Wage Price Spirals

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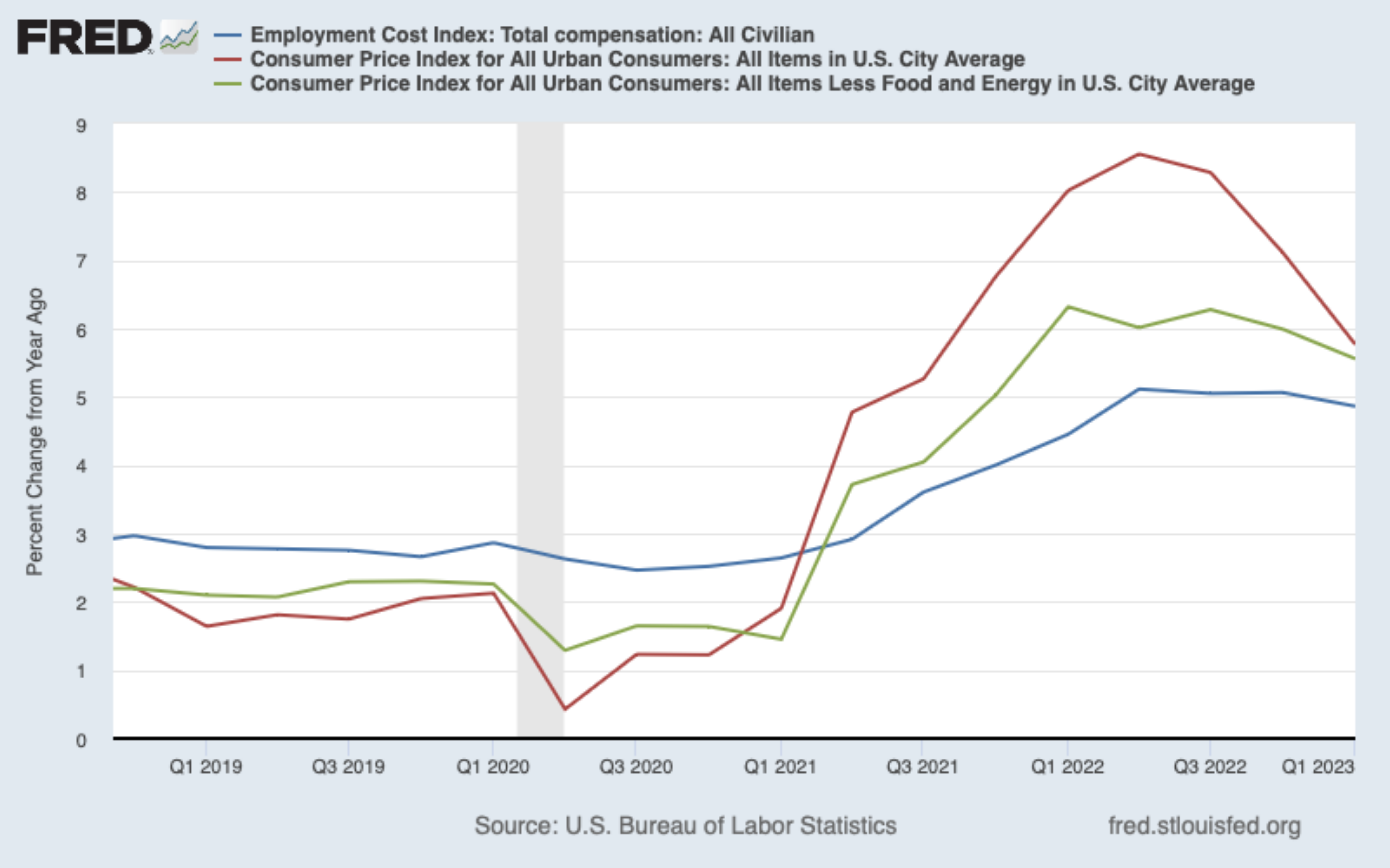
Wage inflation and price inflation



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- Optimal policy

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- Weber-Wasner "Seller's Inflation" (often misnamed "greedflation")
  - inflation from increase in inputs

1. Wage and Price Setting

Model

- Standard NK model with sticky nominal wages (Erceg-Henderson-Levin, 2000)
- Include non-labor input X in inelastic supply
- Preferences

$$\int_0^\infty e^{-\rho t}\left(\frac{1}{1-\sigma}C_t^{1-\sigma} - \frac{\Phi_t}{1+\eta}\int_0^1 N_{jt}^{1+\eta}dj\right)dt,$$

- C_t is CES composite of continuum of varieties
- Technology

$$Y_{jt} = \left(a_L L_{jt}^{\frac{\epsilon-1}{\epsilon}} + a_X X_{jt}^{\frac{\epsilon-1}{\epsilon}}\right)^{\frac{\epsilon}{\epsilon-1}}$$

Labor and non-labor input

- Multiple labor types

$$L_t = \left(\int_0^1 N_{jt}^{1-1/\zeta} dj \right)^{\frac{1}{1-1/\zeta}}$$

- Each supplied by monopolist wage setter (union)

- Input X supplied inelastically by representative household
- Flexible price P_{Xt}

Firms' Optimality

From now all log deviations from ss

- All firms use same mix of labor and X
- Nominal marginal cost

$$w_t - mpl_t$$

- MPL depends on aggregate input to labor ratio and on the steady state share of the input

$$mpl_t = \frac{s_X}{\epsilon}\left(x_t - l_t\right)$$

- Price of the input

$$p_{Xt} = w_t - \frac{1}{\epsilon}\left(x_t - l_t\right)$$

"Marginal Cost" of Labor

- Rate at which workers willing to supply one more unit of labor

$$mrs_{\tau,t} + p_t$$

- MRS depends on when worker's reset wages
- But on average is simply

$$mrs_t = \phi_t + \sigma y_t + \eta n_t$$

Price and Wage Setting

- Firms get to reset price: Poisson with rate λ_p
- Optimal price setting

$$p_t^* = \left(\rho + \lambda_p\right) \int_t^\infty e^{-\left(\rho + \lambda_p\right)(\tau - t)} \left(w_\tau - mpl_\tau\right) d\tau$$

- For workers

$$w_t^* = \left(\rho + \lambda_w\right) \int_t^\infty e^{-\left(\rho + \lambda_w\right)(\tau - t)} \left(p_\tau + mrs_{\tau,t}\right) d\tau$$

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Flexible Prices and Wages

- Two equations above become

$$p_t = w_t - mpl_t$$

- And

$$w_t = p_t + mrs_t$$

- So we need $mpl_t = mrs_t$!
- Sticky prices models capture the tension that comes from quantities not compatible with $mpl_t = mrs_t$

Price and Wage Dynamics

- Given paths for mpl_t and mrs_t + initial condition for ω_t dynamics of prices and wages fully characterized by

