Inflation is Conflict

Guido Lorenzoni + Ivan Werning

Inflation Is Conflict

Inflation Is Conflict

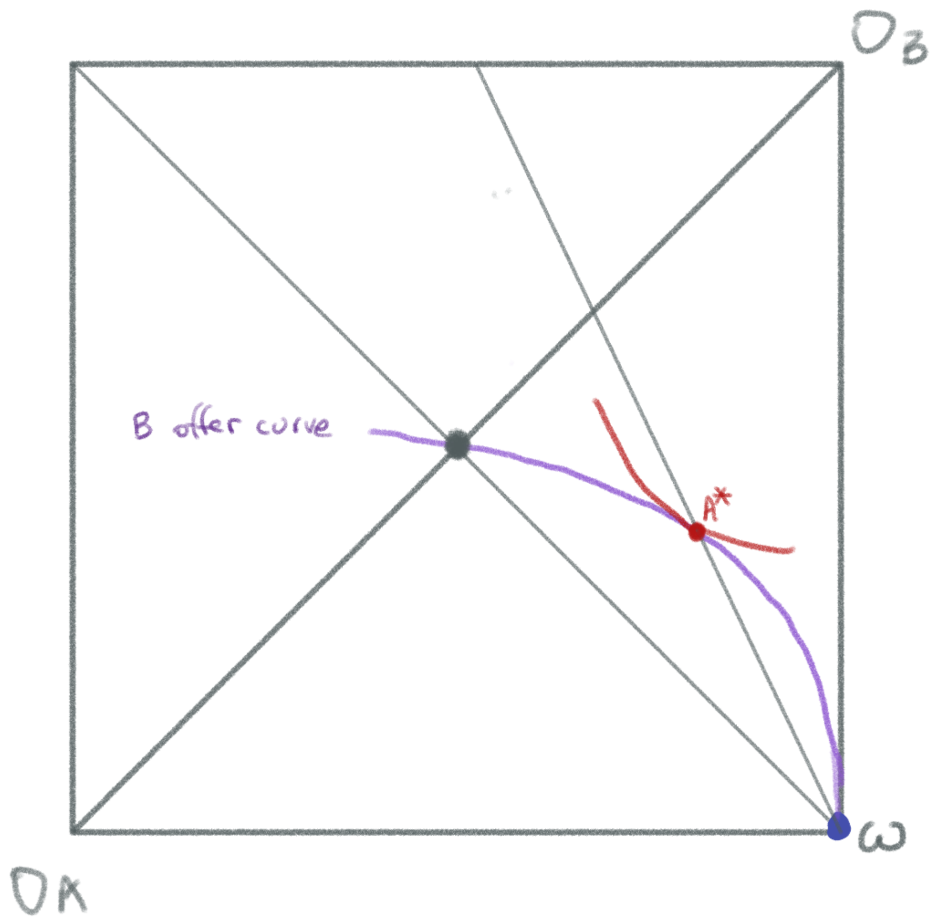
- **Questions…**
  - Mechanism for inflation?
  - Proximate cause of inflation?
  - Useful minimal common framework for wide set of models?

Inflation Is Conflict

- **Questions…**
  - Mechanism for inflation?
  - Proximate cause of inflation?
  - Useful minimal common framework for wide set of models?
- **Our answer: two ingredients…**
  - Conflict = Disagreement on relative prices
  - Staggered prices (distill best of NK models!)

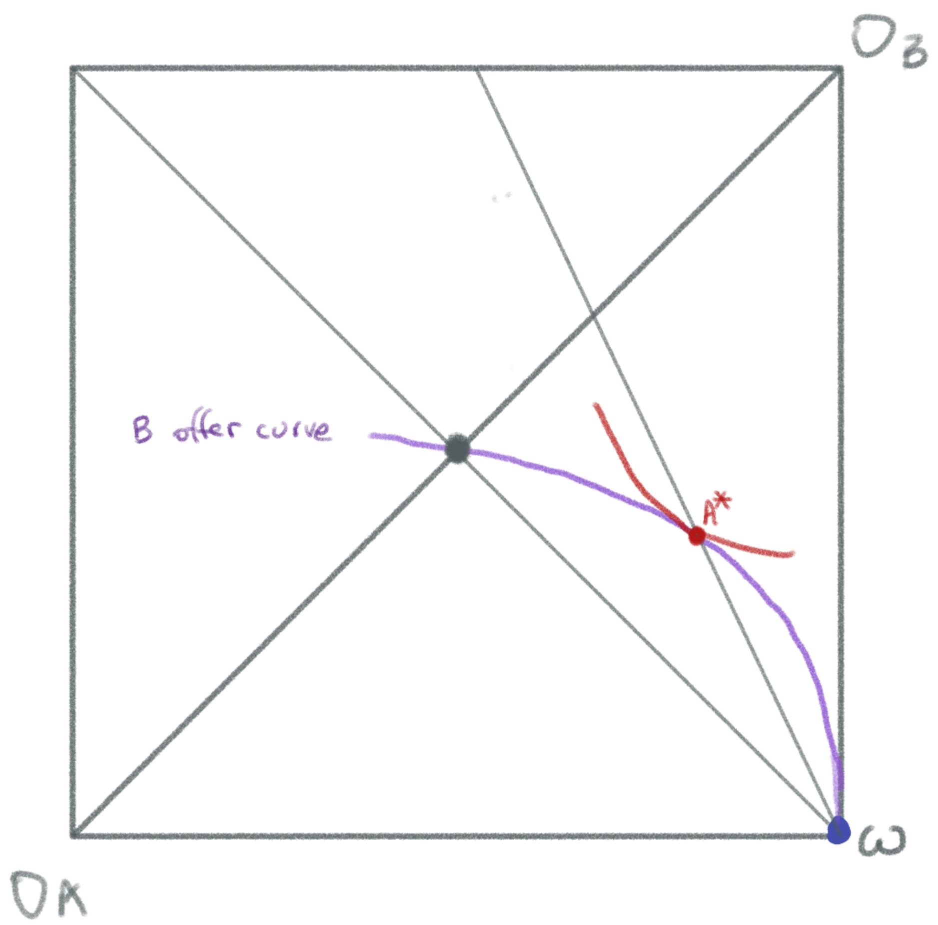
Inflation Is Conflict

- **Questions…**
  - Mechanism for inflation?
  - Proximate cause of inflation?
  - Useful minimal common framework for wide set of models?
- **Our answer: two ingredients…**
  - Conflict = Disagreement on relative prices
  - Staggered prices (distill best of NK models!)



Inflation Is Conflict

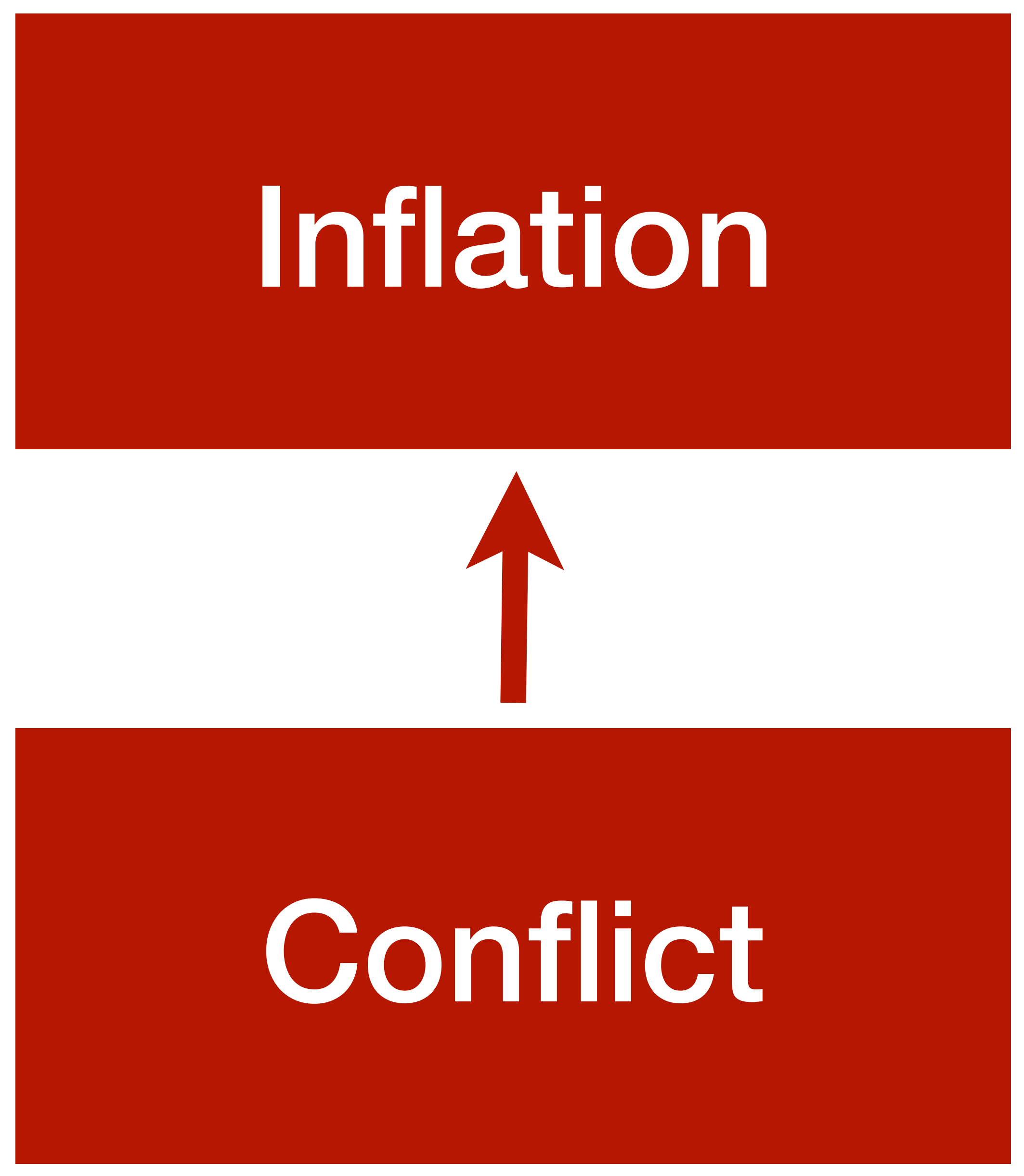
- **Questions…**
  - Mechanism for inflation?
  - Proximate cause of inflation?
  - Useful minimal common framework for wide set of models?
- **Our answer: two ingredients…**
  - Conflict = Disagreement on relative prices
  - Staggered prices (distill best of NK models!)
- **Our contribution…**
  - Extends existing ideas and creates bridge to modern macro
  - Isolate conflict in a stylized model
  - Network economy, non-stationary, inflation expectations, REE, stability



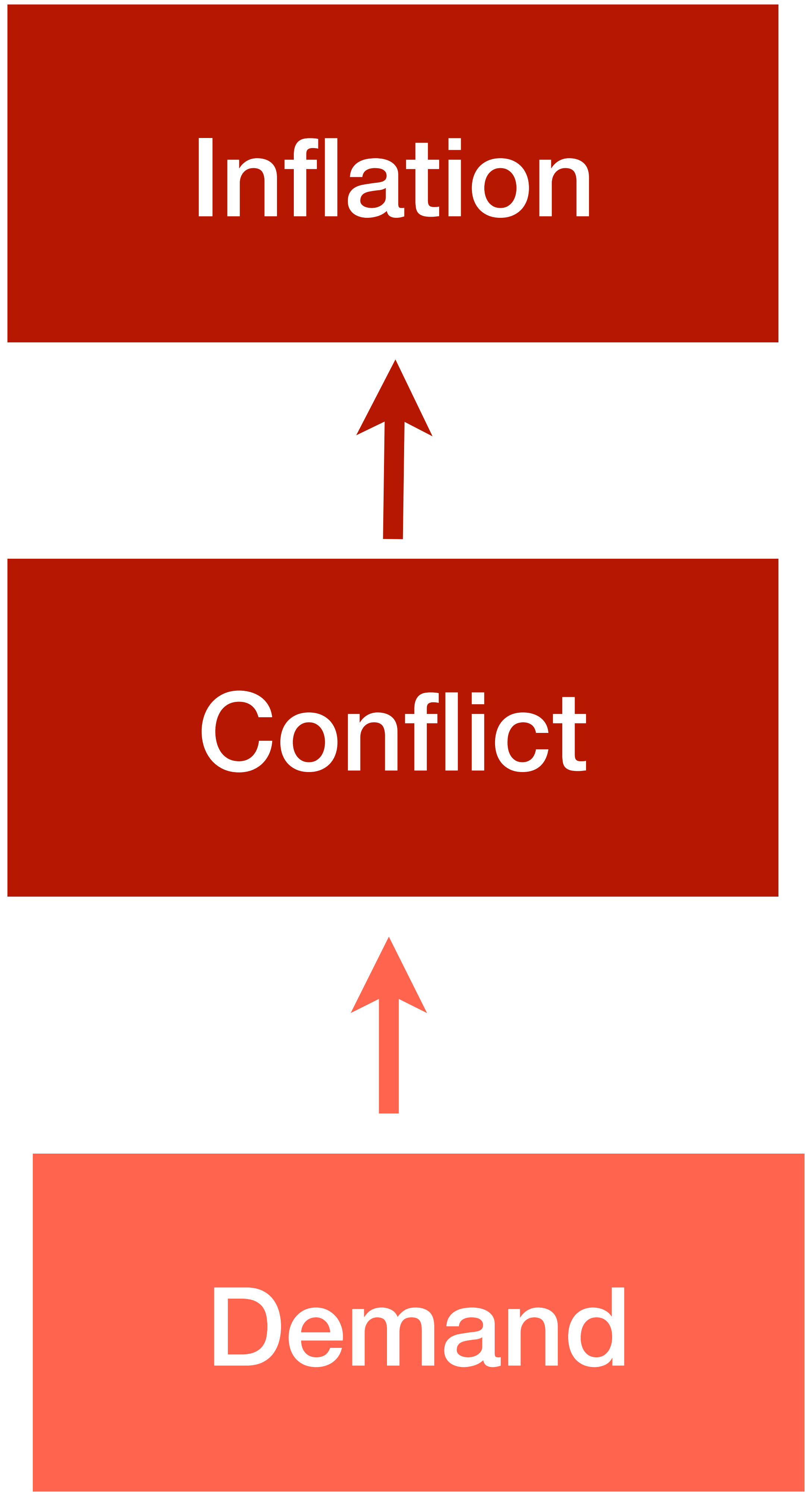
Causality (DAG)

