F_t$$

since households obtain jobs through employment agency paying a fee γ_t^b proportional to their income.

- Optimal labor-force participation is:

$$F_t = \left(\frac{(1 - s + (1-\gamma_t^b)m_t u_t \theta_t^{1-\eta})}{\chi_t} w_t \right)^{\frac{1}{\omega}}. \quad (4)$$

Firms

- Firms in a monopolistic-competitive market using labor and energy, $y = A_t N^{\alpha_n} O^{\alpha_o}$ with cost of adjusting prices like in Rotemberg (1982).

$$\pi_t = \frac{(\epsilon - 1)}{\zeta}(\hat{\mu}_t + (1-\alpha_o)\hat{w}_t + (1-\alpha_n-\alpha_o)\hat{N}_t - \hat{A}_t + \alpha_o \hat{q}_t) + \beta E_t \pi_{t+1}$$

with

$$\hat{N}_t = \frac{1}{\omega}(\hat{w}_t - \hat{\chi}_t - \varsigma_2 \hat{\gamma}_t^b) - \left(\frac{\varsigma_1}{\omega} + \frac{\bar{u}}{1-\bar{u}}\right)\hat{u}_t,$$

and the Beveridge curve

$$\hat{u}_t = -\frac{s - \bar{u}}{s}(\hat{m}_t + (1-\eta)\hat{\theta}_t)$$

Employment agency

- The employment agency i chooses the number of vacancy to maximize profits

$$\gamma_t^b w_t M_t(i) - \gamma_t^c V_t(i),$$

γ_t^c is the marginal cost of one unit of vacancy, and

$$M_t(i) = \underbrace{m_t \theta_t^{-\eta}}_{\text{Success rate of a vacancy}} V_t(i).$$

- Agencies supply vacancies insofar as marginal benefits equalize costs

$$\underbrace{\gamma_t^b w_t m_t \theta_t^{-\eta}}_{\text{Marginal benefit}} = \underbrace{\gamma_t^c}_{\text{Marginal cost}}$$

which delivers additional restriction that enable model to pin down real wages at its flexible value:

$$w_t^{flex} = \frac{1}{m_t} \frac{\gamma_t^c}{\gamma_t^b} \theta_t^{\eta} \tag{5}$$

Combine:

$$\pi_t = \frac{(\epsilon - 1)}{\zeta}(\hat{\mu}_t + (1 - \alpha_o)\hat{w}_t^{flex} + (1 - \alpha_n - \alpha_o)\hat{N}_t - \hat{A}_t + \alpha_o \hat{q}_t) + \beta E_t \pi_{t+1}$$

$$\hat{N}_t = \frac{1}{\omega}(\hat{w}_t^{flex} - \hat{\chi}_t) - \left(\frac{\varsigma}{\omega} + \frac{\bar{u}}{1 - \bar{u}}\right)\hat{u}_t,$$

$$\hat{u}_t = -\frac{s - \bar{u}}{s}(\hat{m}_t + (1 - \eta)\hat{\theta}_t)$$

$$\hat{w}_t^{flex} = \hat{\gamma}_t^c - \hat{\gamma}_t^b + \eta\hat{\theta}_t - \hat{m}_t$$

to imply

$$\pi_t = \kappa^{tight}\hat{\theta}_t + \kappa_{\upsilon}^{tight}(\hat{\upsilon}_t + \hat{\vartheta}_t) + \beta E_t \pi_{t+1}$$

$$\hat{\upsilon}_t = \upsilon(\underbrace{\hat{A}_t}_{\text{Productivity (-)}}, \underbrace{\hat{q}_t}_{\text{Oil price (+)}}, \underbrace{\hat{\mu}_t}_{\text{Markup (+)}}, \underbrace{\hat{\chi}_t}_{\text{Labor force participation (-)}})$$

$$\hat{\vartheta}_t = \vartheta(\underbrace{\hat{\gamma}_t^c}_{\text{Vacancy cost (+)}}, \underbrace{\hat{\gamma}_t^b}_{\text{Vacancy benefit (-)}}, \underbrace{\hat{m}_t}_{\text{Matching efficiency (-)}})$$

Wage mechanism and wage norm

- Wage mechanism is

$$W_t = \max(W_t^{norm}, P_t w_t^{flex})$$

- $\theta_t > \theta_t^* \Rightarrow$ **Tight** Labor Market: wages are fully flexible and given by:

$$w_t^{flex} = \frac{1}{m_t}\frac{\gamma_t^c}{\gamma_t^b}\theta_t^\eta$$

- $\theta_t < \theta_t^* \Rightarrow$ **Loose** Labor Market: wages are set according to a wage norm

$$W_t^{norm} = (W_{t-1}(\Pi_{t+1}^e)^\delta)^\lambda (P_t w_t^{flex})^{1-\lambda}. \tag{6}$$

  Keynes' wage norm, $W_t^{norm} = W_{t-1}$, nested if $\lambda = 1$ and $\delta = 0$.
- θ_t^* is given by

$$\theta_t^* = \frac{\gamma_t^b}{\gamma_t^c} m_t \left(w_{t-1}\frac{(\Pi_{t+1}^e)^\delta}{\Pi_t}\right)^{\frac{1}{\eta}}$$

The Inv-L Phillips Curve:

