Inflation: Conflict and Spirals

Norges Bank/IMF/IMFER Conference - June 2023

Guido Lorenzoni and Ivan Werning

Conflict and spirals

- **Conflict, disagreement, disappointment** central to inflation experience
- Tension between *aspirations* and *realizations* of **relative prices**
- They are there in our models! A bit hidden: we try to bring them out

- **Spirals**: dynamics of one central relative price **W/P**
- Effects of demand shocks and supply shocks
- Inflation as **waves** of relative price adjustment

1. Conflict

Relative prices

- Inflation and relative prices
- Perennial source of misunderstanding
- People: “I hate inflation, it erodes my purchasing power!”
- Economists: “That’s *not* really the problem, problem is that with high inflation *all* prices rise”
- Cost is not that *your* relative price changes, cost is that: money is a bad store of value (Friedman), that all relative prices are a bit off (NK model)
- But is naive view really wrong?

A network economy

- A network of sectors (including labor)
- Each sector n cares about relative price (in logs)

$$P_n - \sum_{n'} m_{nn'} P_{n'}$$

Coefficients m capture:
Input output structure
Consumption baskets of worker groups

- Each is trying to get their **aspiration** relative price

$$a_n$$

Can we make everyone happy?

- Is there a vector P such that

$$P - MP = a\,?$$

- Answer: yes iff

$$\gamma' a = 0$$

γ is a measure of network centrality of each sector

- Definition

$$\text{Conflict} = \gamma' a$$

Can we make everyone happy?

- Simple example

$$P - W = a_P$$
$$W - P = a_W$$

- No conflict iff

$$a_P + a_W = 0$$

Price setting

- Continuous time Calvo pricing
- Myopic agents set price

$$P^*_{nt} = a_{nt} + \sum_{n'} m_{nn'} P_{n't}$$

- Law of motion of prices

$$\dot{P}_{nt} = \lambda_n (P^*_{nt} - P_{nt})$$

- Where λ_n is Poisson intensity of resetting

Steady state

- Suppose a is constant
- Then for any initial vector of prices P_0 inflation in all sectors converges to the same value

$$\Pi^C = \frac{1}{\bar{d}} \cdot \gamma' a$$

Conflict!

- Where $\bar{d}$ is the average price duration

$$\bar{d} = \sum_n \gamma_n \frac{1}{\lambda_n}$$

Transitional dynamics

- Along transition to steady state

$$\pi_t = \Pi_t^A + \Pi^C$$

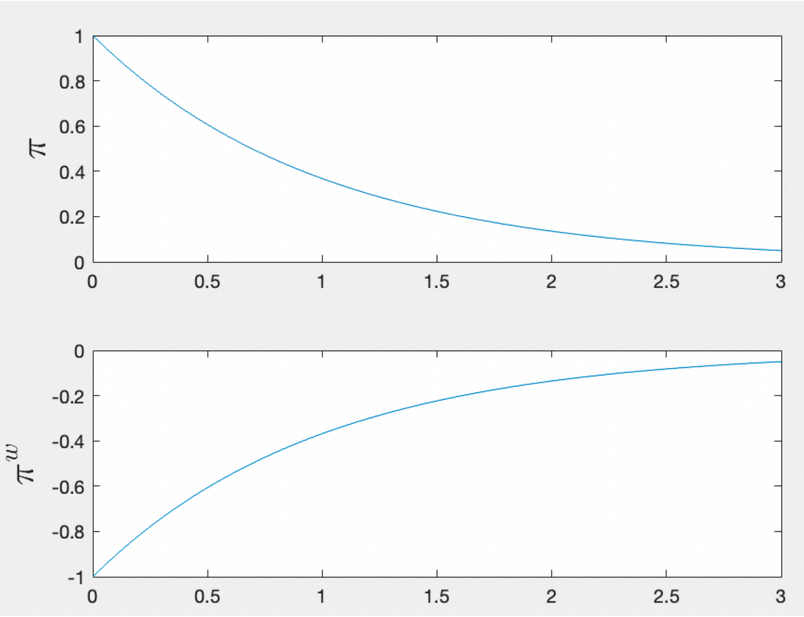
- We label two components "adjustment" inflation and "conflict" inflation

- **Result 1**: adjustment can never be positive for all sectors
- **Result 2**: adjustment eventually goes to zero

Examples (Wage/Price)