Inflation

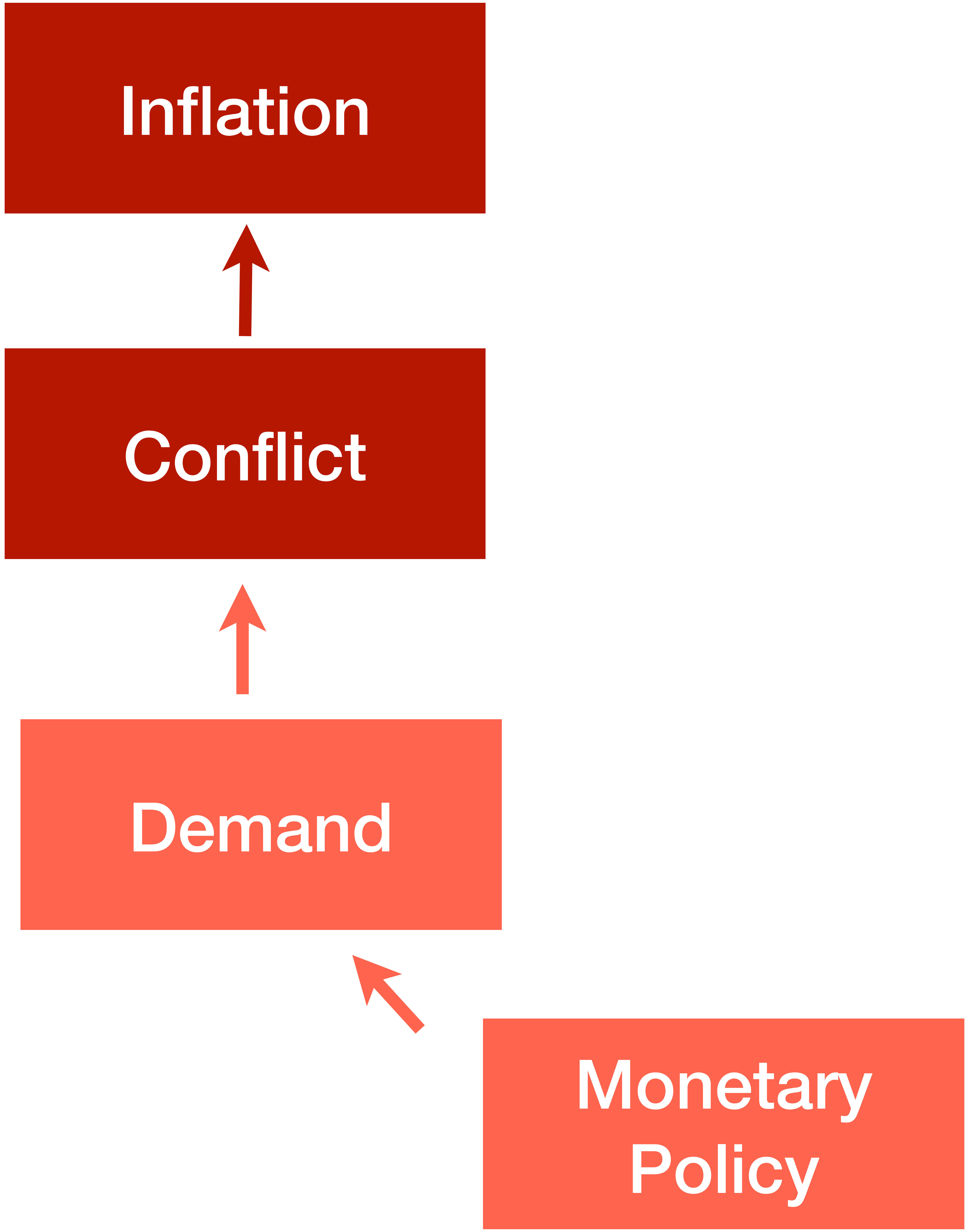
Causality (DAG)



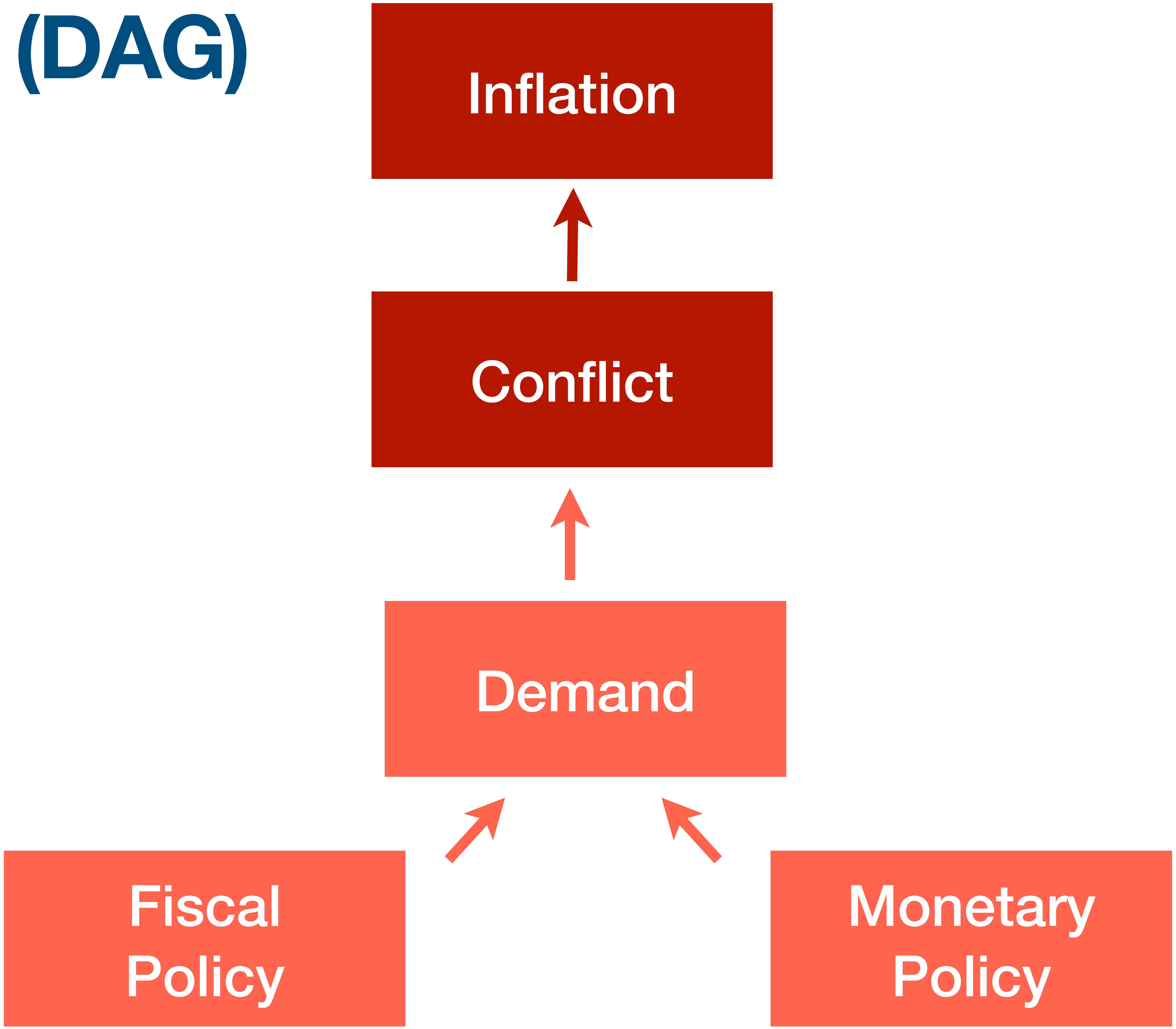
Causality (DAG)



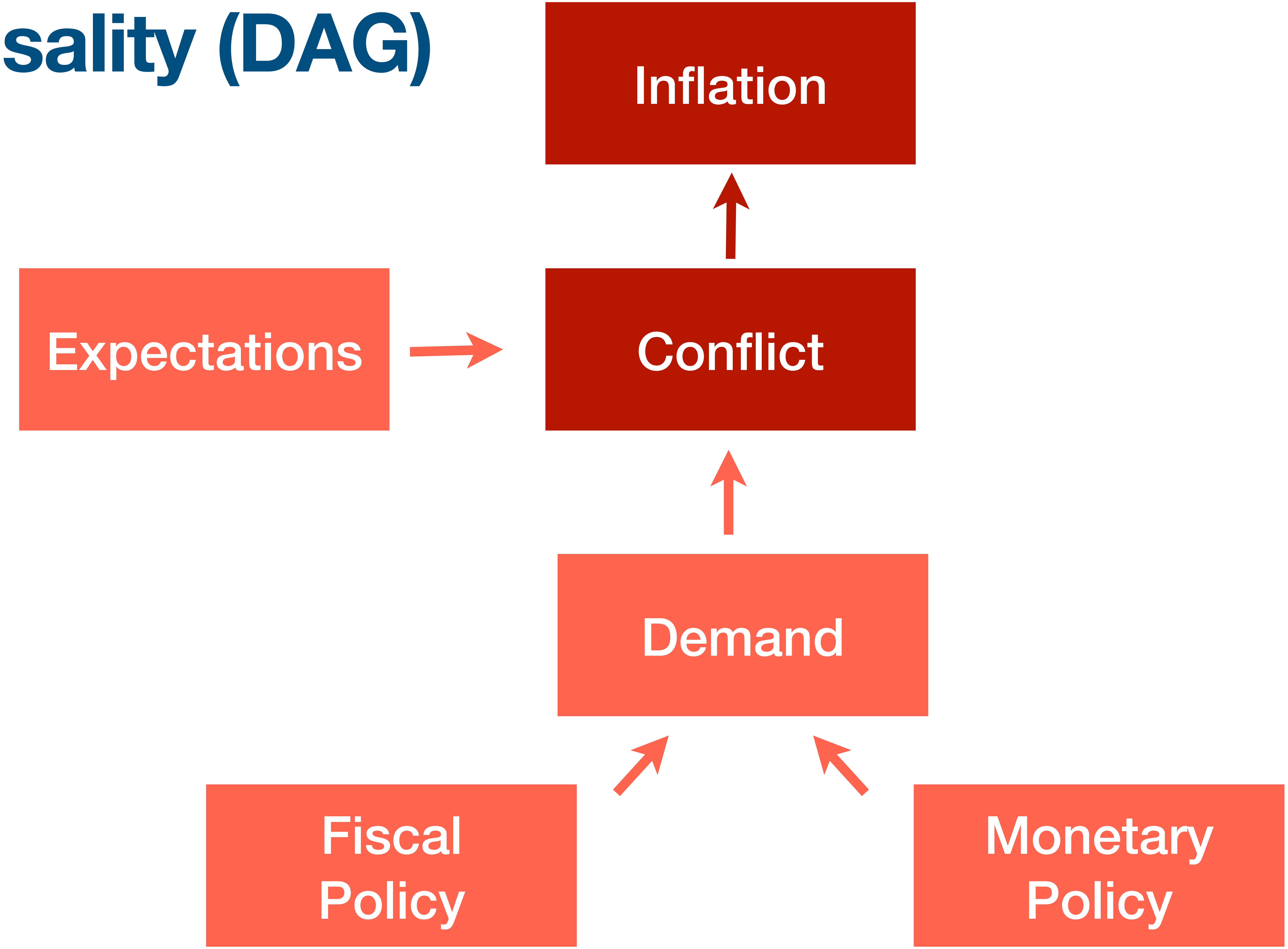
Causality (DAG)