$$\rho\pi_t = \Lambda_p\left(\omega_t - mpl_t\right) + \dot{\pi}_t$$

$$\rho\pi_t^w = \Lambda_w\left(mrs_t - \omega_t\right) + \dot{\pi}_t^w$$

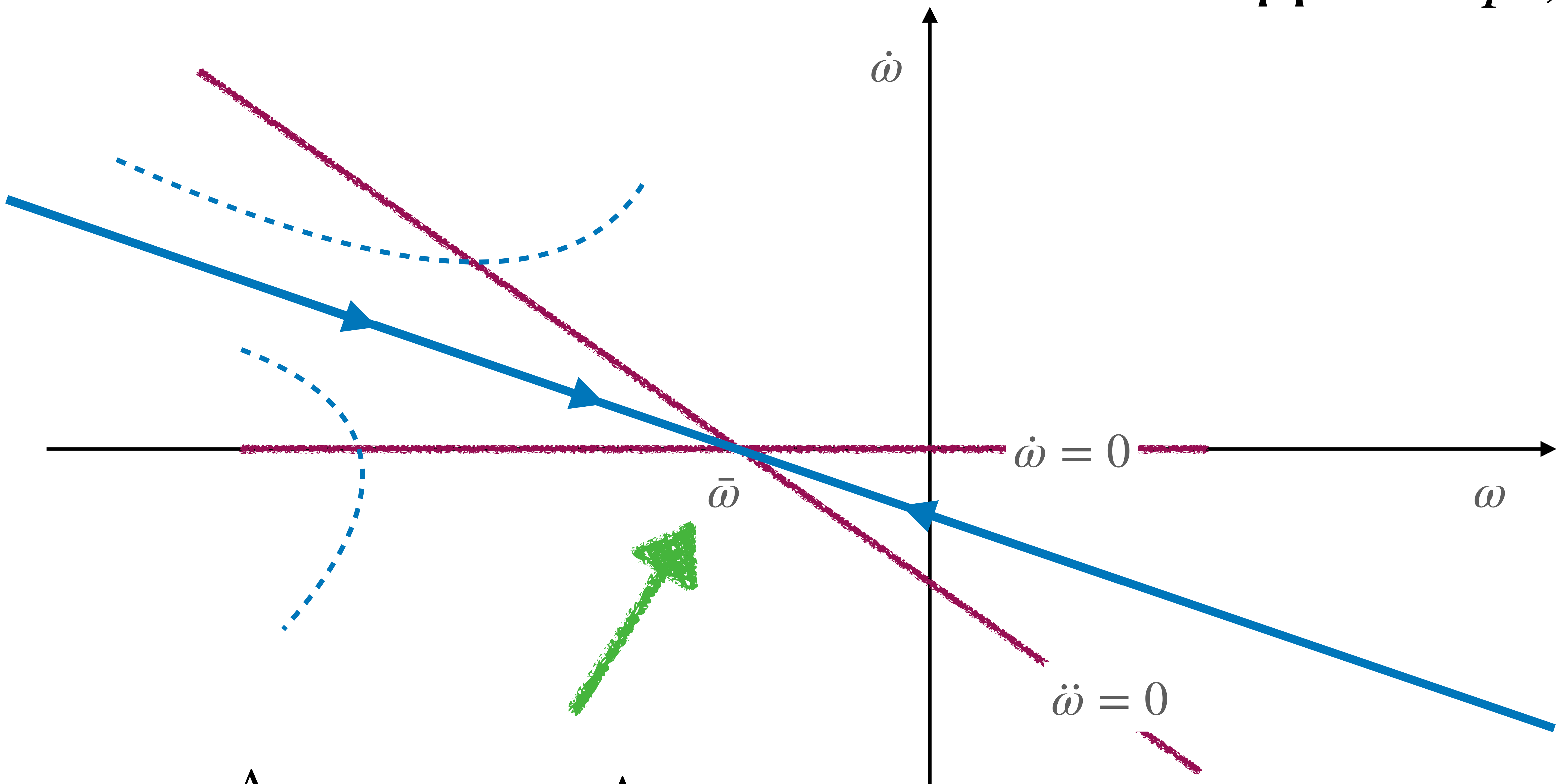
$$\dot{\omega}_t = \pi_t^w - \pi_t$$

Where $\Lambda_p = \lambda_p\left(\rho + \lambda_p\right)$ and $\Lambda_w = \lambda_w \dfrac{\rho + \lambda_w}{1 + \eta\zeta}$

2. Real Wage Dynamics

Phase Diagram

Suppose *mpl*, *mrs* constant and $mpl \neq mrs$



$$\overline{\omega} = \frac{\Lambda_p}{\Lambda_p + \Lambda_w} \cdot mpl + \frac{\Lambda_w}{\Lambda_p + \Lambda_w} \cdot mrs$$

$$\rho\pi_t = \Lambda_p \left(\omega_t - mpl\right) + \dot{\pi}_t$$

$$\rho\pi_t^w = \Lambda_w \left(mrs - \omega_t\right) + \dot{\pi}_t^w$$

$$\dot{\omega}_t = \pi_t^w - \pi_t$$

$$\kappa \equiv \frac{\Lambda_p}{\Lambda_p + \Lambda_w}$$

Asymptotic Inflation

$$\rho\pi = \Lambda_p\left(\overline{\omega} - mpl\right)$$

$$\rho\pi^w = \Lambda_w\left(mrs - \overline{\omega}\right)$$

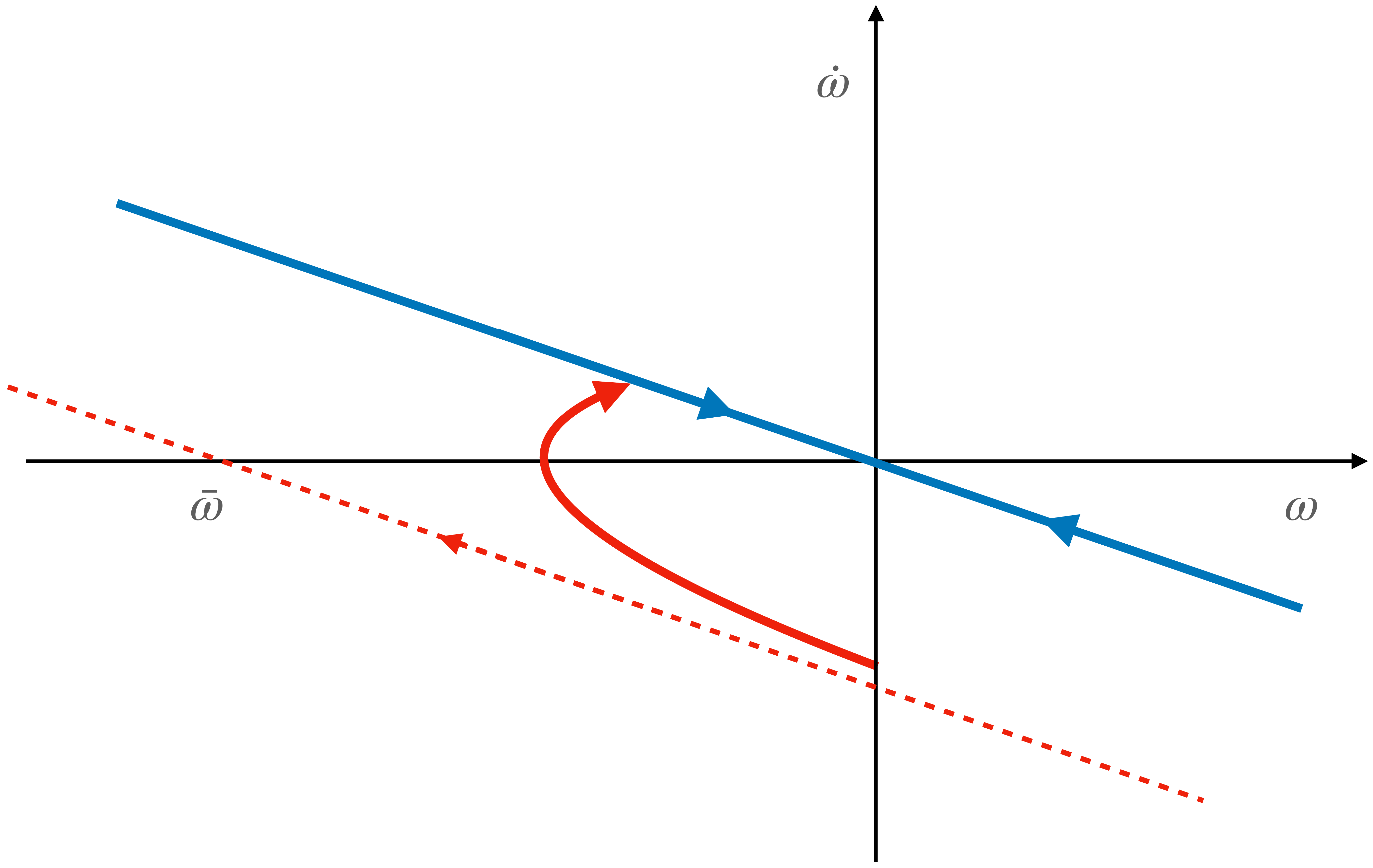
$$\longrightarrow$$

$$\pi = \pi^w = \frac{1}{\rho}\frac{\Lambda_p\Lambda_w}{\Lambda_p + \Lambda_w}(mrs - mpl)$$

- Inflation from disagreement
- Inflation does not resolve disagreement between *mpl* and *mrs*
- It just equalizes the tension on the two sides

- If $\rho \to 0$ then $\pi \to \infty$ (vertical Phillips curve)
- To bring down inflation we need to bring *mpl* = *mrs* (monetary policy)

Phase Diagram: Transitory Shock



A General Decomposition

$$\pi_t = \Pi_t^C - \kappa \cdot \Pi_t^A$$

$$\pi_t^w = \Pi_t^C + (1-\kappa) \cdot \Pi_t^A$$

"Conflict"

$$\Pi_t^C = \frac{\Lambda_p \Lambda_w}{\Lambda_p + \Lambda_w} \int_0^\infty e^{-\rho s}(mrs_{t+s} - mpl_{t+s})\, ds$$

"Adjustment"

$$\Pi_t^A = \dot{\omega}_t = (\Lambda_p + \Lambda_w) \int_0^\infty e^{-\rho s}(\tilde{\omega}_{t+s} - \omega_{t+s})\, ds,$$

$$\tilde{\omega}_t = \kappa \cdot mpl_t + (1-\kappa) \cdot mrs_t$$

Which Way Does W/P Go?

Q: Given paths for *mpl* and *mrs*
- When do we get price inflation?
- When wage inflation?
- Which one is stronger (on impact, down the line)?