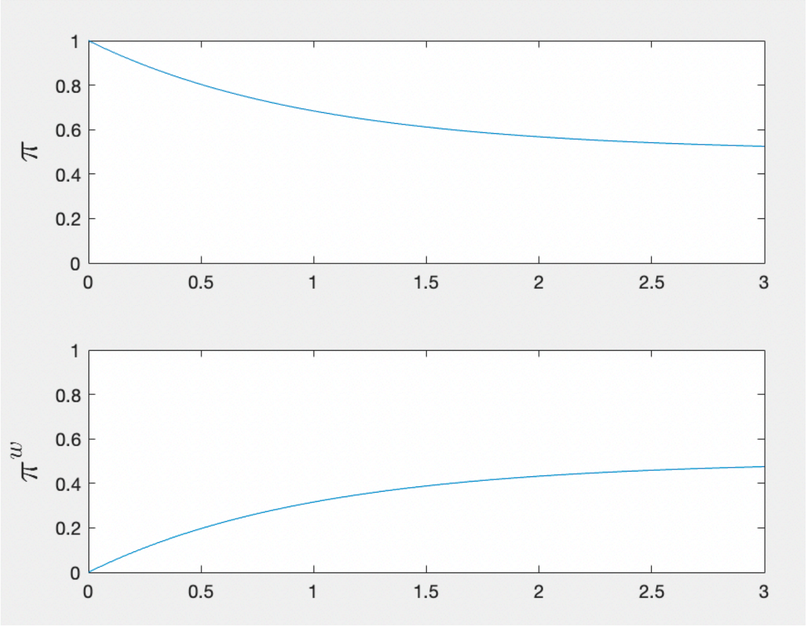
Example 1: No Conflict

$$a_P + a_W = 0 \qquad W_0 - P_0 = 0$$



Example 2: Conflict

$$a_P + a_W > 0 \qquad W_0 - P_0 = 0$$



Disappointment

- Even with inconsistent aspiration relative prices do **converge** in the long run

$$P_{nt} - \sum_{n'} m_{nn'} P_{n't} \to a_n - \frac{d_n}{\bar{d}} \cdot \gamma' a$$

Relative duration

Conflict (again!)

- But all agents are constantly disappointed by these relative prices!

Generalizing #1

- General path for a_{nt}
- Decomposition

$$\pi_t = \Pi_t^A + \Pi_t^C, \qquad \Pi_t^C \equiv \frac{1}{\bar{d}} \cdot \gamma' a_t$$

- **Result 1**: At each point in time t positive inflation is possible in *all* sectors iff conflict is positive
- **Result 2**: Time average of inflation in all sectors is equal to conflict alone in the long run

$$\lim_{T\to\infty} \frac{1}{T}\int_0^T \pi_{nt}\, dt = \lim_{T\to\infty} \frac{1}{T}\int_0^T \Pi_t^C\, dt\,.$$

Generalizing #2

- Forward looking price setters

$$P^*_{nt} = (\rho + \lambda_n)\mathbb{E}_t \int_t^\infty e^{-(\rho+\lambda_n)(s-t)}(a_{ns} + \sum_{n'} m_{nn'}P_{n's})ds$$

- Results go through
- Conflict inflation is now

$$\Pi_t^C = \frac{1}{\bar{D}} \int_0^\infty e^{-\rho s} \left(\gamma' a_t\right) dt$$