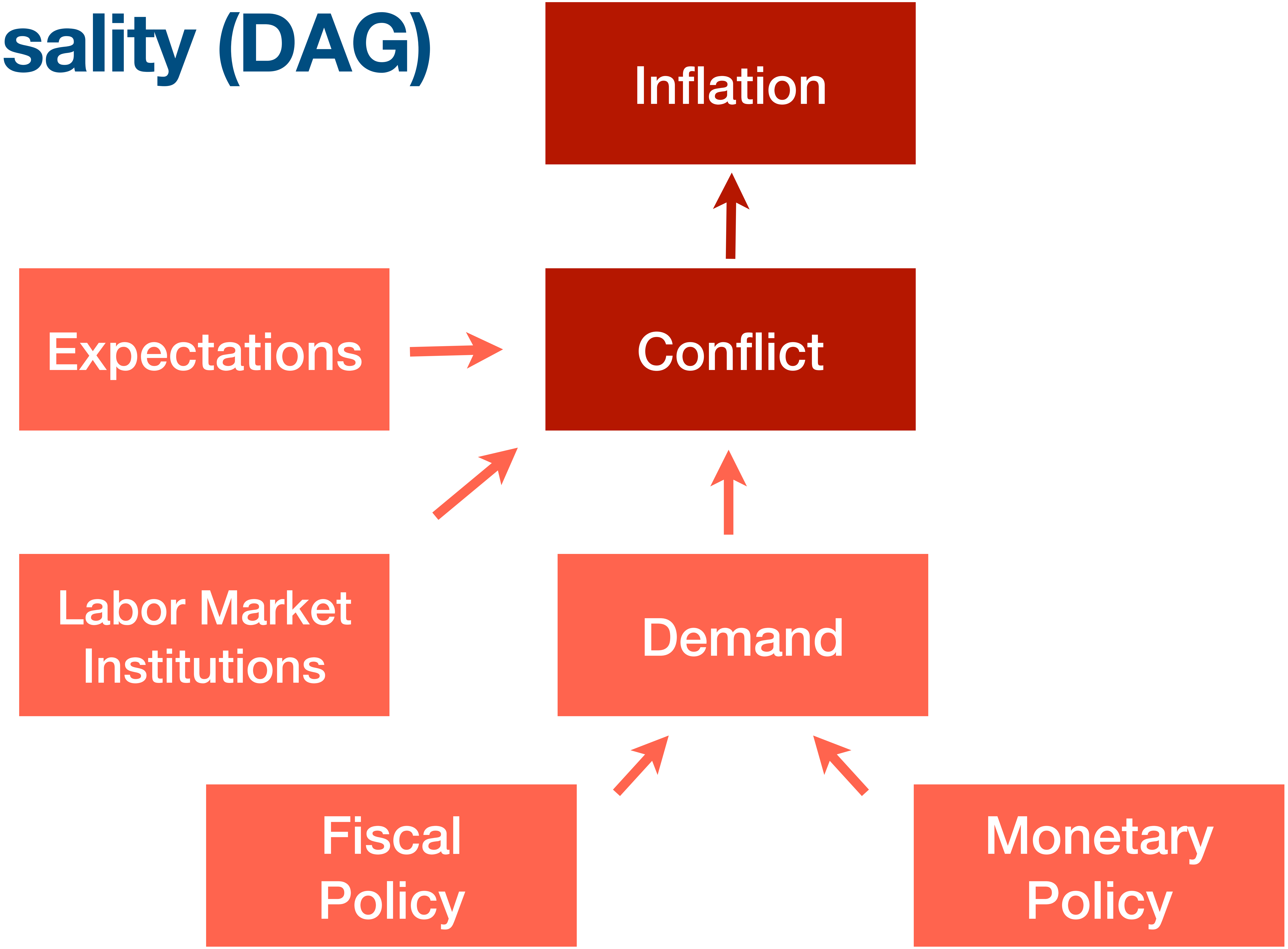
Causality (DAG)



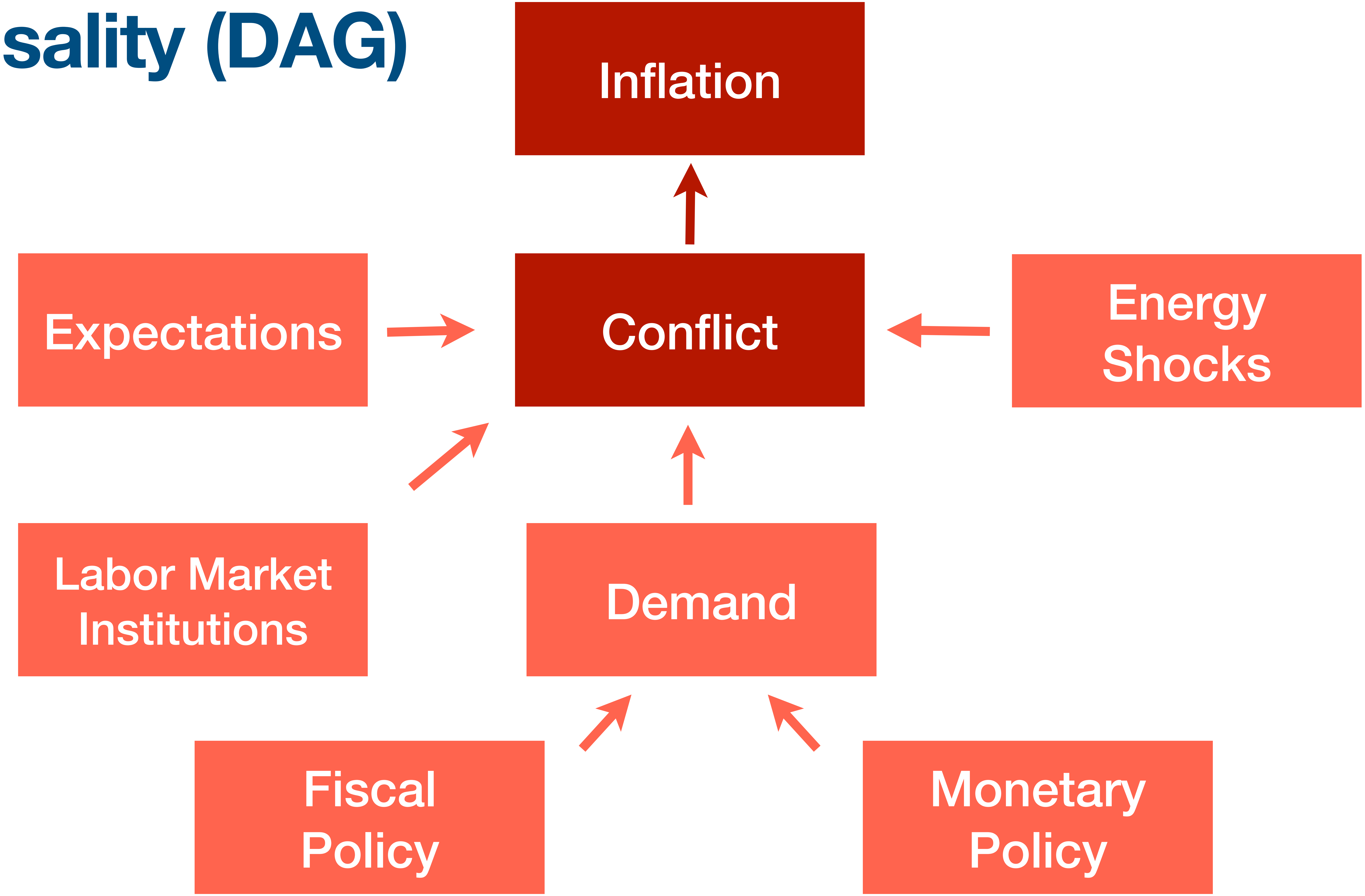
Causality (DAG)



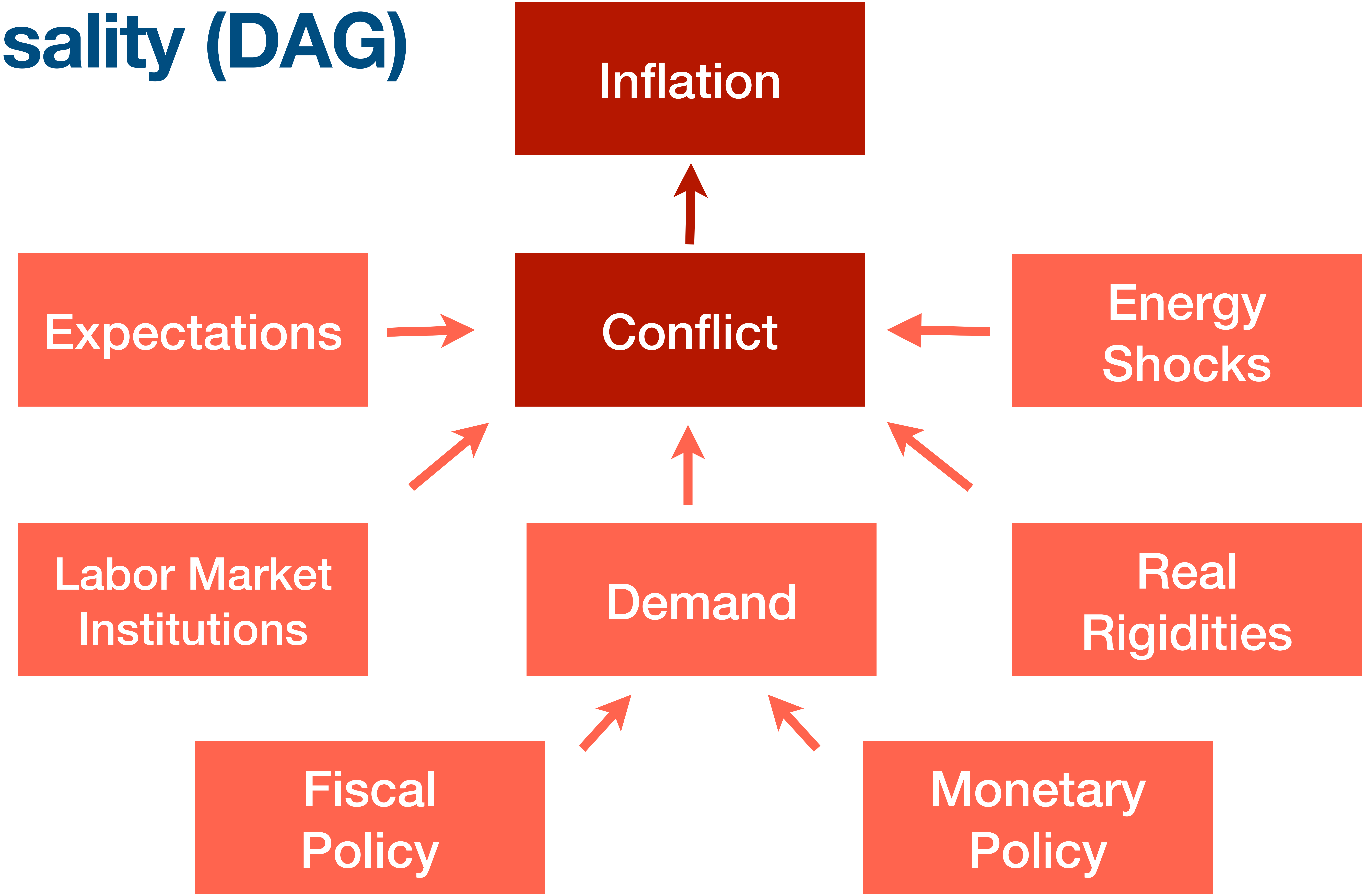
Causality (DAG)



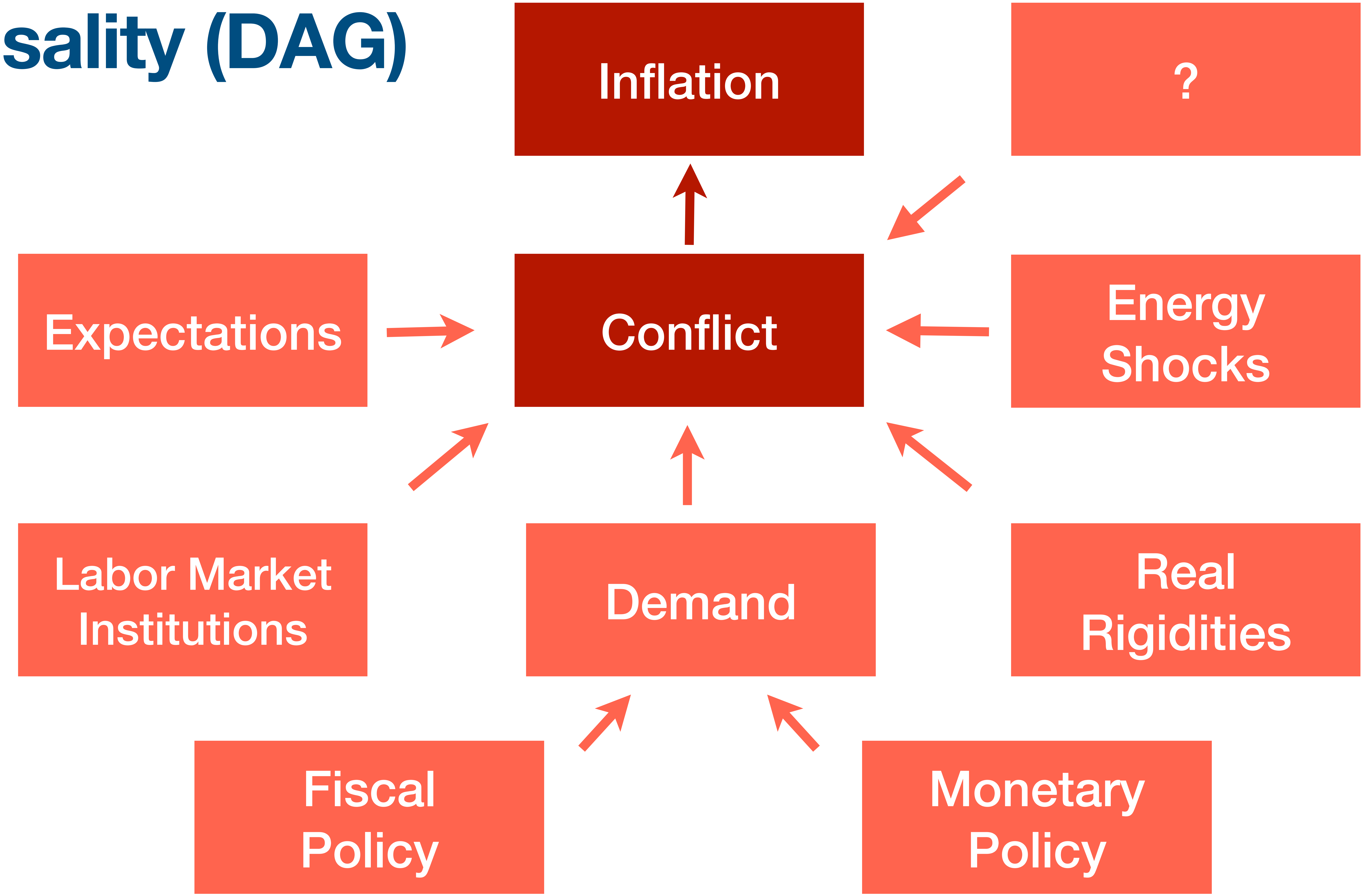
Causality (DAG)