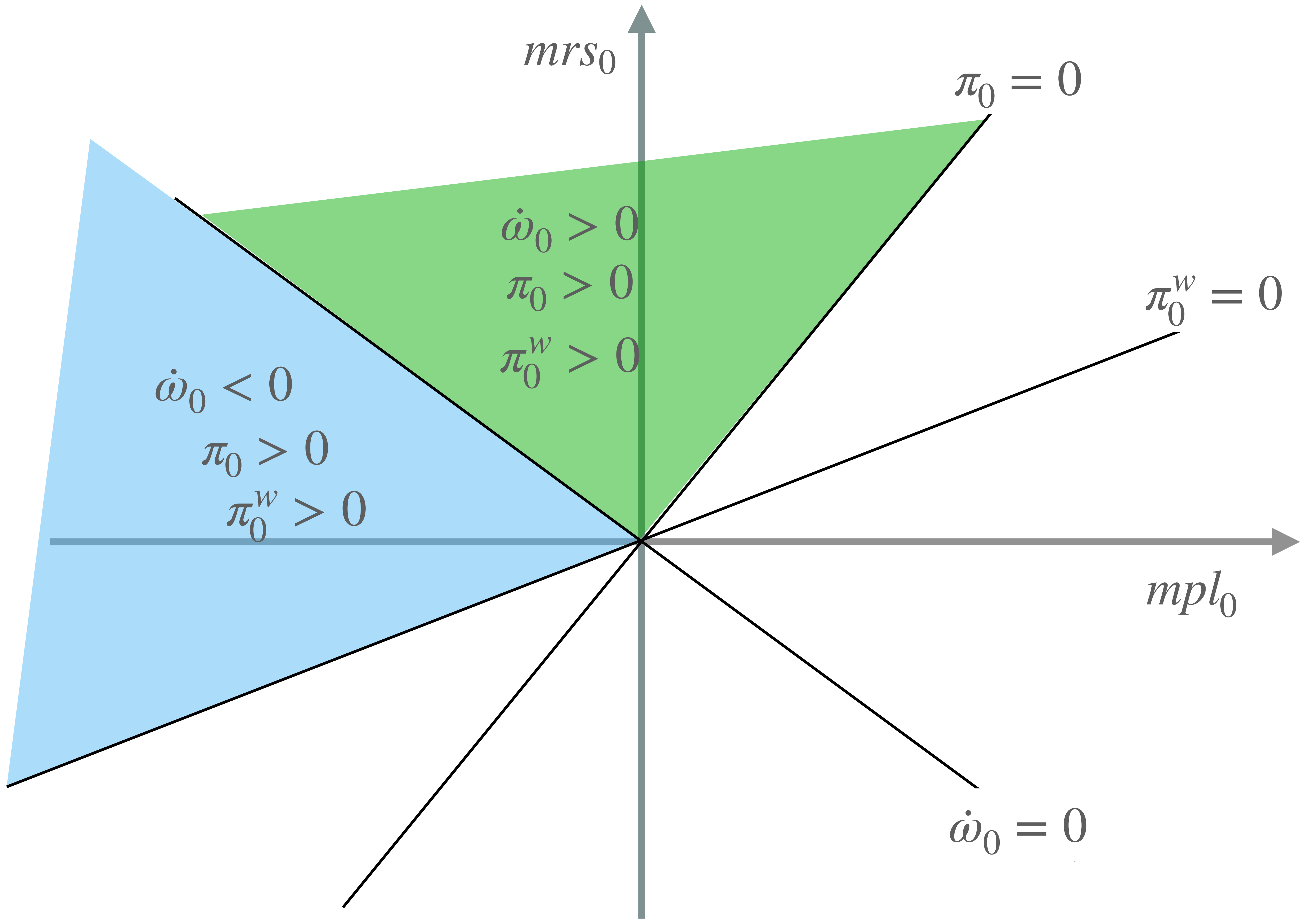
- Economy starts in steady state
- For $t < 0$: no conflict $mpl_t = mrs_t = 0$, real wage in steady state $w_t - p_t = 0$ no inflation
- Shock:

$$mrs_0 \neq 0, \qquad mpl_0 \neq 0$$

- Then

$$\dot{mrs}_t = -\delta \cdot mrs_t, \qquad \dot{mpl}_t = -\delta \cdot mpl_t$$

Regions



mrs_0
$\pi_0 = 0$
$\dot{\omega}_0 > 0$
$\pi_0 > 0$
$\pi_0^w > 0$
$\pi_0^w = 0$
$\dot{\omega}_0 < 0$
$\pi_0 > 0$
$\pi_0^w > 0$
mpl_0
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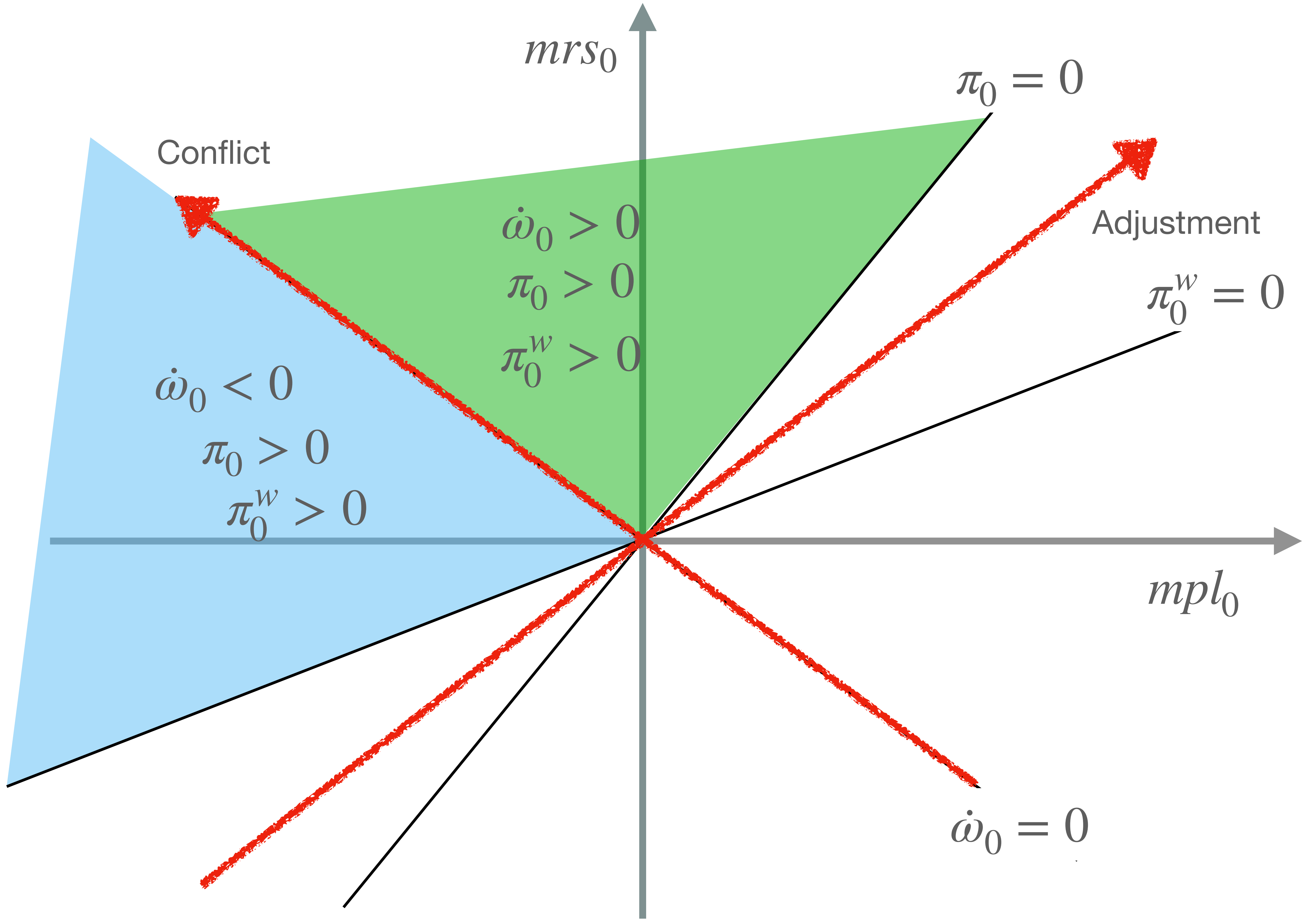