- Where

$$\bar{D} = \sum_n \frac{\gamma_n}{\lambda_n(\lambda_n + \rho)}$$

Measuring conflict inflation

- Conflict inflation is just a weighted average of sectoral inflation

$$\Pi_t^C = \sum_n \psi_n \pi_n$$

- Where

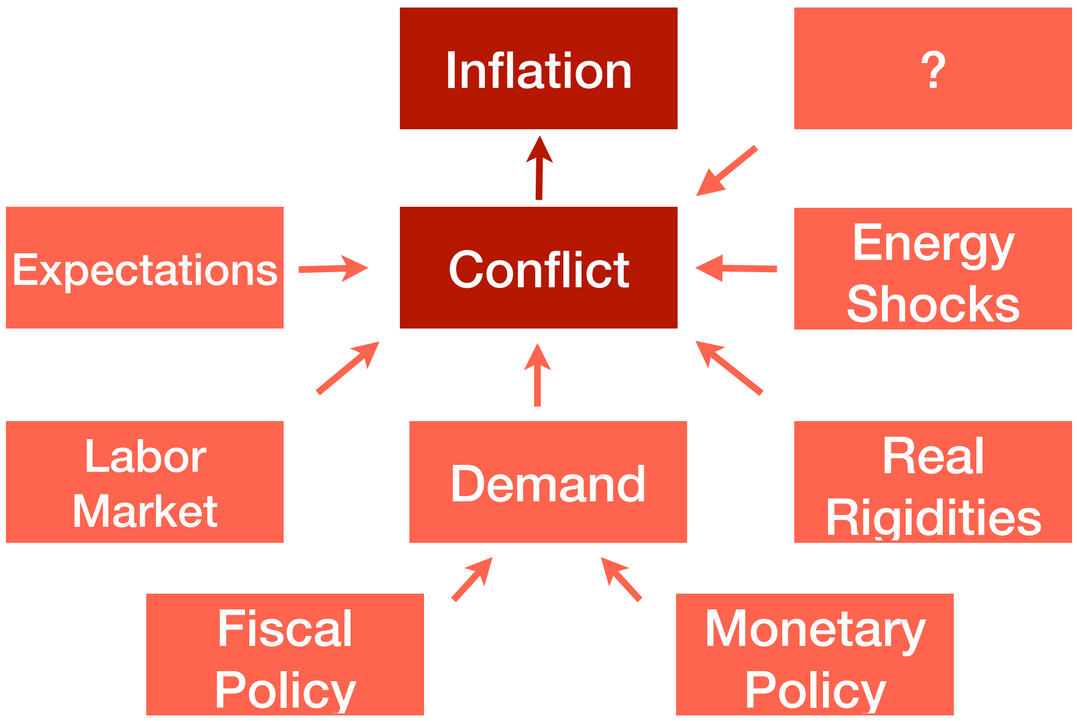
$$\psi_n = \frac{\frac{\gamma_n}{\lambda_n(\rho + \lambda_n)}}{\sum_{n'} \frac{\gamma_{n'}}{\lambda_{n'}(\rho + \lambda_{n'})}}$$

- Π_t^C has the property of not depending on past history of relative prices
- Similar property to "Divine Coincidence Index" of Rubbo (2022)
- Can be extended to adaptive expectations and indexing

Is this a new channel?

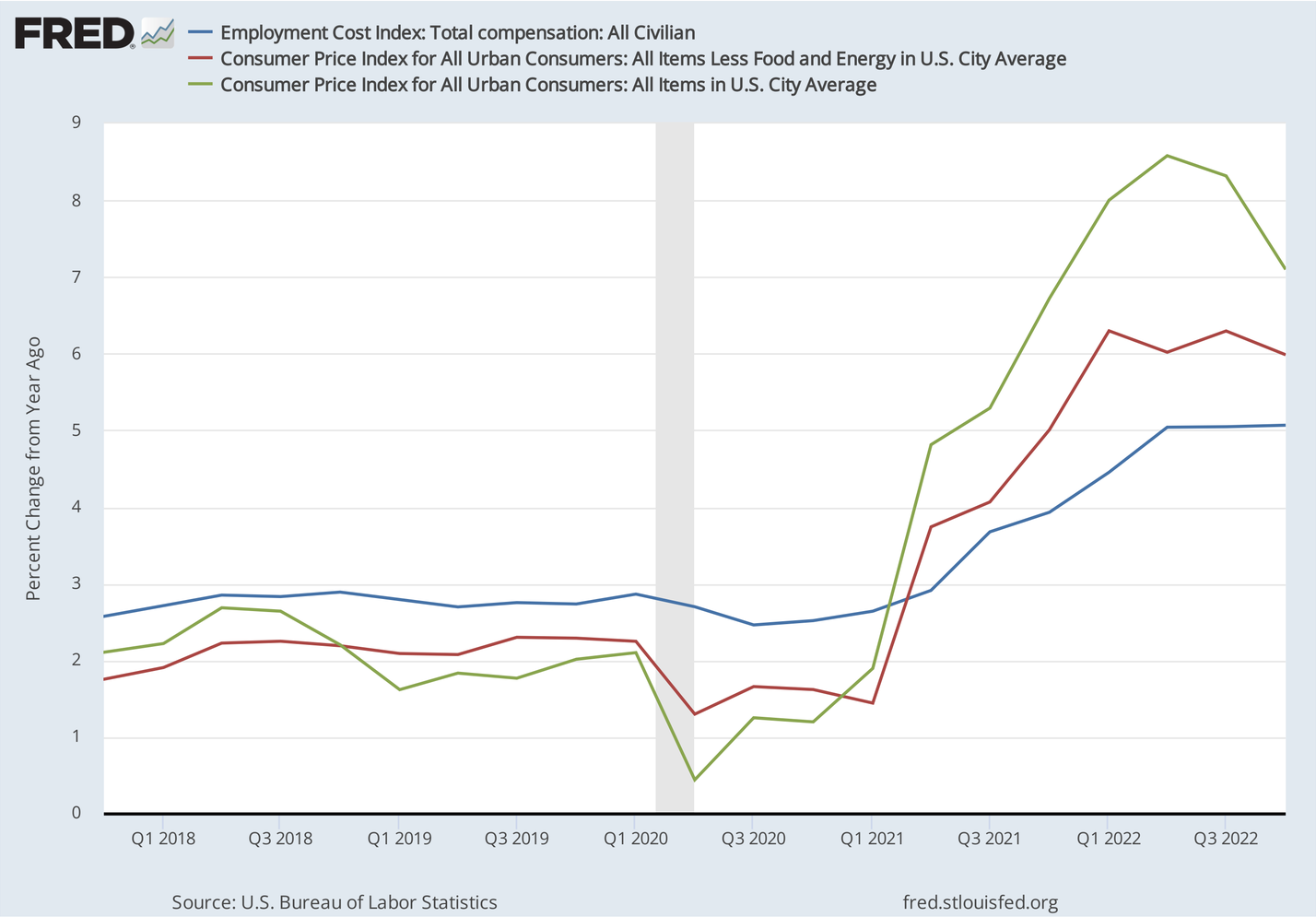
- Not really
- Vector a_t obviously endogenous
- Many standard forces can determine a_t
- In fact, we'll see an application in a completely standard NK model