Causality (DAG)



Causality (DAG)



Staggered Pricing Block

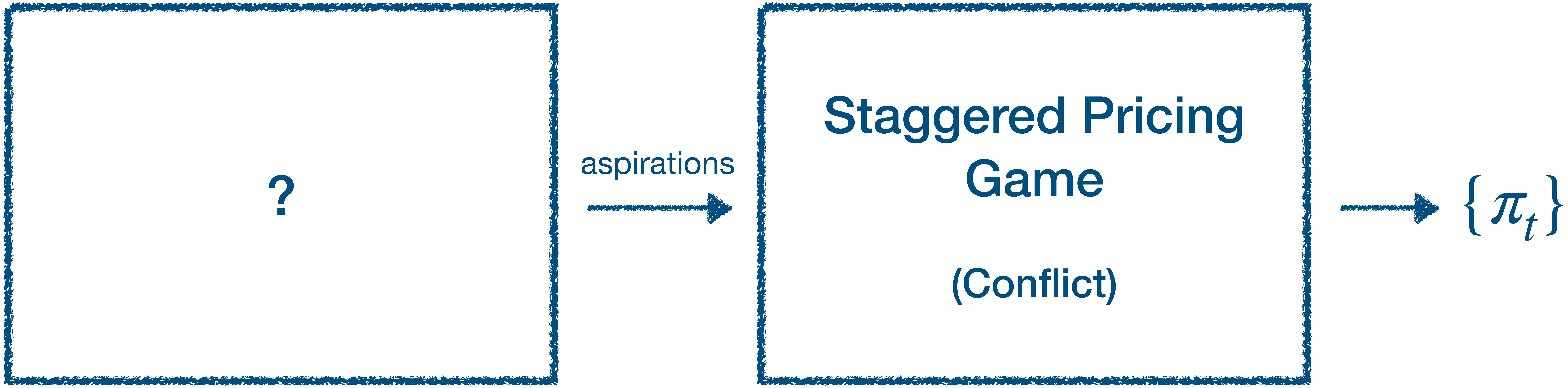
Staggered Pricing Game

(Conflict)

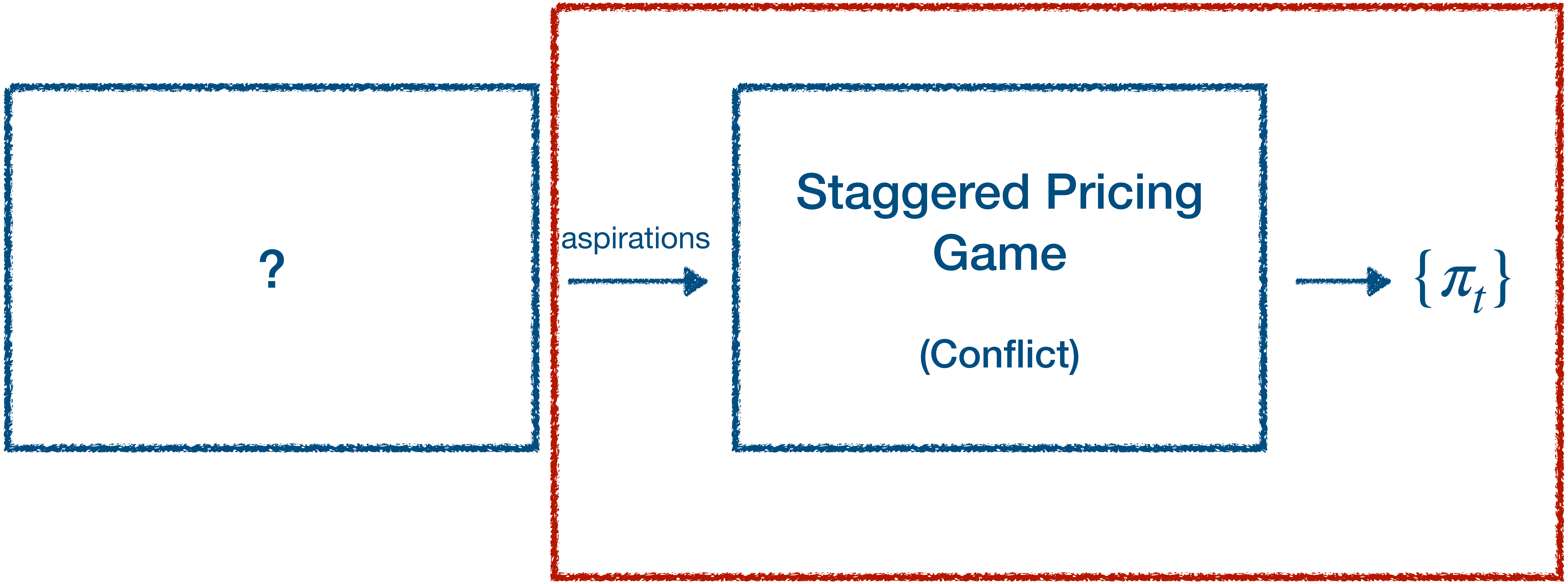
$\longrightarrow \{\pi_t\}$

Staggered Pricing Block

Staggered Pricing Block



Staggered Pricing Block



Conflict Perspective: Two Parts

Conflict Perspective: Two Parts

- **#1 Stylized Model…**
  - stylized, simple, conceptual, “intuition pump”, “shock to the system”
  - far from standard traditional models (on purpose)
    no money, no credit, no savings, no interest rates, no output, no employment
  - **Goal:** not realism, *isolate conflict*

Conflict Perspective: Two Parts

- **#1 Stylized Model…**
  - stylized, simple, conceptual, “intuition pump”, “shock to the system”
  - far from standard traditional models (on purpose)
    no money, no credit, no savings, no interest rates, no output, no employment
  - **Goal:** not realism, *isolate conflict*
- **#2 General Framework…**
  - akin to macro models…
  - but stripped down and N sectors (fewer special assumptions)
  - result: decomposition of conflict and adjustment inflation
  - **Goal:** conflict $\rightarrow$ standard modern macro *bridge*

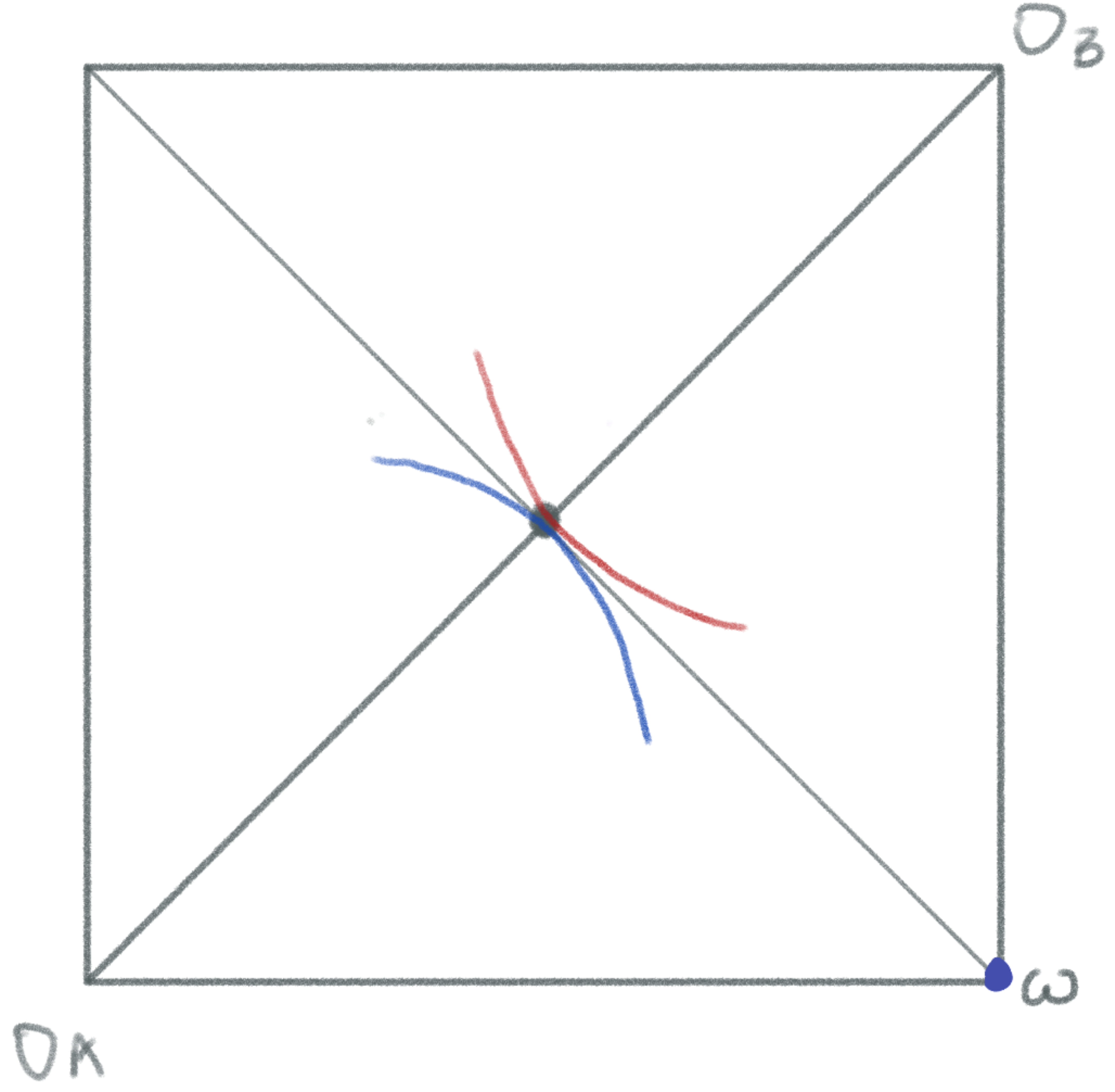
- Stylized Model ← **Now!**
- General Framework
- Applications

#1 Stylized Model

- Two agents: A and B
- Two goods: A and B
- No production: endowments
  (1,0) for A
  (0,1) for B
- Utility: $U^A = U(c^A, c^B) \quad U^B = U(c^B, c^A)$
  Symmetry: $U(c, c')$ where
- Agents meet each period:
  identical exchange economy

#1 Stylized Model

- Two agents: A and B
- Two goods: A and B
- No production: endowments
  (1,0) for A
  (0,1) for B
- Utility: $U^A = U(c^A, c^B) \quad U^B = U(c^B, c^A)$
  Symmetry: $U(c, c')$ where
- Agents meet each period:
  identical exchange economy



Staggered Pricing, Trading and Barter

Staggered Pricing, Trading and Barter

- **Staggered sticky prices**, agents take turn setting prices…
  - A in even periods
  - B in odd periods

Staggered Pricing, Trading and Barter

- **Staggered sticky prices**, agents take turn setting prices…
  - A in even periods
  - B in odd periods
- **Prices are "nominal" (not relative)…**
  - formally: just numbers in $\mathbb{R}$
  - economically: maybe some unit of account (but <u>not</u> goods)
  - informally: unit of account is by convention in some currency

Staggered Pricing, Trading and Barter

- **Staggered sticky prices**, agents take turn setting prices…
    - A in even periods
    - B in odd periods
- **Prices are "nominal" (not relative)…**
    - formally: just numbers in $\mathbb{R}$
    - economically: maybe some unit of account (but <u>not</u> goods)
    - informally: unit of account is by convention in some currency
- **No currency or money** held nor exchanged

Staggered Pricing, Trading and Barter

- **Staggered sticky prices**, agents take turn setting prices…
  - A in even periods
  - B in odd periods
- **Prices are “nominal” (not relative)…**
  - formally: just numbers in $\mathbb{R}$
  - economically: maybe some unit of account (but <u>not</u> goods)
  - informally: unit of account is by convention in some currency
- **No currency or money** held nor exchanged
- **Trade by barter…**
  - using prevailing relative prices taken as ratio of nominal ones
  - alternating who chooses quantities (buyer) and who does not (seller)

$p_{B,-1}$

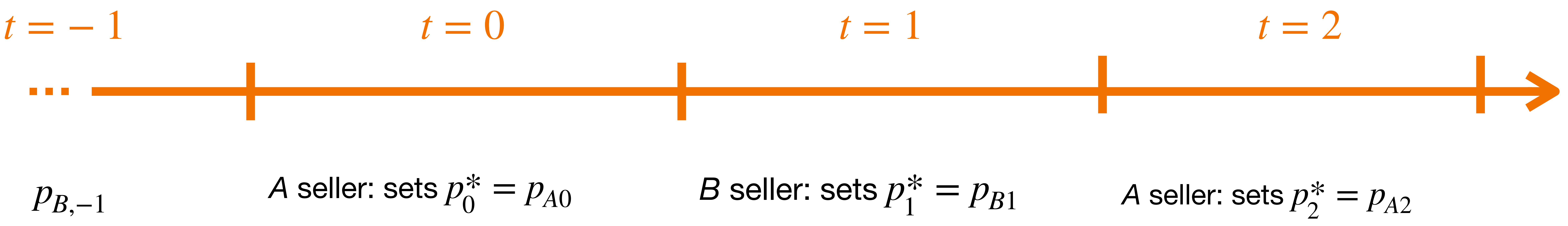
$p_{B,-1}$

A seller: sets $p_0^* = p_{A0}$

$p_{B,-1}$

A seller: sets $p_0^* = p_{A0}$

B seller: sets $p_1^* = p_{B1}$


$t = -1$
$t = 0$
$t = 1$
$t = 2$
$p_{B,-1}$
A seller: sets $p_0^* = p_{A0}$
B seller: sets $p_1^* = p_{B1}$
A seller: sets $p_2^* = p_{A2}$