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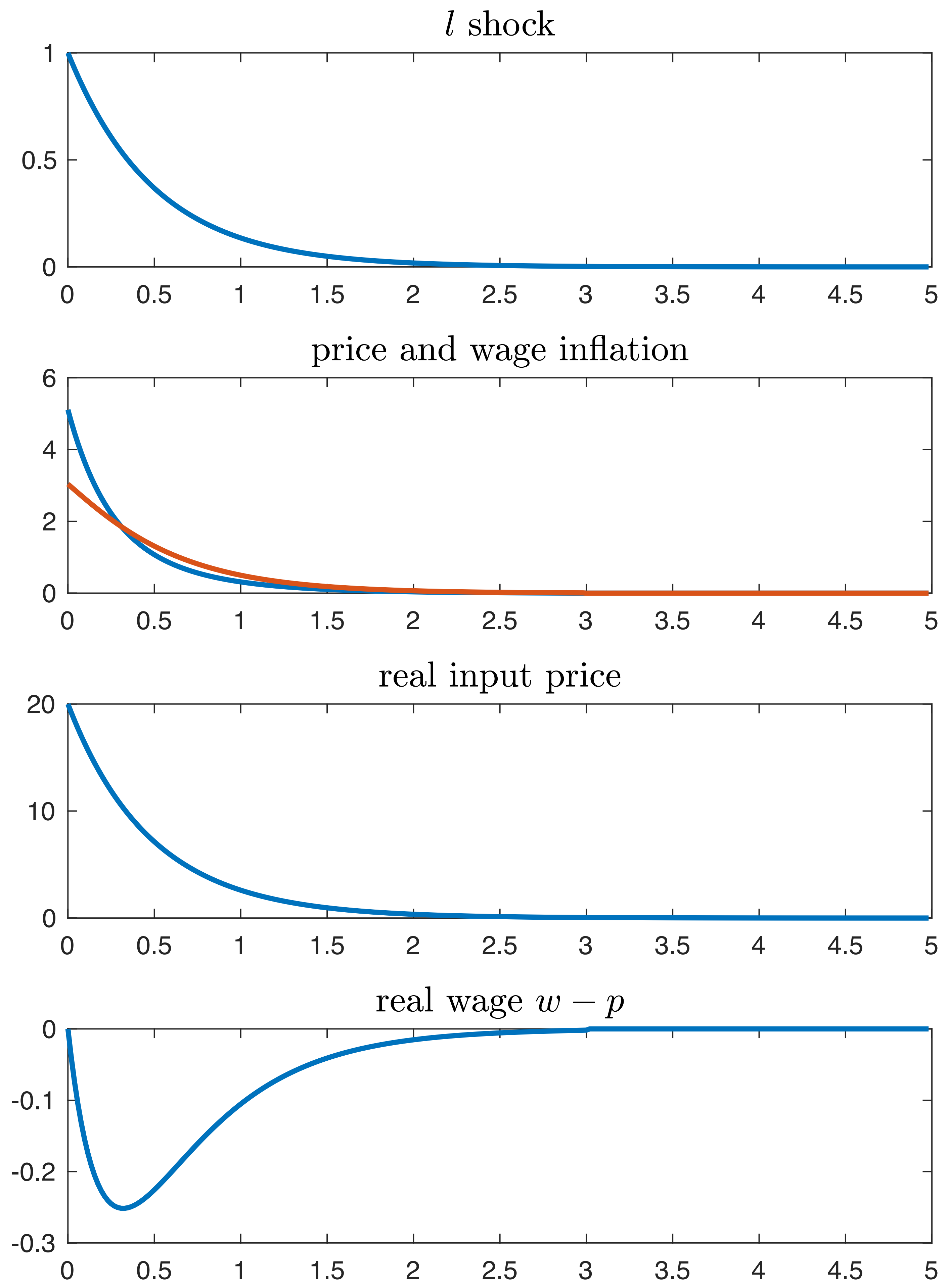
3. Demand and Supply Shocks

A Demand Shock

- A monetary policy mistake
- Economy is in steady state with $\pi = \pi^w = 0$ and $y = n = 0$
- Monetary stimulus causes unexpected shock $n_0 > 0$ with $n_t = e^{-\xi t} n_0$
- What happens to inflation in:
  - Input X price
  - Other goods
  - Wages

A Demand Shock

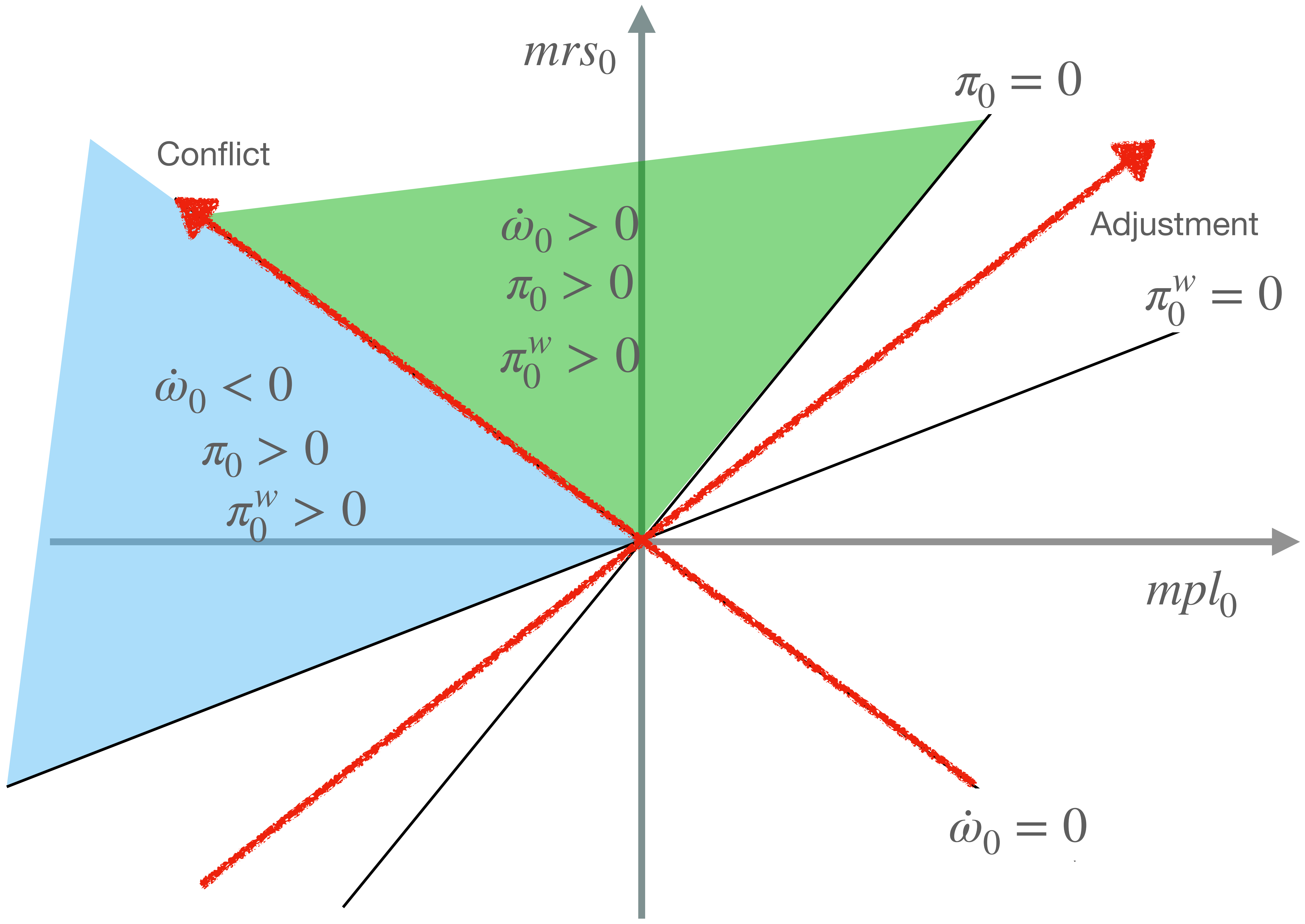


Three phases:

- Very fast response of *X* price
- Pass-through into other goods
- Reaction of wages

See Ball, Leigh, Mishra (2022) for importance of pass-through from non-core to core inflation

Regions



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mpl_0
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When Does a Demand Shock Produce Lower Wages?