Causality (DAG)



2. Spirals

Wage inflation and price inflation



Real wage movements and shocks

- In an inflation episode if the real wage falls what do we learn about the sources of the shock?
- Can inflation be driven by excess demand if real wages fall? [Yes]
- If real wages eventually start rising, should we worry inflation is more entrenched? [Not necessarily]
- If supply shocks hit, should we expect inflation to fall when they stop increasing the price of some input (growth) or when input price goes back down (level)? [Level]

Model

- Mostly standard NK model
  - price and wage stickiness
  - include other input for firms (supply constrained)
- 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 a CES composite of continuum of varieties, with elasticity of substitution ϵ
- Technology

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

Wage setters and input

- Multiple labor types

$$L_{jt} = \left(\int_0^1 L_{jkt}^{1-1/\zeta} dk \right)^{\frac{1}{1-1/\zeta}} \quad \text{for firm } j$$

- Each supplied by a monopolist wage setter (union)
- Input supplied by representative household on competitive market, supply X_t at price P_{Xt}

Firms' aspirations

- All firms use same mix of labor and X

$$a_{Pt} = -\, mpl_t$$

- Firms aim to get real wages = to MPL
- MPL depends on aggregate input to labor ratio

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

Workers' aspirations

- Workers aspiration is driven by their willingness to convert leisure into consumption