$p_{B,-1}$

A seller: sets $p_0^* = p_{A0}$

B buyer with $\frac{p_{A0}}{p_{B-1}}$

B seller: sets $p_1^* = p_{B1}$

A seller: sets $p_2^* = p_{A2}$

$p_{B,-1}$

A seller: sets $p_0^* = p_{A0}$

B buyer with $\dfrac{p_{A0}}{p_{B-1}}$

B seller: sets $p_1^* = p_{B1}$

A buyer with $\dfrac{p_{B1}}{p_{A0}}$

A seller: sets $p_2^* = p_{A2}$

$p_{B,-1}$

A seller: sets $p_0^* = p_{A0}$

B buyer with $\dfrac{p_{A0}}{p_{B-1}}$

B seller: sets $p_1^* = p_{B1}$

A buyer with $\dfrac{p_{B1}}{p_{A0}}$

A seller: sets $p_2^* = p_{A2}$

B buys with $\dfrac{p_{A2}}{p_{B1}}$

$p_{B,-1}$

A seller: sets $p_0^* = p_{A0}$

B buyer with $\dfrac{p_{A0}}{p_{B-1}}$

B seller: sets $p_1^* = p_{B1}$

A buyer with $\dfrac{p_{B1}}{p_{A0}}$

A seller: sets $p_2^* = p_{A2}$

B buys with $\dfrac{p_{A2}}{p_{B1}}$

$$P_t^* = P_t^A = P_{t+1}^A \qquad t = 0,2,\ldots$$

$$P_t^* = P_t^B = P_{t+1}^B \qquad t = 1,3,\ldots$$

$p_{B,-1}$

A seller: sets $p_0^* = p_{A0}$

B buyer with $\dfrac{p_{A0}}{p_{B-1}}$

B seller: sets $p_1^* = p_{B1}$

A buyer with $\dfrac{p_{B1}}{p_{A0}}$

A seller: sets $p_2^* = p_{A2}$

B buys with $\dfrac{p_{A2}}{p_{B1}}$

$$P_t^* = P_t^A = P_{t+1}^A \qquad t = 0,2,\ldots$$

$$P_t^* = P_t^B = P_{t+1}^B \qquad t = 1,3,\ldots$$

Barter: Buyer take-it-or-leave-it offer

buy c' $\rightarrow$ pay $\dfrac{P_t^*}{P_{t-1}^*}c'$ in own good

$t = -1$ | $t = 0$ | $t = 1$ | $t = 2$

$\cdots$

$p_{B,-1}$	A seller: sets $p_0^* = p_{A0}$	B seller: sets $p_1^* = p_{B1}$	A seller: sets $p_2^* = p_{A2}$
	B buyer with $\dfrac{p_{A0}}{p_{B-1}}$	A buyer with $\dfrac{p_{B1}}{p_{A0}}$	B buys with $\dfrac{p_{A2}}{p_{B1}}$

$$P_t^* = P_t^A = P_{t+1}^A \qquad t = 0,2,\ldots$$

$$P_t^* = P_t^B = P_{t+1}^B \qquad t = 1,3,\ldots$$

Barter: Buyer take-it-or-leave-it offer

buy c' $\rightarrow$ pay $\dfrac{P_t^*}{P_{t-1}^*}c'$ in own good

$$\sum_{t=0}^{\infty} \beta^t u(c_t, c_t')$$


$t-1$
seller price setting
buyer offer
seller accept/reject
$t+1$

$t-1$
seller
price
setting
buyer offer
seller
accept/reject
$t+1$
...

P_t^*

$$P_t^* \quad \rightarrow \quad p_t = \frac{P_t^*}{P_{t-1}^*}$$

$$P_t^* \rightarrow p_t = \frac{P_t^*}{P_{t-1}^*} \rightarrow$$

$$\boxed{\begin{aligned} V(p) &= \max_{c,c'} u(c,c') \\ c &= 1 - pc' \\ u(1-c',pc') &\geq u(1,0) \end{aligned}}$$

$$P_t^* \rightarrow p_t = \frac{P_t^*}{P_{t-1}^*} \rightarrow$$

$$V(p) = \max_{c,c'} u(c, c')$$

$$c = 1 - pc'$$

$$u(1 - c', pc') \geq u(1,0)$$

(not binding)

$$P_t^* \rightarrow p_t = \frac{P_t^*}{P_{t-1}^*} \rightarrow \boxed{\begin{aligned} V(p) &= \max_{c,c'} u(c,c') \\ c &= 1 - pc' \\ u(1-c', pc') &\geq u(1,0) \end{aligned}} \rightarrow c' = D(p)$$

(not binding)

(standard demand)

$$P_t^* \rightarrow p_t = \frac{P_t^*}{P_{t-1}^*} \rightarrow$$

$$V(p) = \max_{c,c'} u(c, c')$$

$$c = 1 - pc'$$

$$u(1 - c', pc') \geq u(1,0)$$

(not binding)

$$\rightarrow c' = D(p)$$

(standard demand)

Seller controls today, but
other agent controls tomorrow!

Static problem!

$$P_t^* \rightarrow p_t = \frac{P_t^*}{P_{t-1}^*} \rightarrow \boxed{\begin{array}{c} V(p) = \max_{c,c'} u(c, c') \\ c = 1 - pc' \\ u(1 - c', pc') \geq u(1,0) \end{array}} \rightarrow c' = D(p)$$

(not binding)

(standard demand)

Seller controls today, but
other agent controls tomorrow!

Static problem!

$$P_t^* = p^* \cdot P_{t-1}^*$$

$t-1$ ... seller price setting — buyer offer — seller accept/reject — $t+1$

$$P^*_t \rightarrow p_t = \frac{P^*_t}{P^*_{t-1}} \rightarrow$$

Seller controls today, but other agent controls tomorrow!

Static problem!

$$\boxed{\begin{aligned} V(p) &= \max_{c,c'} u(c,c') \\ c &= 1 - pc' \\ u(1-c', pc') &\geq u(1,0) \end{aligned}}$$

(not binding)

$$\rightarrow c' = D(p)$$

(standard demand)

$$P^*_t = p^* \cdot P^*_{t-1}$$

$$\boxed{\begin{aligned} p^* &\equiv \arg\max_p v(p) \\ v(p) &\equiv u(1-D(p), pD(p)) \end{aligned}}$$

Equilibrium: Positive Conflict Inflation

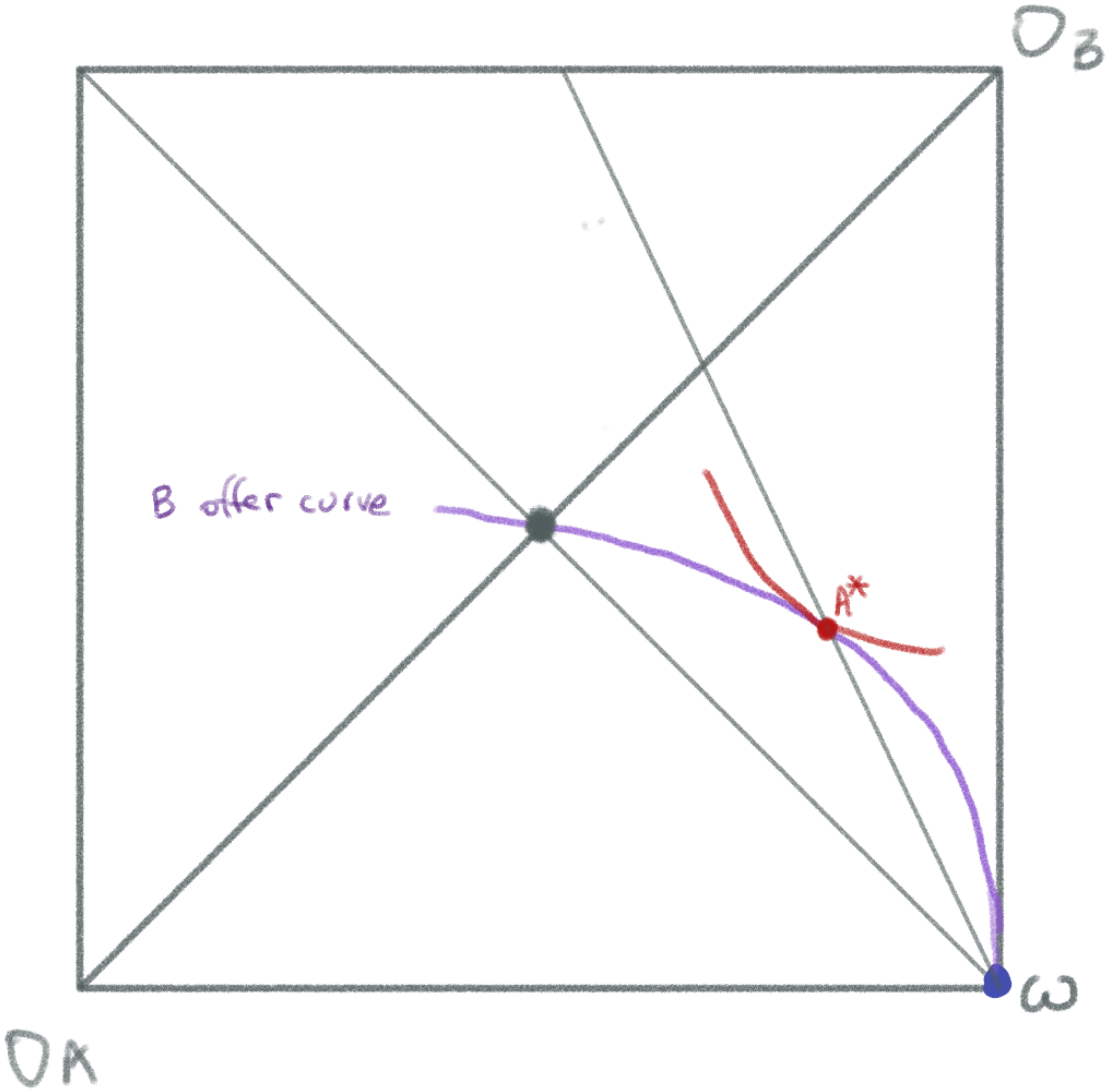
Seller acts as a monopolist against some given demand function…