A supply-constrained demand shock

$$\frac{\Lambda_p}{\Lambda_w}\frac{s_X}{\epsilon} > \sigma s_L + \eta$$

Prices relatively less sticky than wages

Scarce input has high share and low elasticity of substitution with labor

Relatively weak response of real wage demands to hot labor market

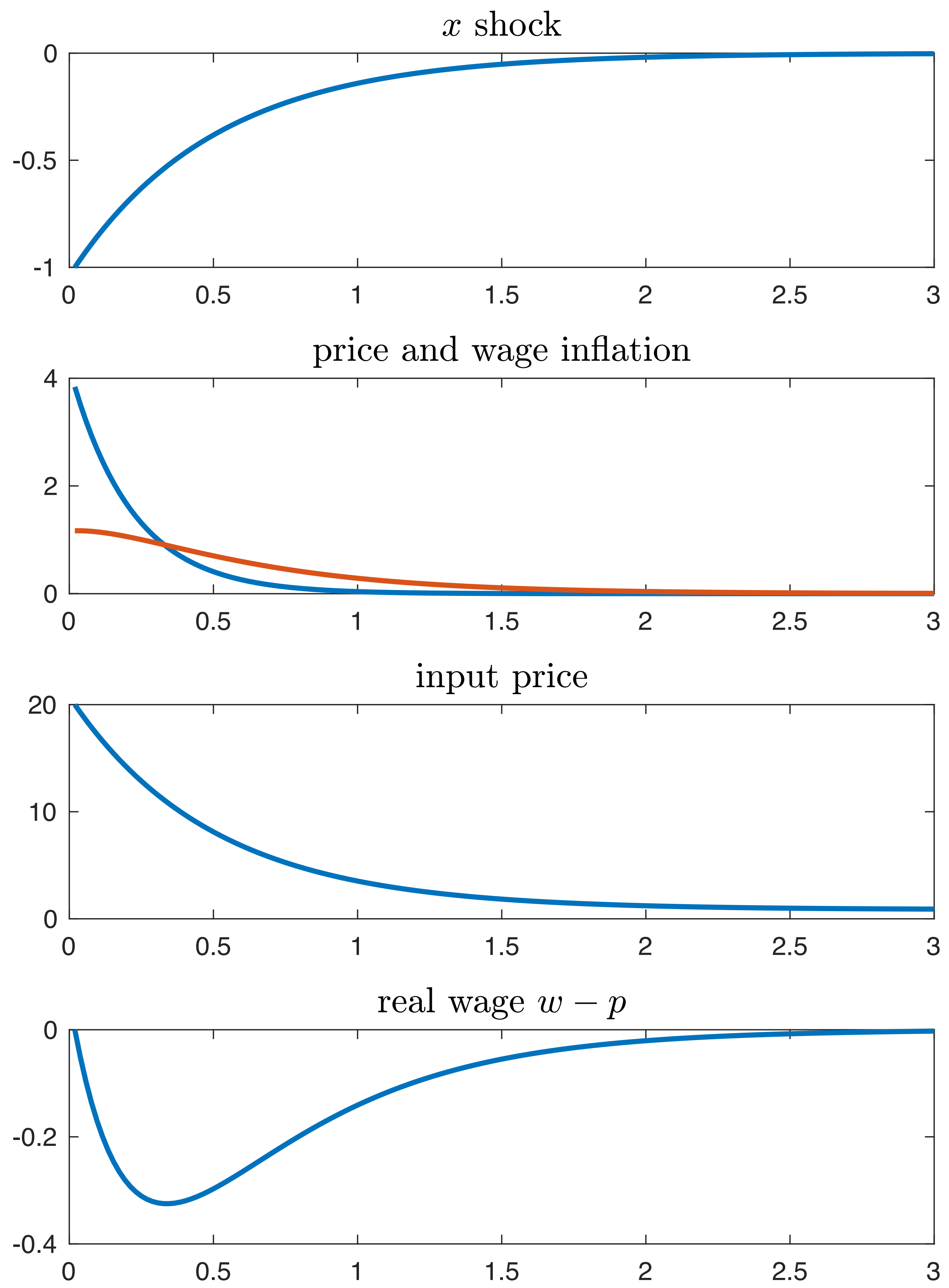
A supply shock

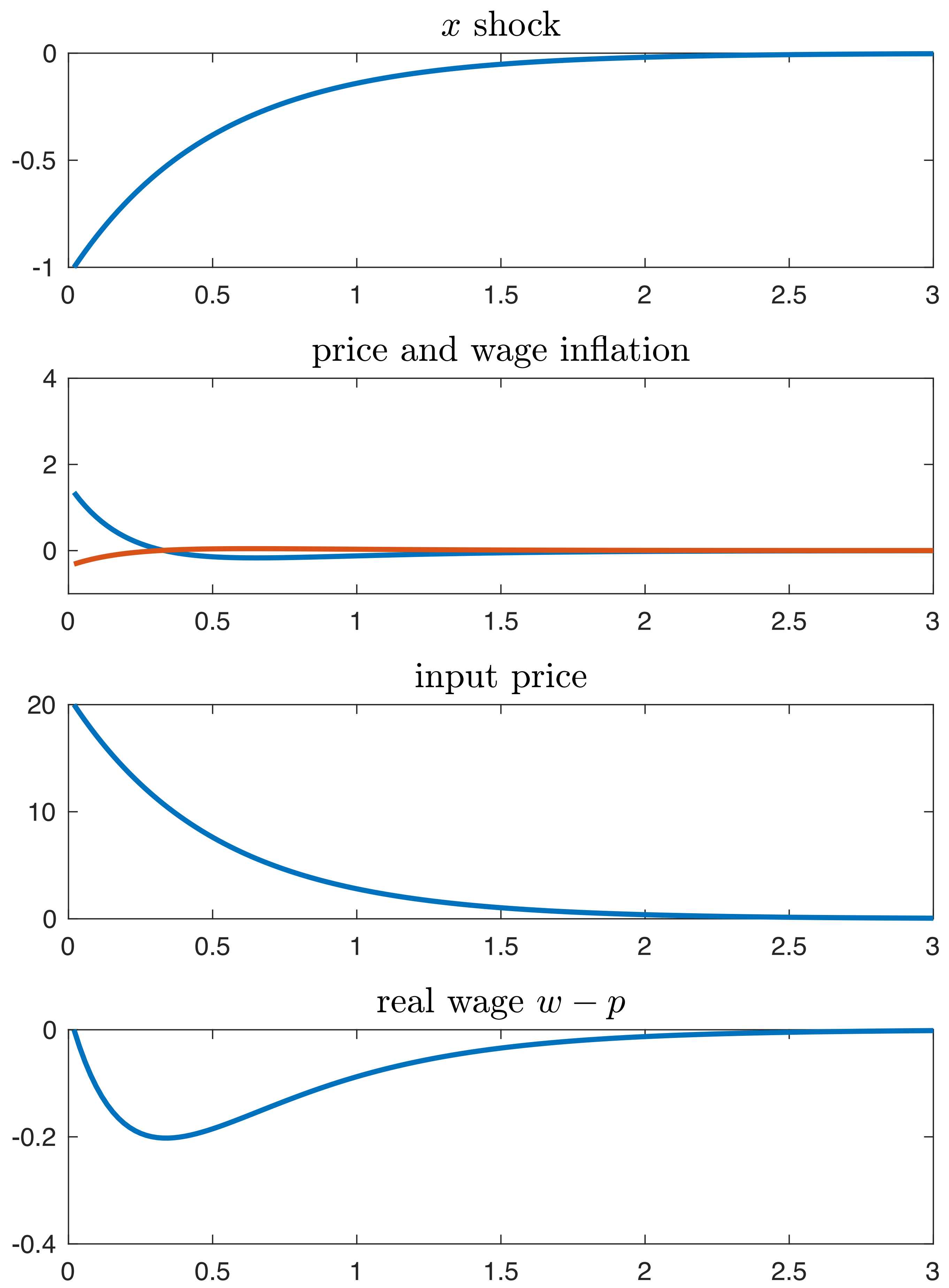
- Availability of input falls temporarily
- Two different responses of monetary policy captured by y path

  - **Response 1**: keep y on original path (zero)
  - **Response 2**: let y replicate flexible price benchmark y^*

Supply shock

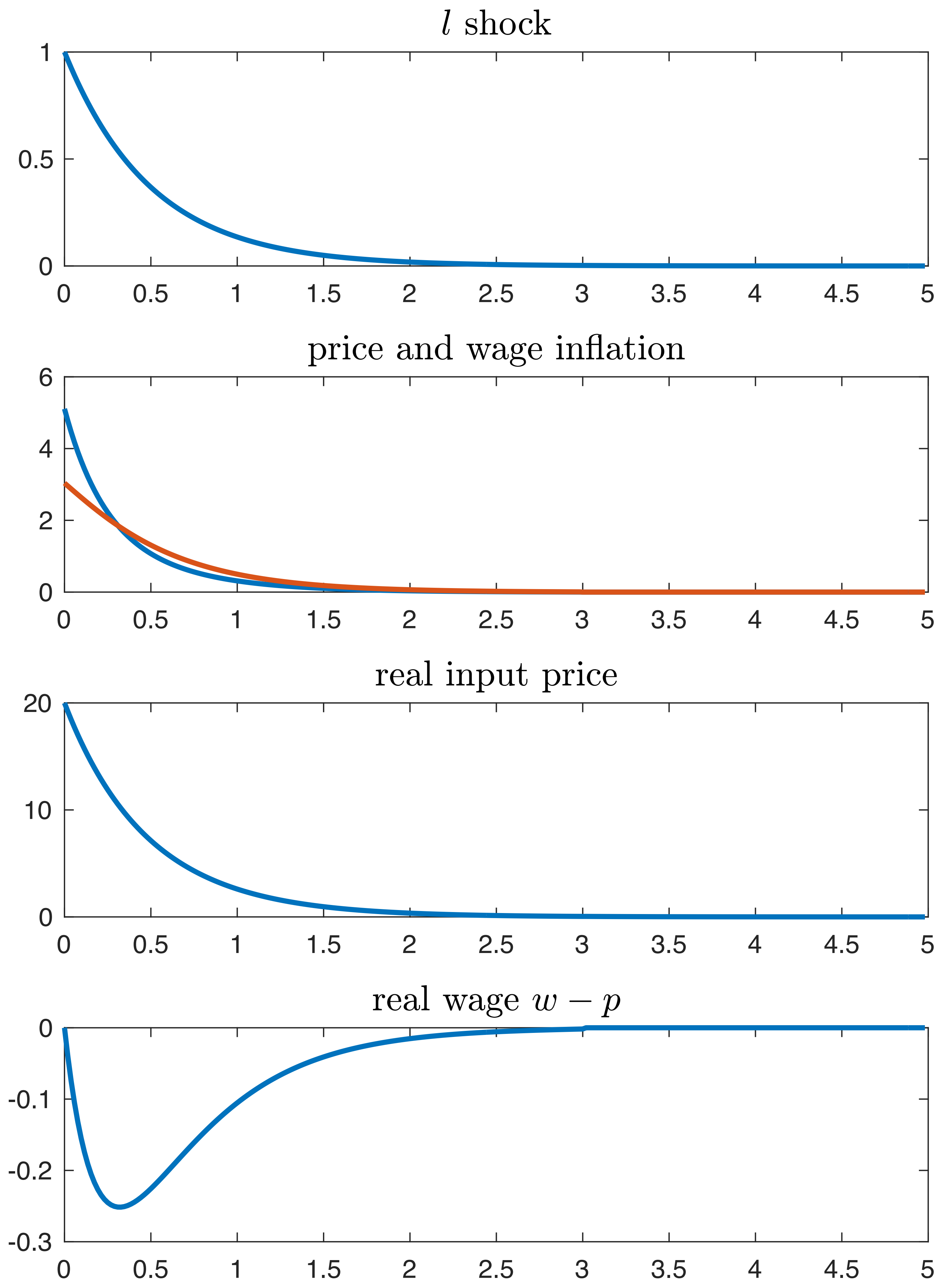
Two responses





Why w/p falls less?