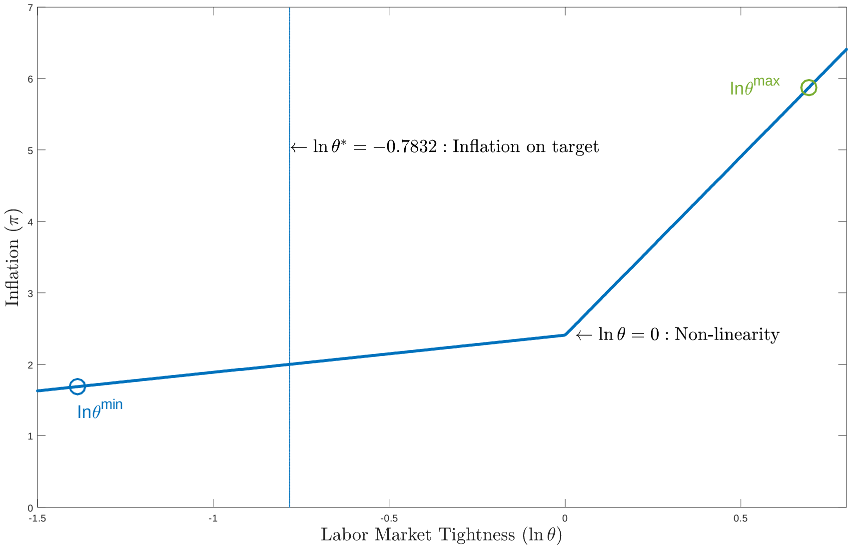
$$\pi_t = \begin{cases} \kappa^{tight}\hat{\theta}_t + \kappa_{\upsilon}^{tight}(\hat{\upsilon}_t + \hat{\vartheta}_t^{tight}) + \beta E_t \pi_{t+1} & \text{if } \hat{\theta}_t > \theta^* \\ \kappa_w \hat{w}_{t-1} + \kappa\hat{\theta}_t + \kappa_{\upsilon}(\hat{\upsilon}_t + \hat{\vartheta}_t) + \kappa_{\beta} E_t \pi_{t+1} & \text{if } \hat{\theta}_t \leq \theta^* \end{cases}$$

where

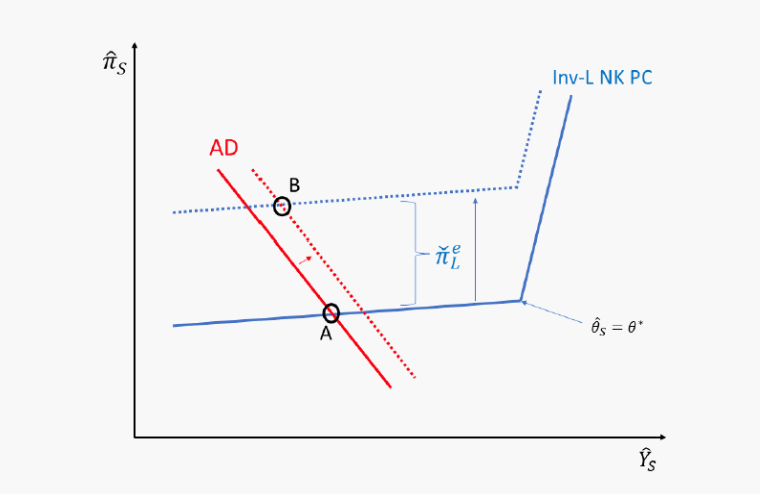
$$\begin{aligned} \kappa^{tight} &> \kappa \\ \kappa_{\upsilon}^{tight} &> \kappa_{\upsilon} \end{aligned}$$

while κ_{β} can be higher or lower than β.

An Inv-L New-Keynesian Phillips Curve

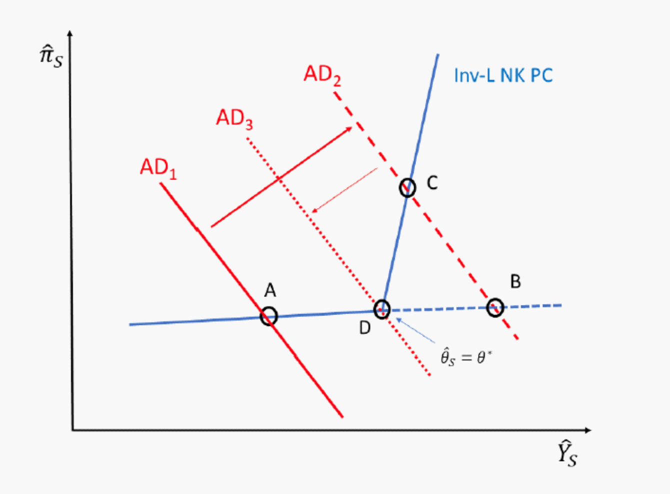


Period in which $\theta < 1$, oil shock and inflation expectations unanchored $\Rightarrow$ hard landing.



Policy Implications: the 2020s

Period in which $\theta > 1$, energy/supply and demand shocks, inflation expectations anchored $\Rightarrow$ soft landing.



Conclusion

- Recent inflationary surge might be driven by demand and supply shocks interacting on a steep Phillips curve that arises under extraordinarily tight labor market.
- We have provided evidence and theory of an Inv-L Phillips Curve.
- Policy implications include the thesis that an appropriate monetary policy can bring down inflation without creating a deep recession.