… wants relative price > 1

Equilibrium: Positive Conflict Inflation

Seller acts as a monopolist against some given demand function…

… wants relative price > 1

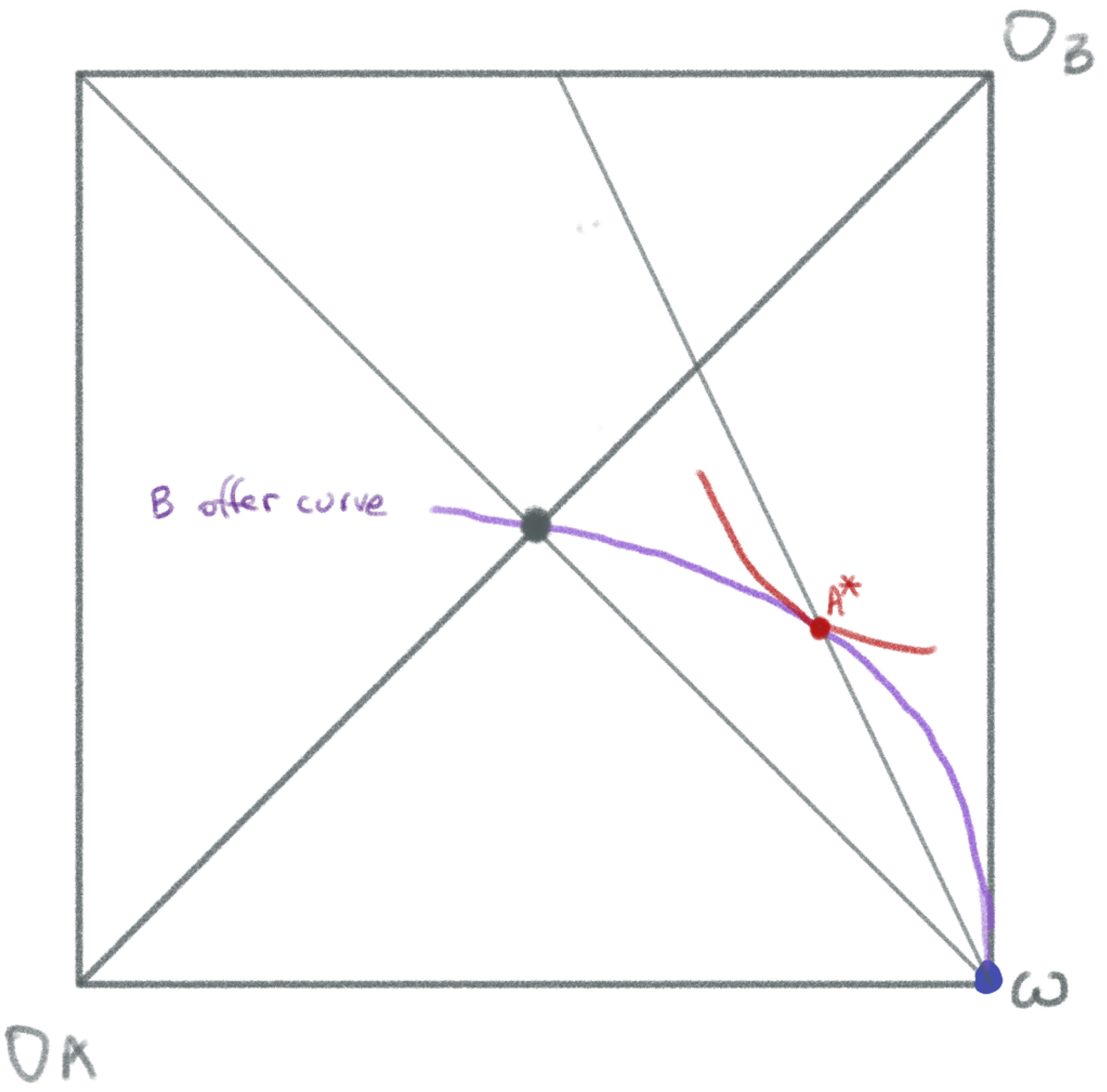


Equilibrium: Positive Conflict Inflation

Seller acts as a monopolist against some given demand function…

… wants relative price > 1

$$\frac{P_t^*}{P_{t-1}^*} > 1$$



Equilibrium: Positive Conflict Inflation

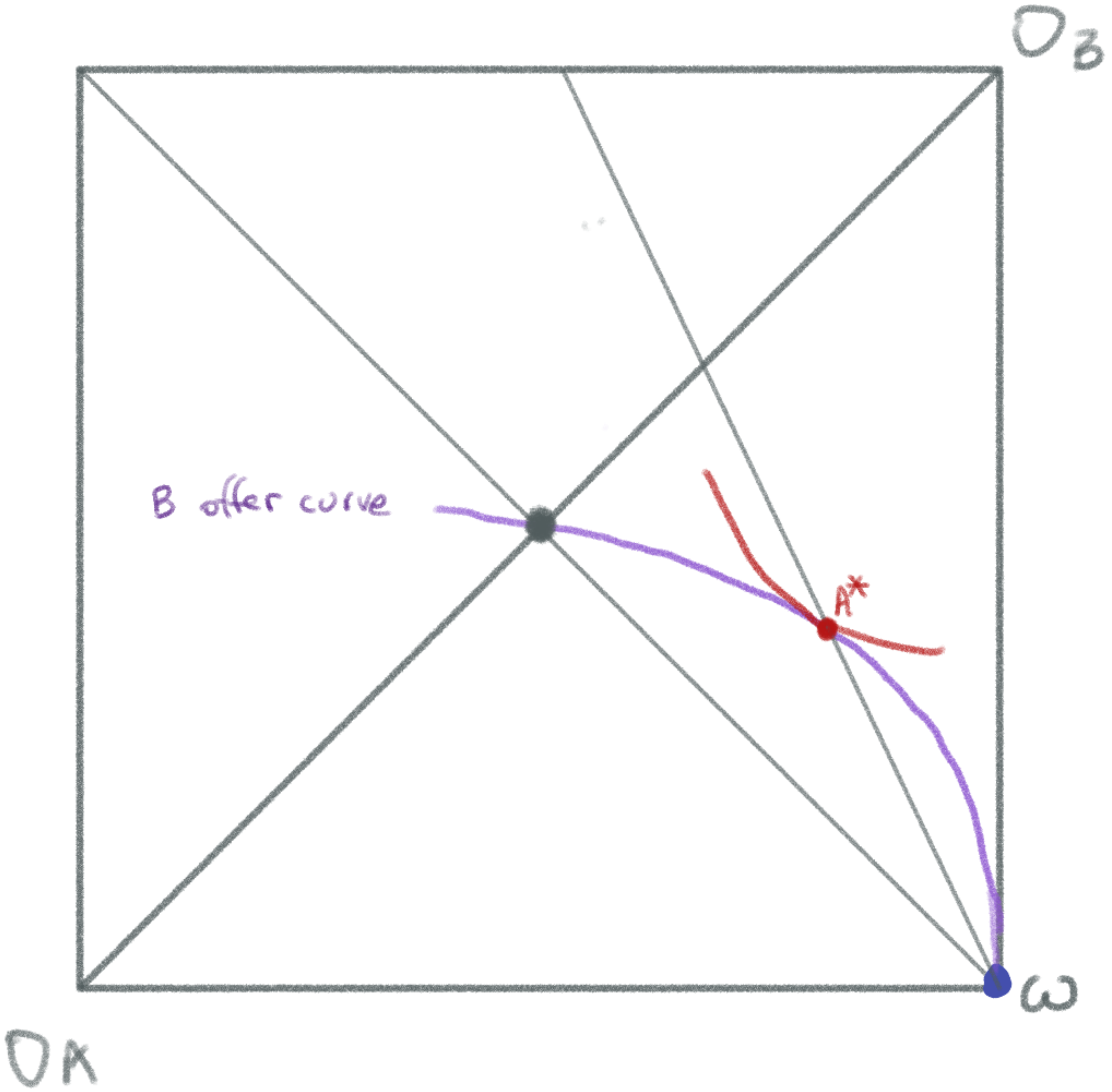
Seller acts as a monopolist against some given demand function…

… wants relative price > 1

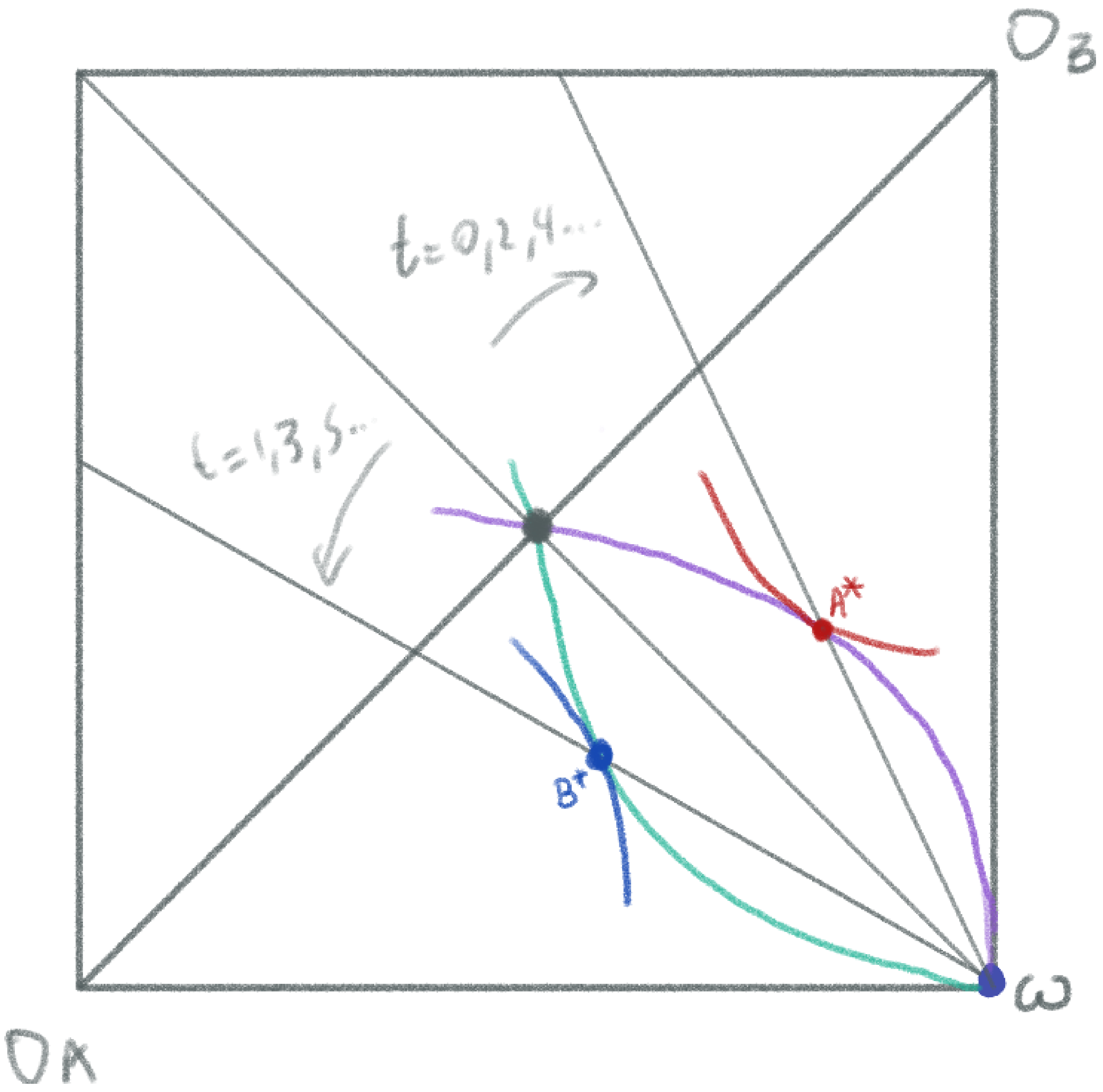
$$\frac{P_t^*}{P_{t-1}^*} > 1$$

No Role for Inflation Expectations here!