$$a_{Wt} = mrs_t$$

- Where MRS is

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

AR1 shocks

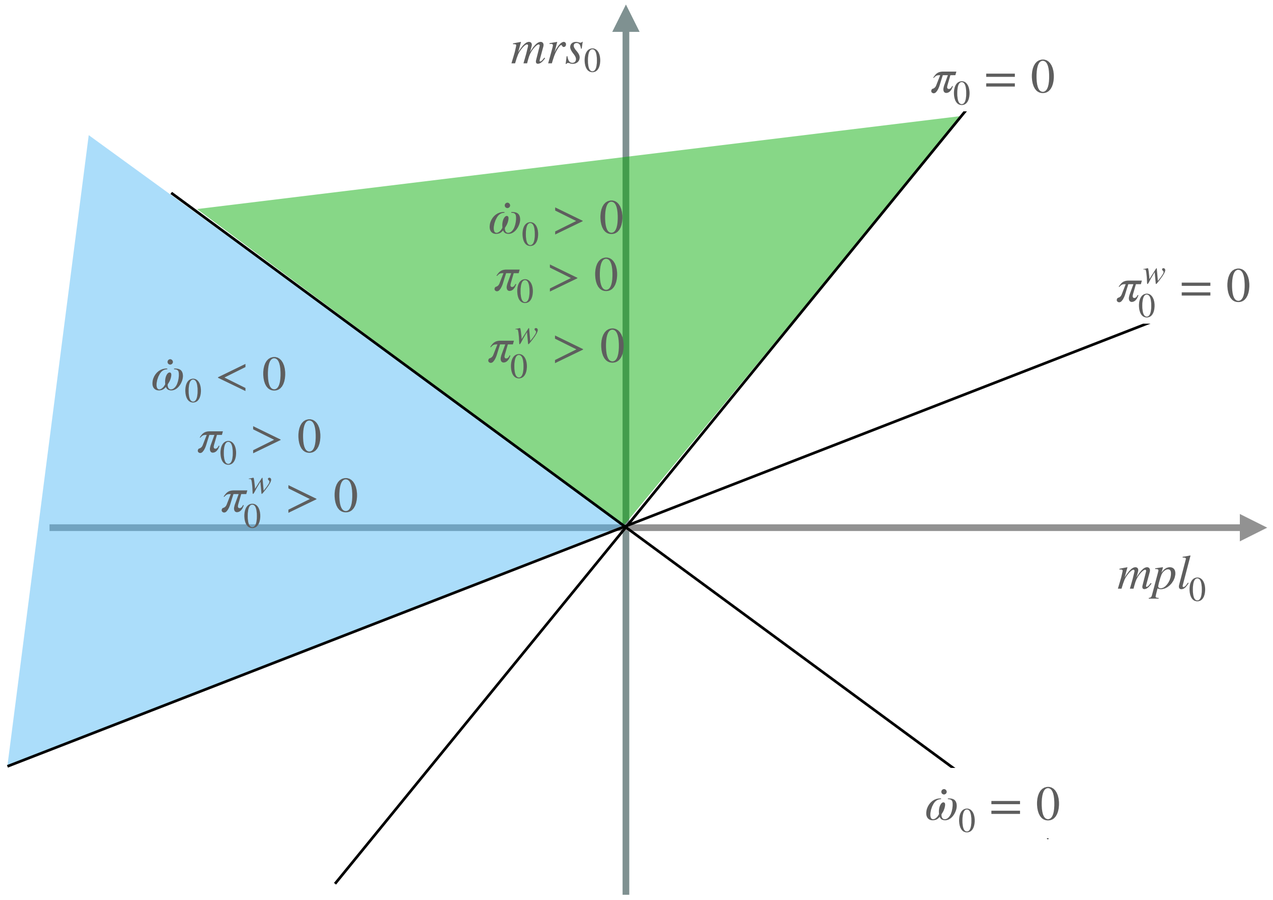
- Economy starts in steady state
- For $t < 0$: no conflict $mpl_t = mrs_t = 0$, real wage in steady state$w_t - p_t = 0$, no inflation
- Shock:

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

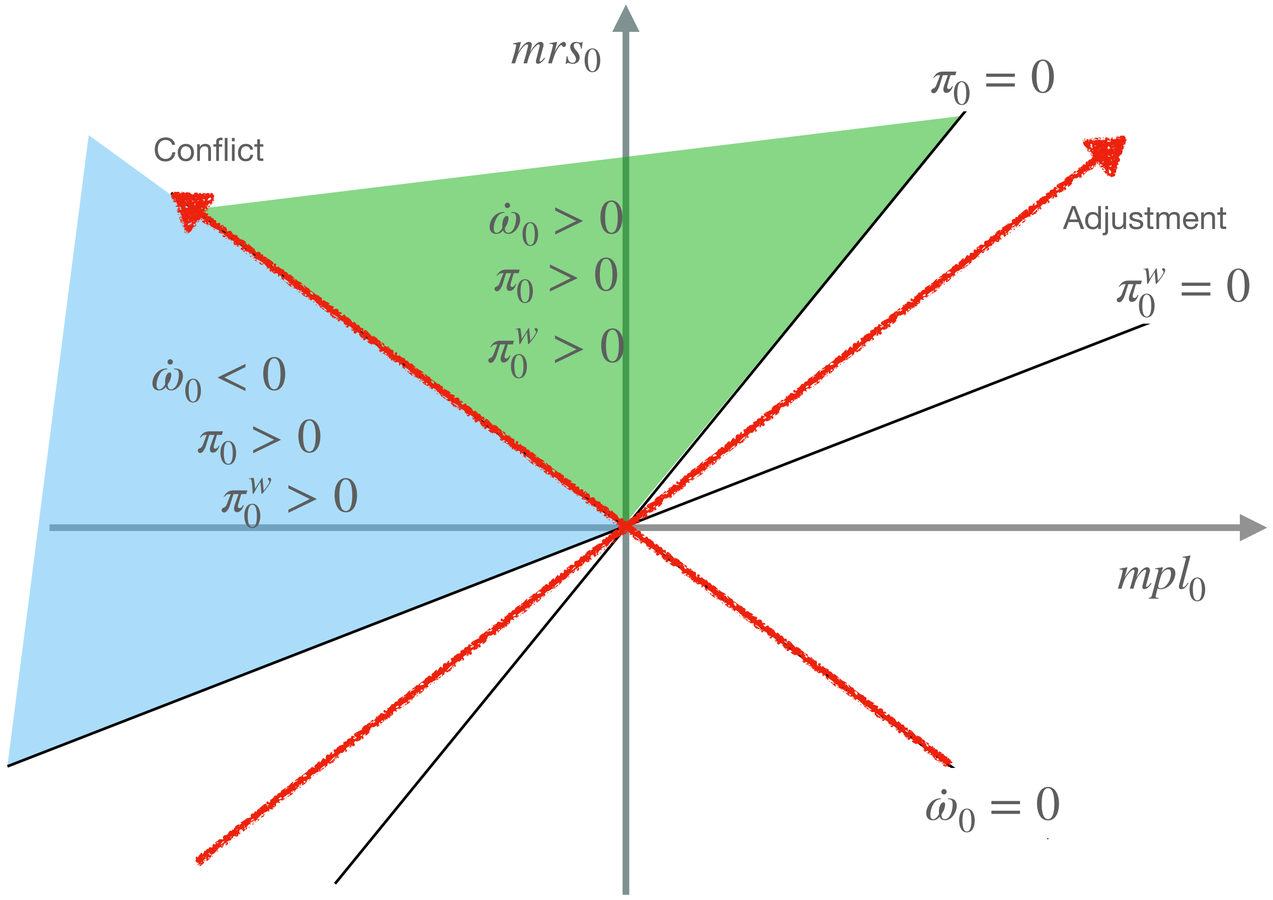
- Then

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

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
$\dot{\omega}_0 = 0$

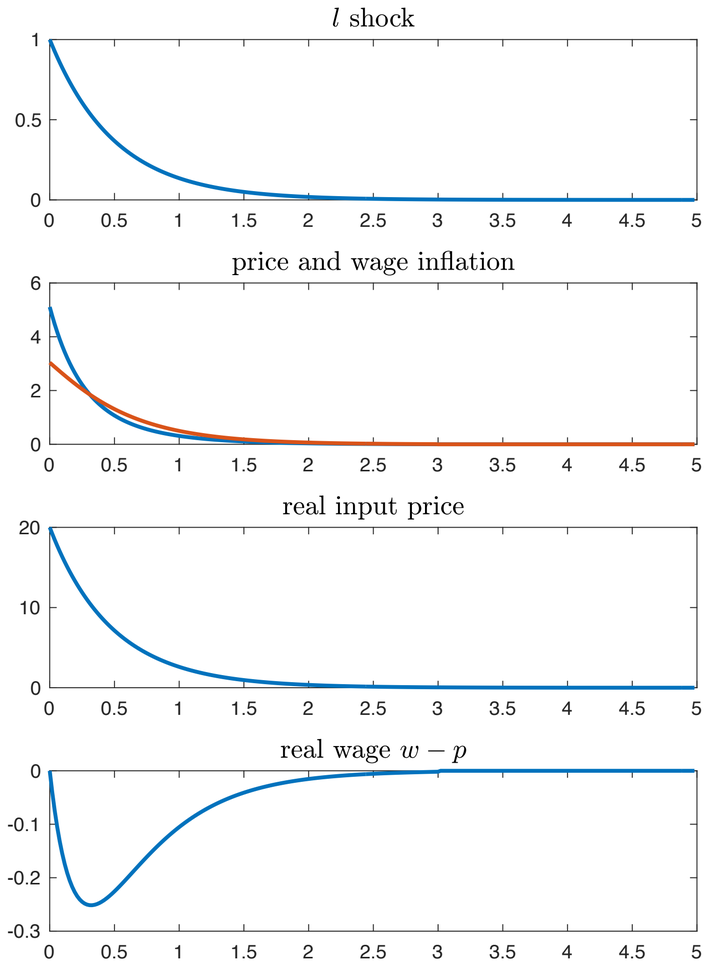
Regions


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

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 $n_t = e^{-\delta t} n_0$
- 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

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

Notation: $\Lambda_p = \lambda_p\left(\rho + \lambda_p\right)$ and $\Lambda_w = \lambda_w(\rho + \lambda_w)$