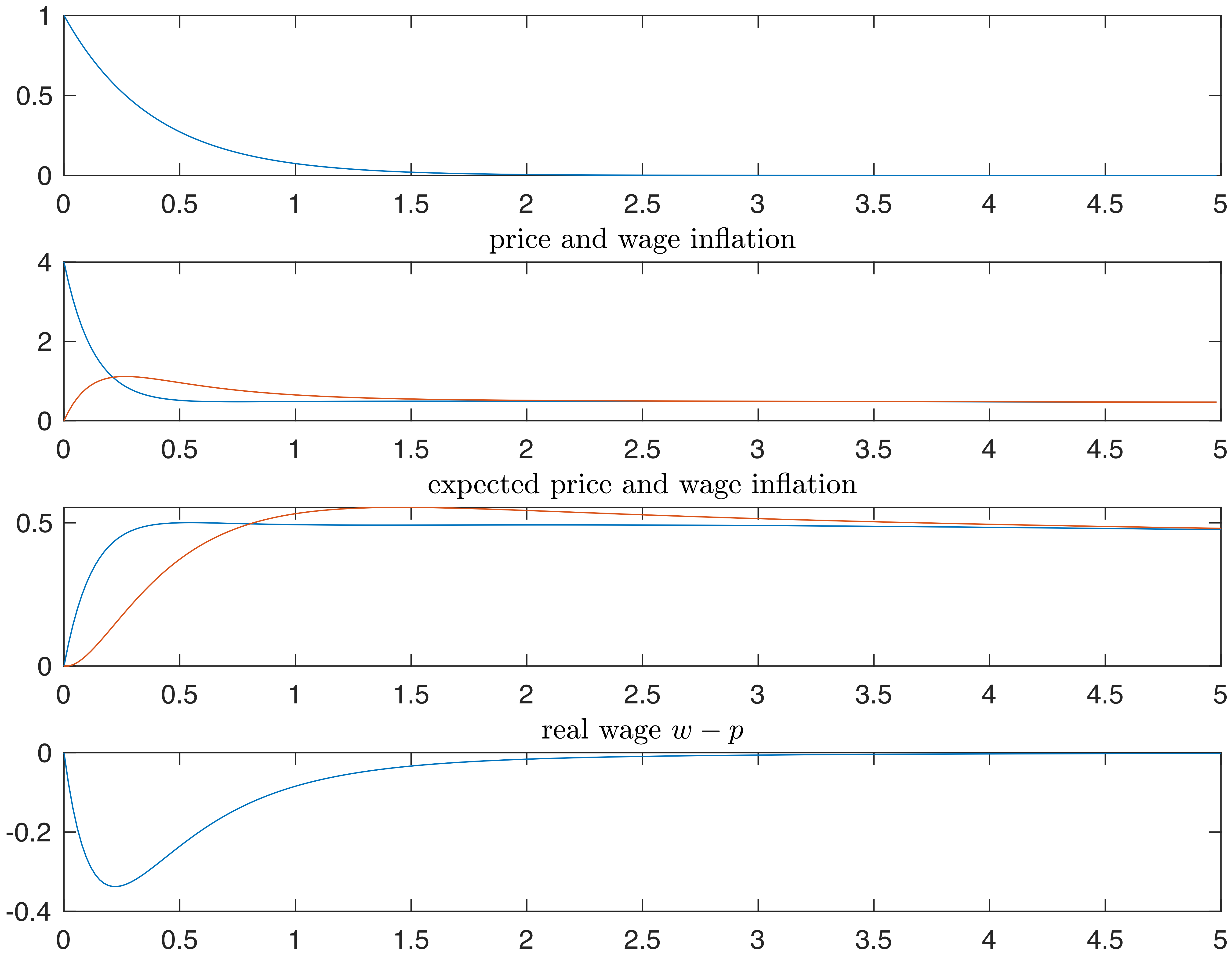
Demand or Supply Shocks?



Why Does Inflation Fall?

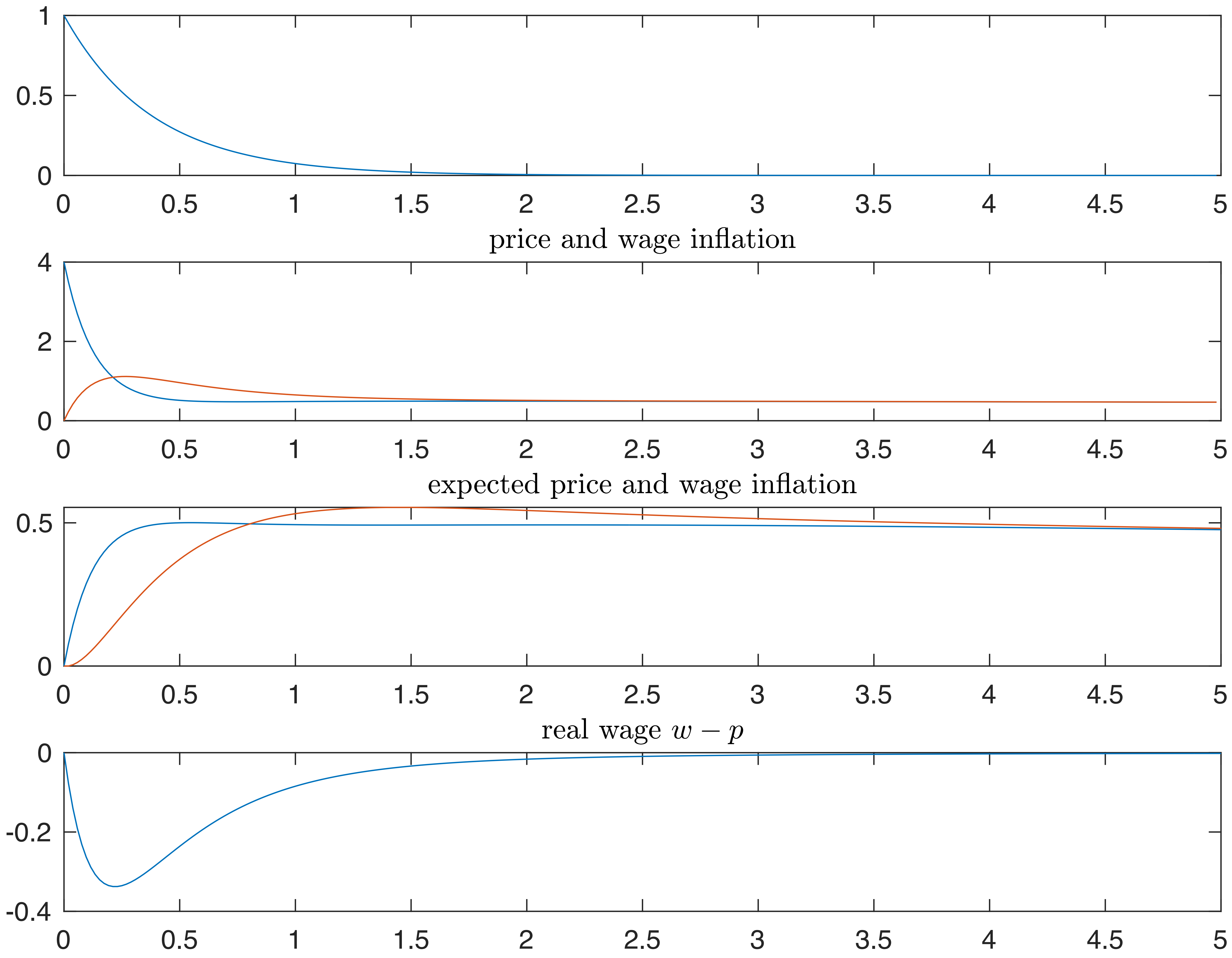
- We have shown price inflation can fall even with higher wage inflation
- Why does price inflation fall while W/P rises?
  - price of other input falls (negative inflation)…
    … supply constraints easing…
    … related: profit margin is high, room for real wages to recover;
  - wage increases partially priced in (forward looking rational expectations)
- Caveats in reality…
  - are input prices (or supply constraints) falling enough?
  - adaptive non-rational expectations?

Adaptive Expectations



Adaptive Expectations

Wage inflation takes more time to develop....