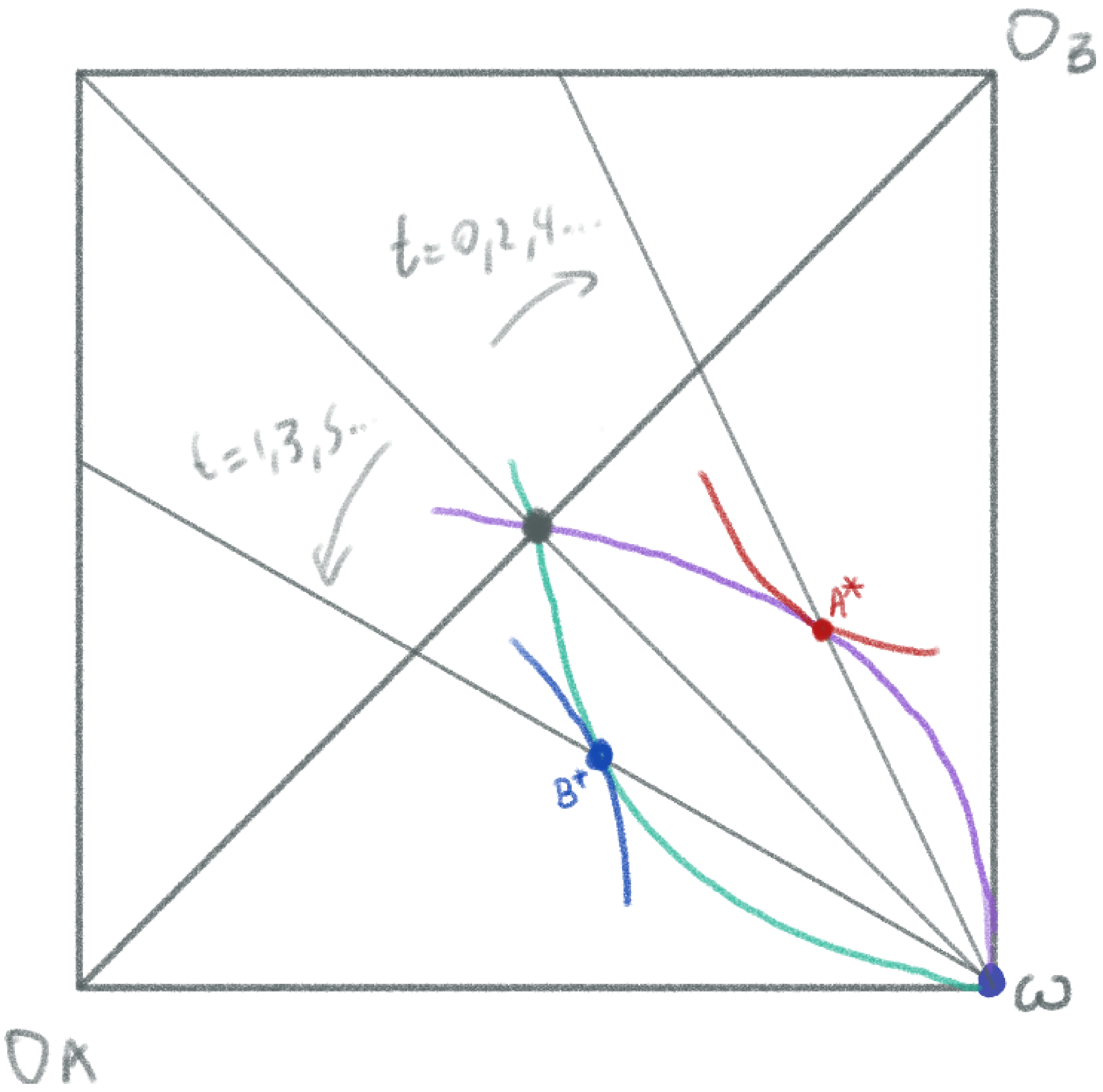
Does not depend on β discount

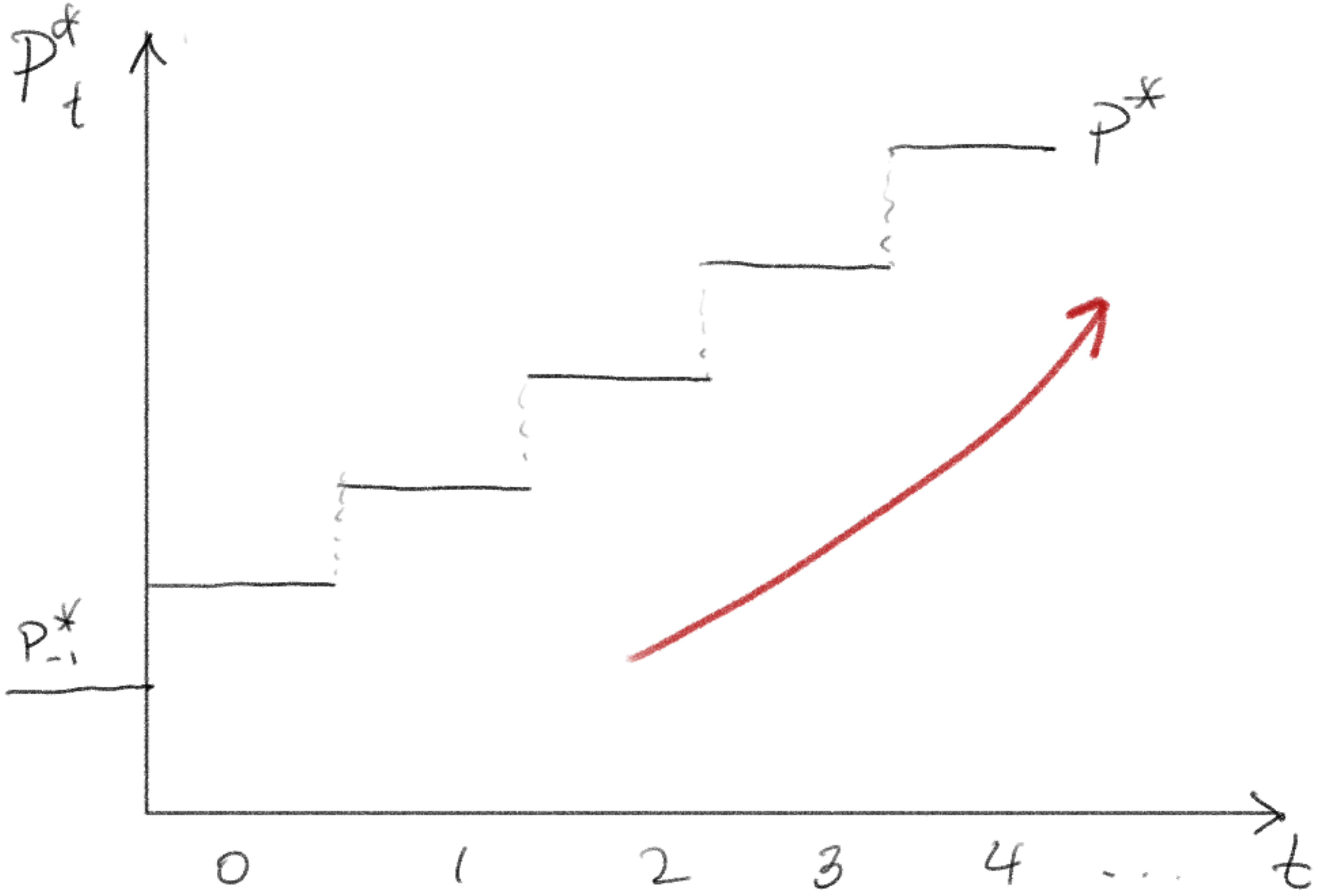


Equilibrium: Positive Conflict Inflation



Equilibrium: Positive Conflict Inflation





Random Matching

- Previous: permanent matches
- Now: random matches (not observed a priori)
- Price resetter: price will now affect relative price tomorrow!

Random Matching

- Previous: permanent matches
- Now: random matches (not observed a priori)
- Price resetter: price will now affect relative price tomorrow!

$$P_t^* = p^*(\Pi^e)P_{t-1}^*$$

$$p^*(\Pi) \equiv \arg\max_p \left\{ v(p) + \beta V((\Pi^e)^2/p) \right\}$$

Random Matching

- Previous: permanent matches
- Now: random matches (not observed a priori)
- Price resetter: price will now affect relative price tomorrow!

$$P_t^* = p^*(\Pi^e) P_{t-1}^*$$

$$p^*(\Pi) \equiv \arg\max_p \left\{ v(p) + \beta V((\Pi^e)^2/p) \right\}$$

$$\boxed{\Pi = p^*(\Pi)}$$

Rational
Expectations
Fixed Point

Random Matching

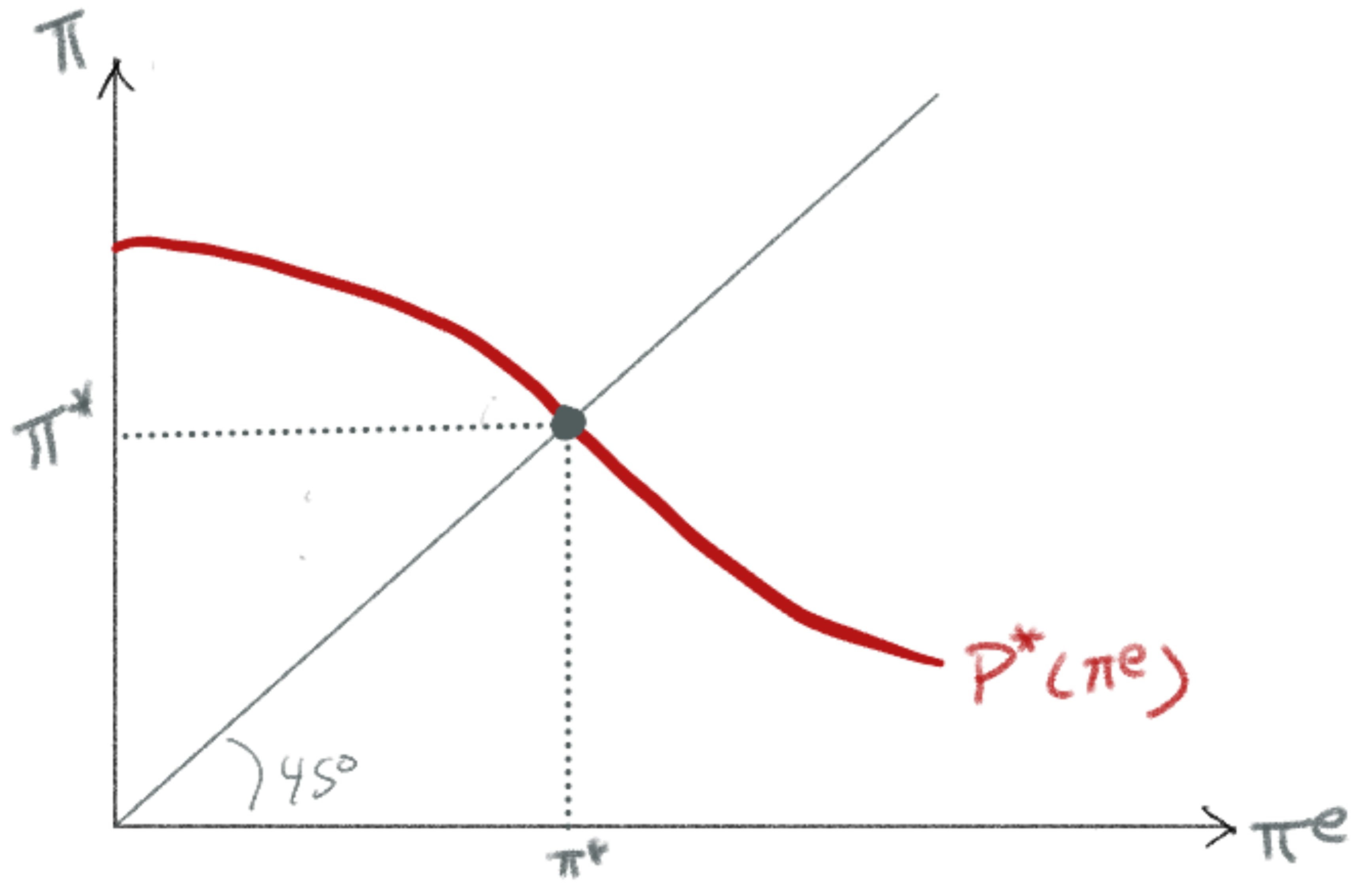
- Previous: permanent matches
- Now: random matches (not observed a priori)
- Price resetter: price will now affect relative price tomorrow!

$$P^*_t = p^*(\Pi^e)P^*_{t-1}$$

$$p^*(\Pi) \equiv \arg\max_p \left\{ v(p) + \beta V((\Pi^e)^2/p) \right.$$

$$\boxed{\Pi = p^*(\Pi)}$$

Rational Expectations Fixed Point



Random Matching

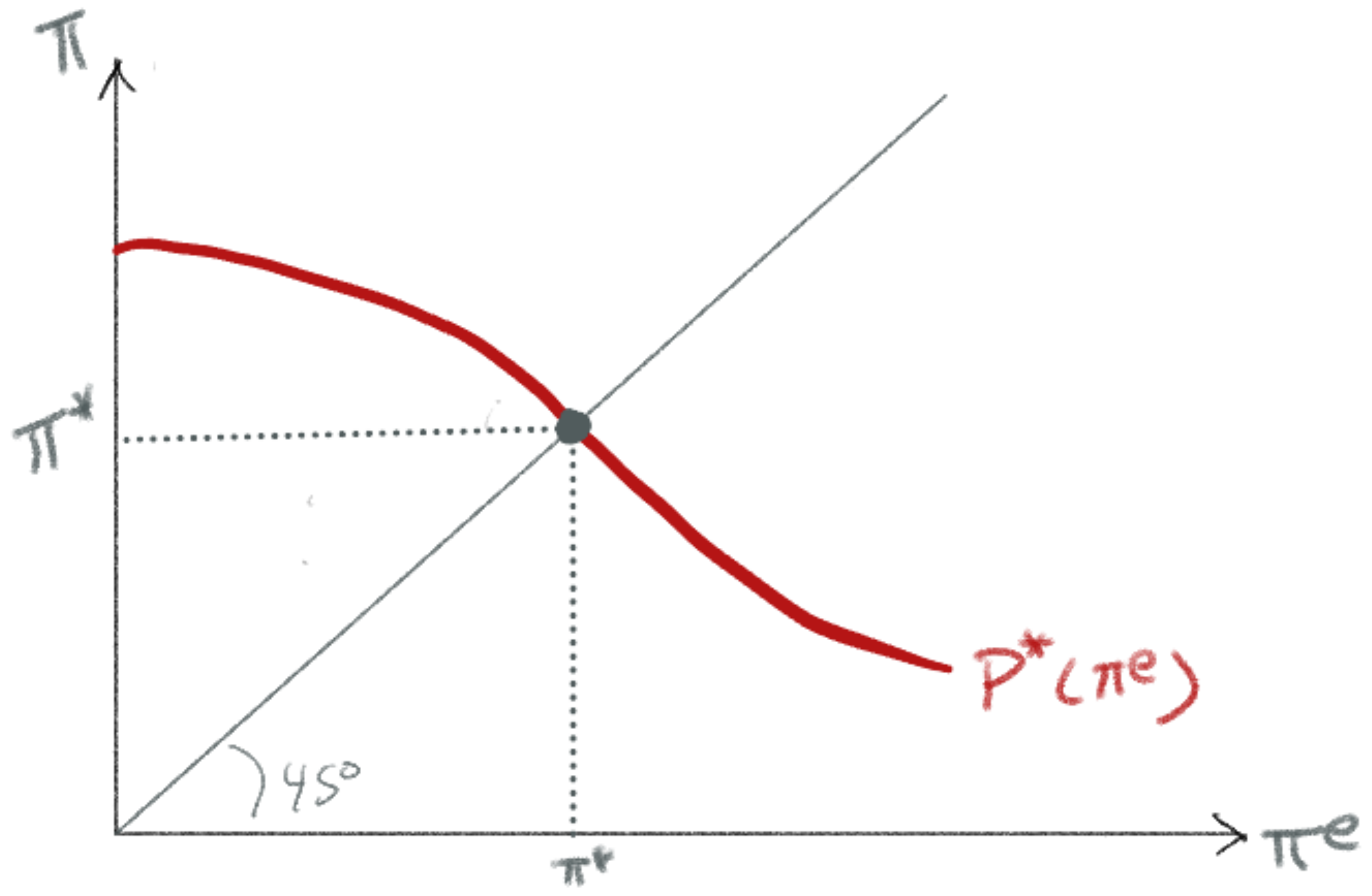
- Previous: permanent matches
- Now: random matches (not observed a priori)
- Price resetter: price will now affect relative price tomorrow!

$$\frac{P_t^*}{P_{t-1}^*} > 1$$

$^e)^2/p)$

$$\boxed{\Pi = p^*(\Pi)}$$

Rational Expectations Fixed Point



Adding Money

Adding Money

- **Questions…**
  - Can we have a unit of account without money?
  - If add money, fixed money supply stops inflation?

Adding Money

- **Questions…**
  - Can we have a unit of account without money?
  - If add money, fixed money supply stops inflation?

Adding Money

- **Questions…**
  - Can we have a unit of account without money?
  - If add money, fixed money supply stops inflation?

- **Extension….**
  - Add money to stylized model (with random matches)
  - **Main result:** nominal money fixed…
    … money is used in exchange…
    … but conflict inflation persists! M/P shrinks towards zero…
  - Converge to moneyless equilibrium studied earlier!

Adding Money

- **Questions…**
  - Can we have a unit of account without money? **Yes we can!**
  - If add money, fixed money supply stops inflation?