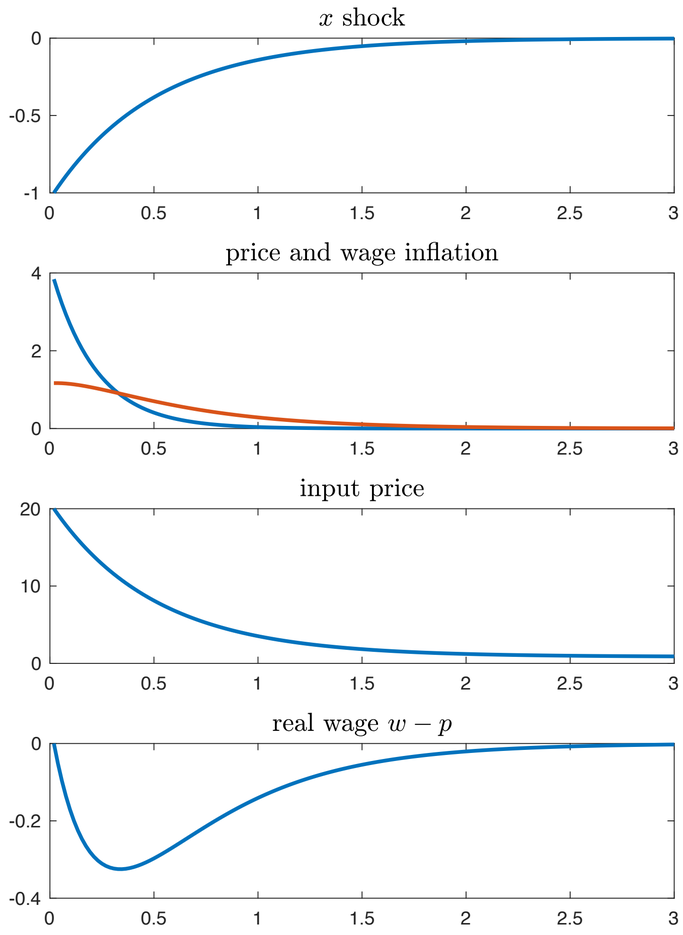
A supply shock

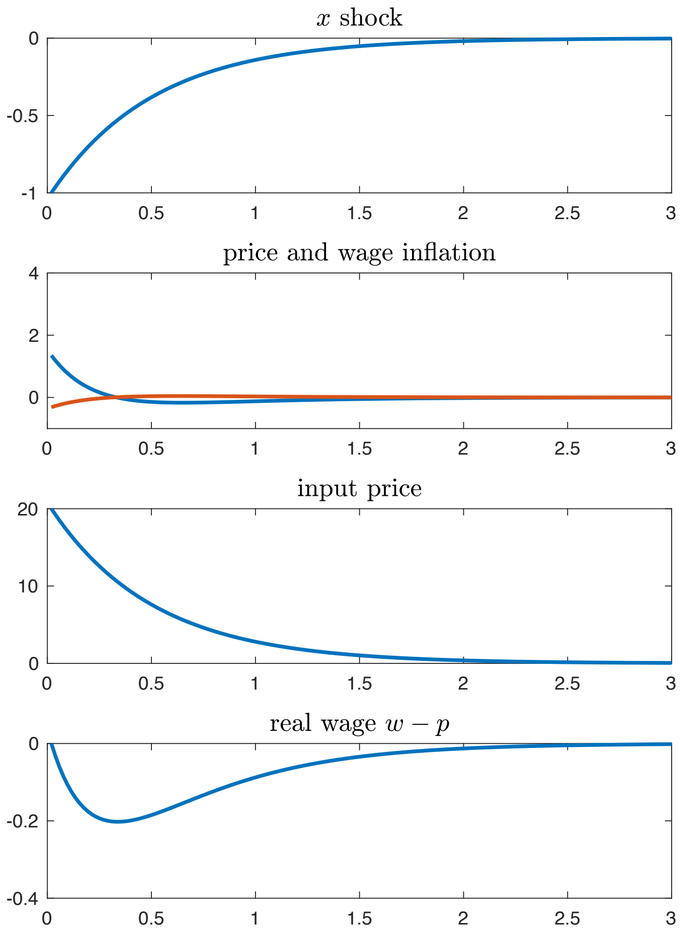
- Availability of input falls temporarily
- Two different responses of monetary policy captured by y path