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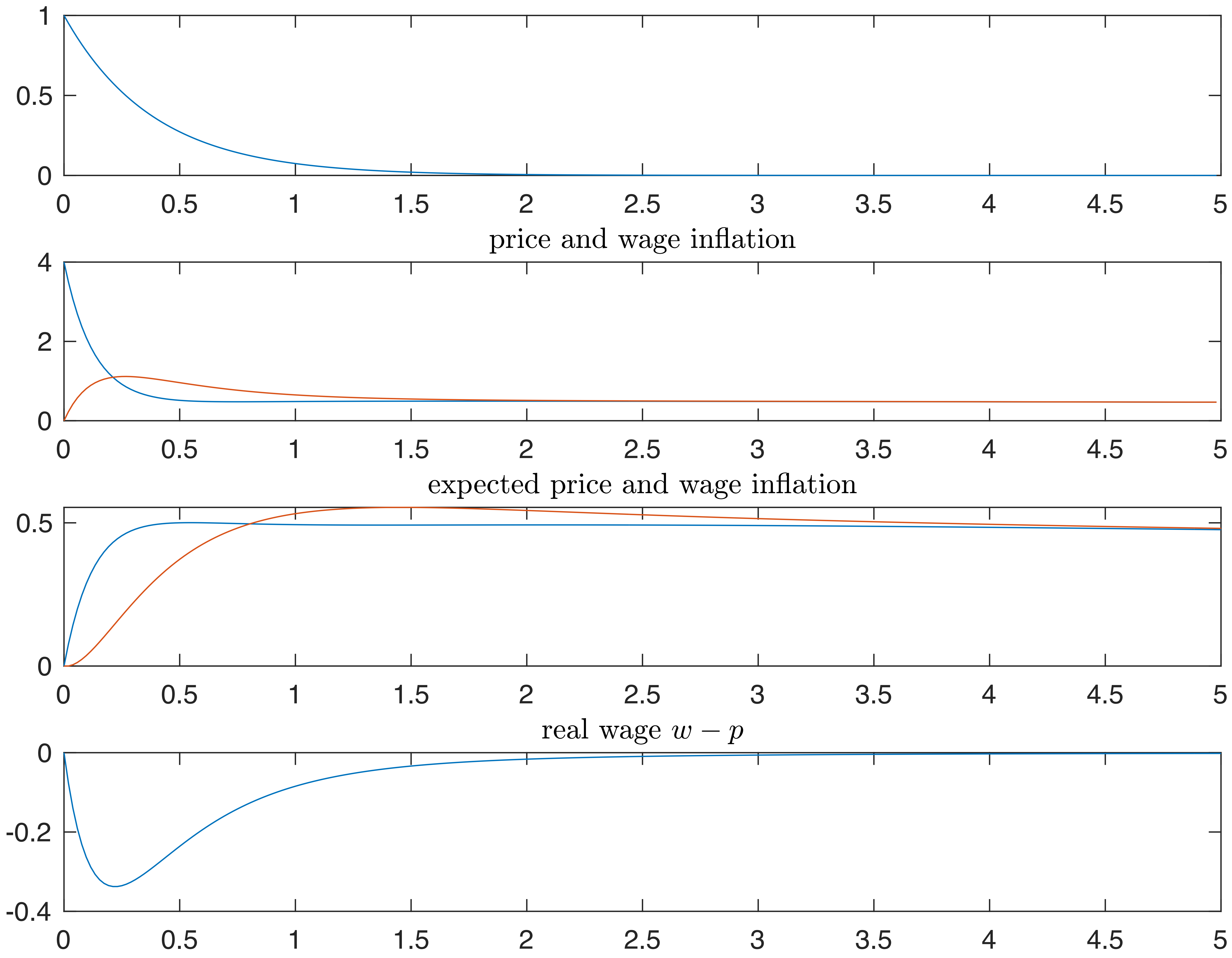


Inflation stays positive for much longer! Does eventually go to zero slowly (outside figure’s range)

Takes a recession to bring infaltion down?

Zero Output Gap Policy

- **Result**: if CB targets zero output gap, we cannot have $\pi > 0$ and $\pi^w > 0$
- Why?
- Zero output gap is equivalent to $mrs_t = mpl_t = \omega_t^*$ so

$$\pi_t = \Lambda_p \int_t^\infty e^{-\rho(s-t)} \left(\omega_s - \omega_s^*\right) ds$$

$$\pi_t^w = \Lambda_w \int_t^\infty e^{-\rho(s-t)} \left(\omega_s^* - \omega_s\right) ds$$

- Is zero output gap optimal?

4. Optimal Policy

Quadratic Approximation

- Usual approach: quadratic approximation of welfare near undistorted steady state
- Objective function

$$-\int_0^\infty e^{-\rho t}\frac{1}{2}\left[\Phi_y\left(y_t - y_t^*\right)^2 + \Phi_p \pi_t^2 + \Phi_w\left(\pi_t^w\right)^2\right] dt$$

- Distorted labor supply margin and distortions due to dispersion in relative prices and relative wages
- Coefficients Φ are functions of model's underlying parameters

Optimal problem

A permanent shock

- Focus on a permanent shock to x_t
- Equivalent to analyze no shock but wrong initial condition: $\omega_0 \neq 0$
- Maximize

$$-\int_0^\infty e^{-\rho t}\frac{1}{2}\left[\Phi_y y_t^2 + \Phi_p \pi_t^2 + \Phi_w \left(\pi_t^w\right)^2\right] dt$$

subject to

$$\rho \pi_t = \Lambda_p \left(\omega_t + \xi_p y_t\right) + \dot{\pi}_t$$

$$\rho \pi_t^w = \Lambda_w \left(\xi_w y_t - \omega_t\right) + \dot{\pi}_t^w$$

$$\dot{\omega}_t = \pi_t^w - \pi_t$$

given ω_0

Questions

- Well known that divine coincidence fails here, but that's just a statement on feasibility

- Can it be optimal to run the economy hot? I.e., have $y_t > 0$ and $\pi_t > 0$
- Can it be optimal to have generalized inflation? I.e., have $\pi_t > 0$ and $\pi_t^w > 0$
- Can it be optimal to have a hot economy AND generalized inflation

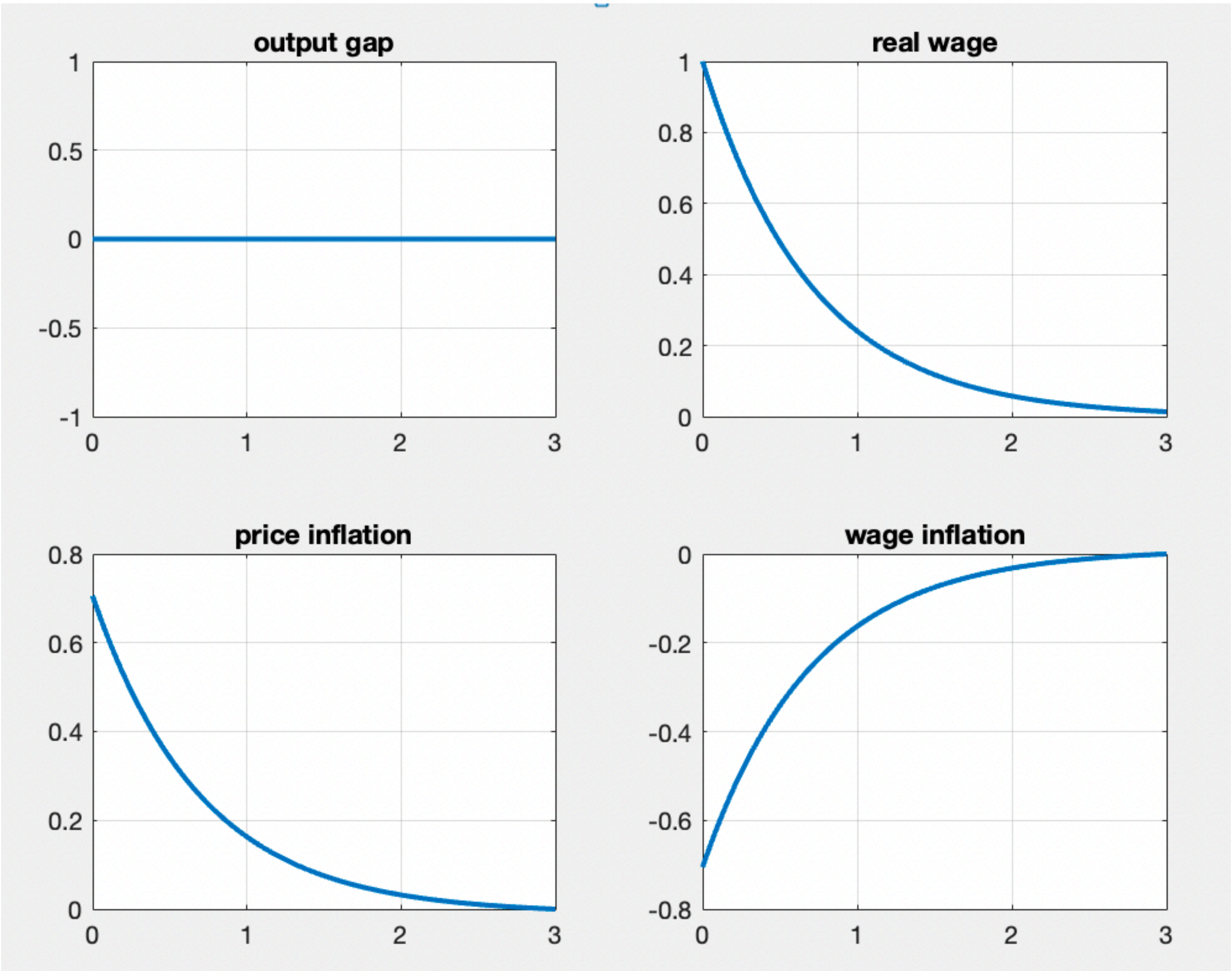
$$y_t > 0, \quad \pi_t > 0, \quad \pi_t^w > 0$$

- If yes, why?