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

Supply shock

Two responses





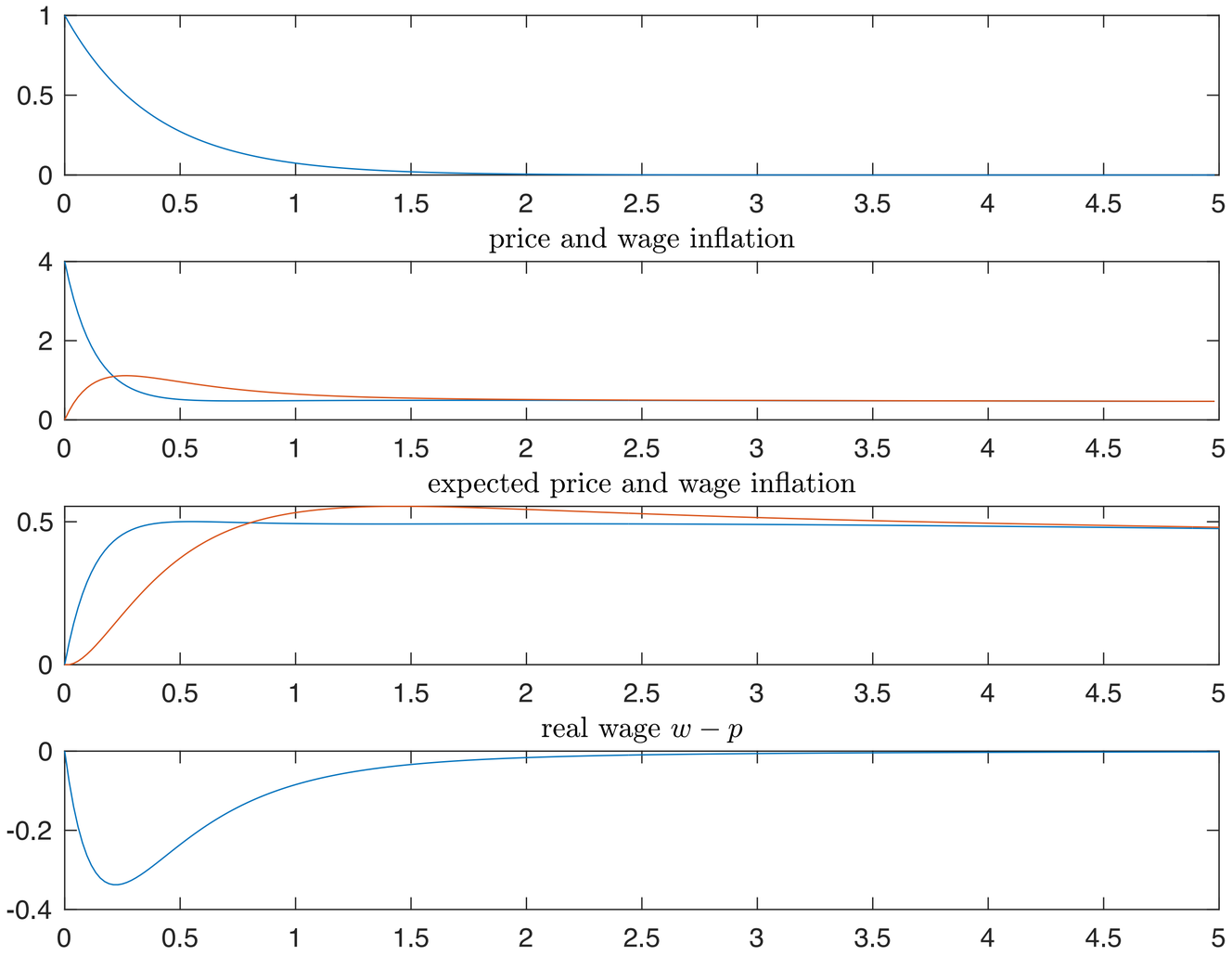
Why w/p falls less?

Why does inflation fall?

- Why does price inflation fall while W/P rises?
  - price of other input falls...
    ... supply constraints easing...
    ... related: profit margin is high, room for real wages to recover
  - wage increases partially priced in (forward looking rational expectations)
- Conflict perspective: inflation usually causes relative prices to move; once relative prices are at new level are people happy with them? If not, is there a relative price at which they will eventually be happy?
- Caveats in reality...
  - are input prices falling enough?
  - adaptive non-rational expectations?

Adaptive expectations

Wage inflation takes more time to develop....



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

Takes a recession to bring infaltion down?

Concluding

- Conflict and wage price spirals are a component of existing macro models
- **How real wage adjusts** during a spiral depends on relative effect of shocks on aspirations
- A pure aggregate demand shock can cause a real wage contraction
- Possible a **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
- Growth in specific prices reflecting shortages can reverse earlier than general wage and price inflation