Example 1: symmetry

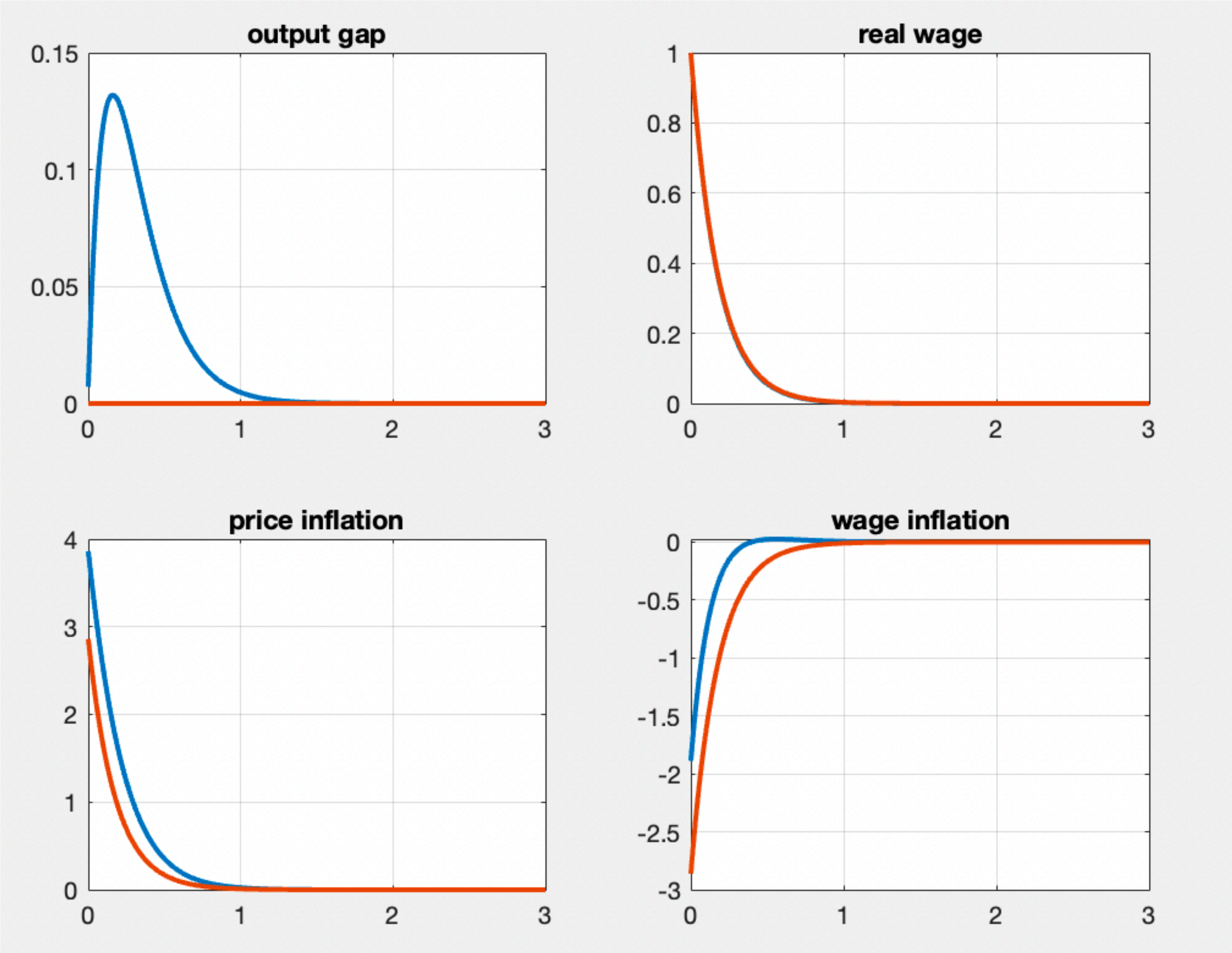
- A very symmetric example where parameters are such that

  1. $\Phi_p = \Phi_w$ same welfare weights
  2. $\Lambda_p = \Lambda_w$ same stickiness
  3. $\xi_p = \xi_w$ same responses of mpl and mrs to output gap deviations



Example 2: hot economy

1. $\Phi_p < \Phi_w$ more concern with wage distortions
2. $\Lambda_p > \Lambda_w$ prices more flex
3. $\xi_p \approx \xi_w$ similar responses of mpl and mrs to output gap deviations



In blue: optimal path
In red: zero output gap

Example 4: hot+generalized

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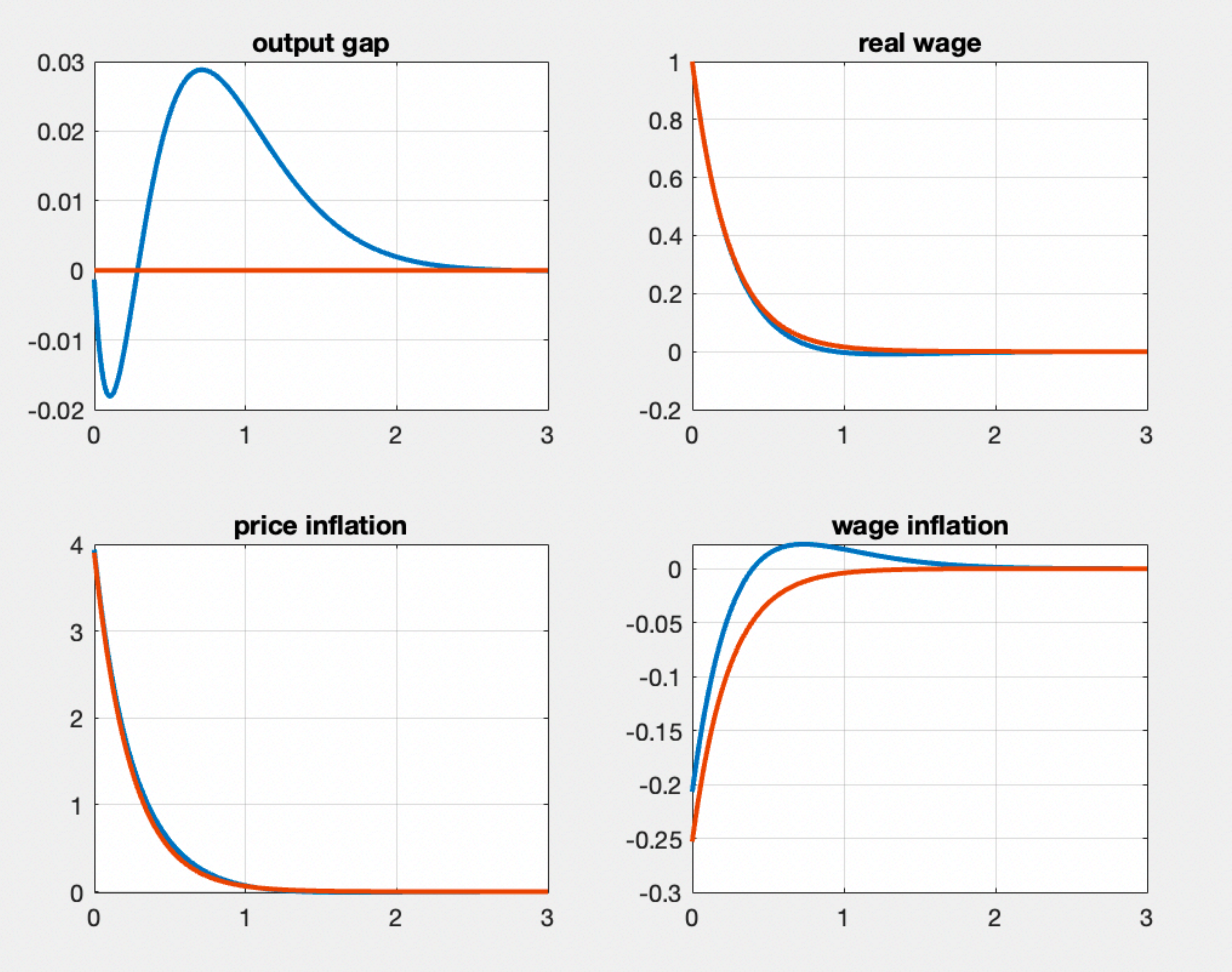

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In red: zero output gap

Concluding

- Wage price spirals are a component of existing macro models
- Which way W/P goes during a spiral depends on **relative** force of disturbances
- Pure aggregate demand shock can cause a real wage contraction
- **3 phase shock** (demand or supply): scarcity pops up in some places, then it feeds back in general inflation, then it feeds back in wage inflation
- Shortages and relative price jumps tend to fade earlier than general wage and price inflation
- Optimal response may involve combinations of $y > y^*, \quad \pi > 0, \quad \pi^w > 0$