- **Extension….**
  - Add money to stylized model (with random matches)
  - **Main result:** nominal money fixed…
    … money is used in exchange…
    … but conflict inflation persists! M/P shrinks towards zero…
  - Converge to moneyless equilibrium studied earlier!

Adding Money

- **Questions…**
  - Can we have a unit of account without money? **Yes we can!**
  - If add money, fixed money supply stops inflation? **No….**

- **Extension….**
  - Add money to stylized model (with random matches)
  - **Main result:** nominal money fixed…
    … money is used in exchange…
    … but conflict inflation persists! M/P shrinks towards zero…
  - Converge to moneyless equilibrium studied earlier!

- Stylized Model
- General Framework ← **Now!**
- Applications

Network Economy

Network Economy

- A network of N “sectors” each sector *n:*

Network Economy

- A network of N “sectors” each sector *n:*
  - good or factor (labor)
  - continuum of varieties

Network Economy

- A network of N “sectors” each sector *n:*
    - good or factor (labor)
    - continuum of varieties
- Each sector cares about relative price (in logs)

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

Input-output
or
Consumption baskets
of workers

Network Economy

- A network of N “sectors” each sector *n:*
  - good or factor (labor)
  - continuum of varieties
- Each sector cares about relative price (in logs)

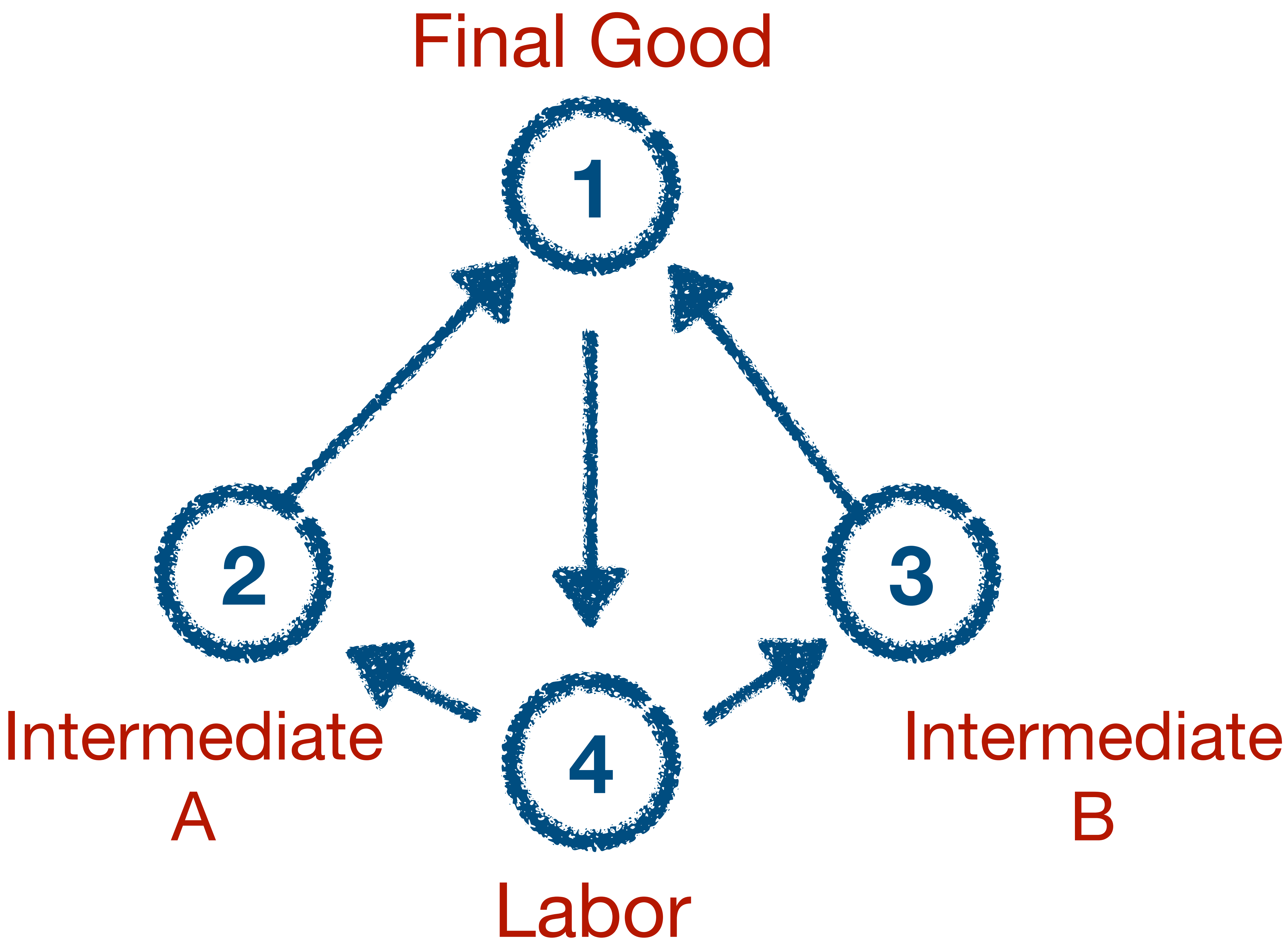
$$P_n - \sum_{n'} m_{nn'} P_{n'}$$

Input-output
or
Consumption baskets
of workers

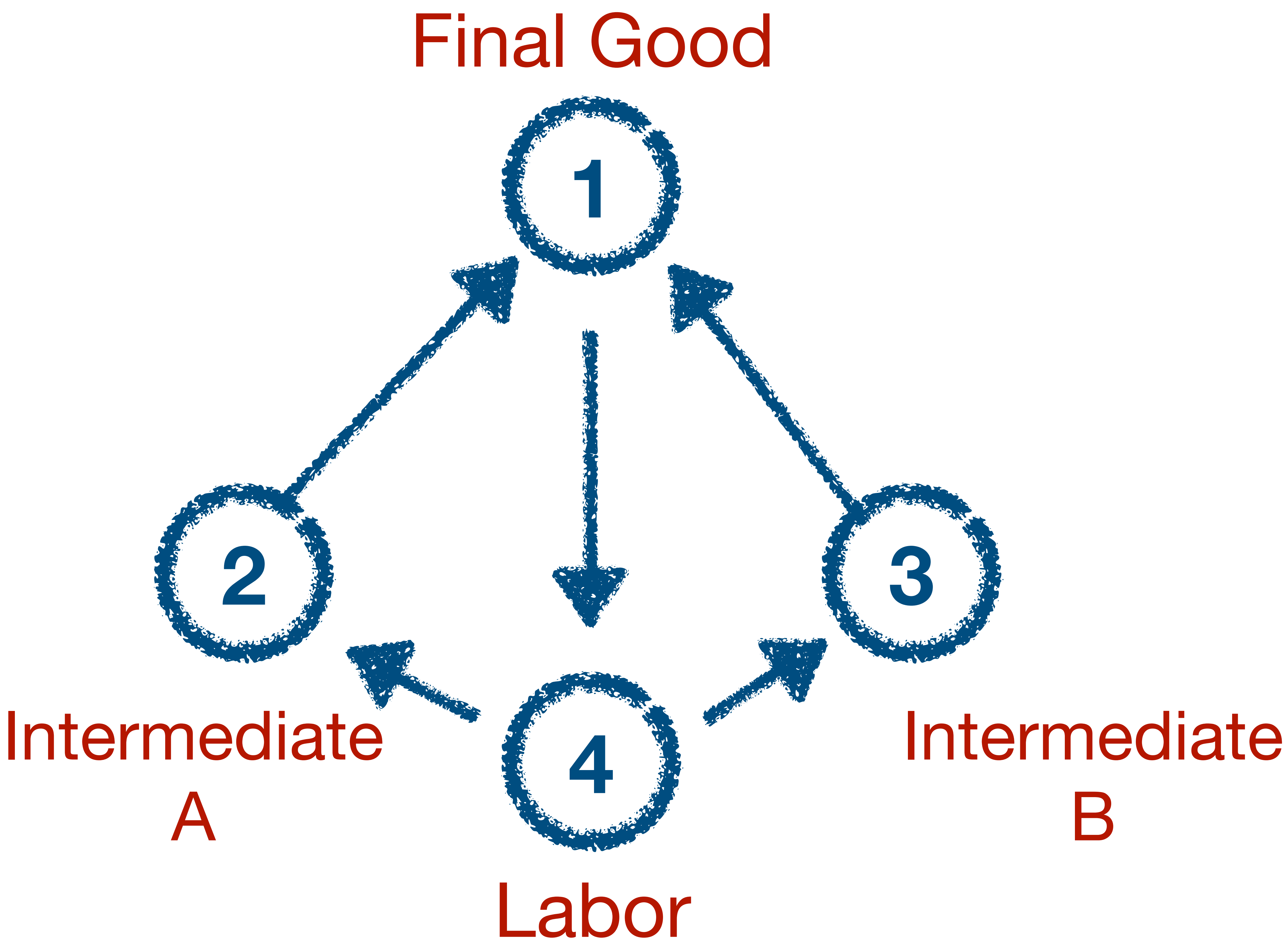
- Each sector has aspiration for relative price…

$$a_n$$

Network Economy



Network Economy



Wage-Price Example

$$W - P = a_W$$

$$P - W = a_P$$

Can we make everyone happy?

Can we make everyone happy?

- Is there a vector P such that…?

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

Can we make everyone happy?

- Is there a vector P such that…?

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

- **Definition:** conflict if above is not possible.

Can we make everyone happy?

- Is there a vector P such that…?

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

- **Definition:** conflict if above is not possible.

Result. No Conflict if and only if

$$\gamma' a = \sum_n \gamma_n a_n = 0$$

where γ is network centrality $\gamma' M = \gamma'$.

Can we make everyone happy?

- Is there a vector P such that…?

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

- **Definition:** conflict if above is not possible.

Result. No Conflict if and only if

$$\gamma' a = \sum_n \gamma_n a_n = 0$$

where γ is network centrality $\gamma' M = \gamma'$.

Wage-Price Example

$$a_W + a_P = 0$$

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

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

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

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

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

$$\dot{P}_{nt} = \lambda_n \left(a_{nt} + \sum_{n'} m_{nn'} P_{n't} - P_{nt} \right)$$

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

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

$$\dot{P}_{nt} = \lambda_n \left(a_{nt} + \sum_{n'} m_{nn'} P_{n't} - P_{nt} \right)$$

$$\dot{P}_t = \Lambda \left(a_t - A P_t \right)$$

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

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

$$\dot{P}_{nt} = \lambda_n \left(a_{nt} + \sum_{n'} m_{nn'} P_{n't} - P_{nt} \right)$$

$$\dot{P}_t = \Lambda \left(a_t - A P_t \right)$$

Conflict Inflation

$$\boxed{\Pi^C_t \equiv \frac{1}{\bar{d}} \sum_n \gamma_{nt} a_{nt}}$$

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

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

$$\dot{P}_{nt} = \lambda_n \left(a_{nt} + \sum_{n'} m_{nn'} P_{n't} - P_{nt} \right)$$

$$\dot{P}_t = \Lambda \left(a_t - A P_t \right)$$

$$\bar{P}_t = \sum_n \psi_n P_{nt}$$

$$\left(\psi_n = \frac{d_n}{\bar{d}} \gamma_n \right)$$

Conflict Inflation

$$\boxed{\Pi^C_t \equiv \frac{1}{\bar{d}} \sum_n \gamma_{nt} a_{nt}}$$

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

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

$$\dot{P}_{nt} = \lambda_n\left(a_{nt} + \sum_{n'} m_{nn'}P_{n't} - P_{nt}\right)$$

$$\dot{P}_t = \Lambda\left(a_t - AP_t\right)$$

Conflict Inflation

$$\boxed{\Pi^C_t \equiv \frac{1}{\bar{d}} \sum_n \gamma_{nt} a_{nt}}$$

$$\bar{P}_t = \sum_n \psi_n P_{nt}$$

$$\left(\psi_n = \frac{d_n}{\bar{d}}\gamma_n\right)$$

$$\boxed{\dot{\bar{P}}_t = \sum_n \psi_n \pi_{nt} = \Pi^C_t}$$

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

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

$$\dot{P}_{nt} = \lambda_n \left(a_{nt} + \sum_{n'} m_{nn'} P_{n't} - P_{nt} \right)$$

$$\dot{P}_t = \Lambda \left(a_t - AP_t \right)$$

Conflict Inflation

$$\boxed{\Pi^C_t \equiv \frac{1}{\bar{d}} \sum_n \gamma_{nt} a_{nt}}$$

$$\bar{P}_t = \sum_n \psi_n P_{nt}$$

$$\left(\psi_n = \frac{d_n}{\bar{d}} \gamma_n \right)$$

$$\dot{\bar{P}}_t = \sum_n \psi_n \pi_{nt} = \Pi^C_t$$

Generalized Sectoral Inflation is Conflict

$$\frac{1}{T} \int_0^T \pi_{nt} \to \Pi^C_t$$

Average or Persistent Inflation is Conflict

Wage-Price Example

$$\dot{P}_t = \lambda_p(a_{pt} + \omega_t)$$

$$\dot{W}_t = \lambda_w(a_{wt} - \omega_t)$$

$$(\omega_t = w_t - p_t)$$

Wage-Price Example

$$\dot{P}_t = \lambda_p(a_{pt} + \omega_t)$$

$$\dot{W}_t = \lambda_w(a_{wt} - \omega_t)$$

$$(\omega_t = w_t - p_t)$$

Example 1: No Disagreement

$$a_{pt} = - a_{wt} = \Delta > 0$$

$$\omega_0 = 0$$

Wage-Price Example

$$\dot{P}_t = \lambda_p(a_{pt} + \omega_t)$$

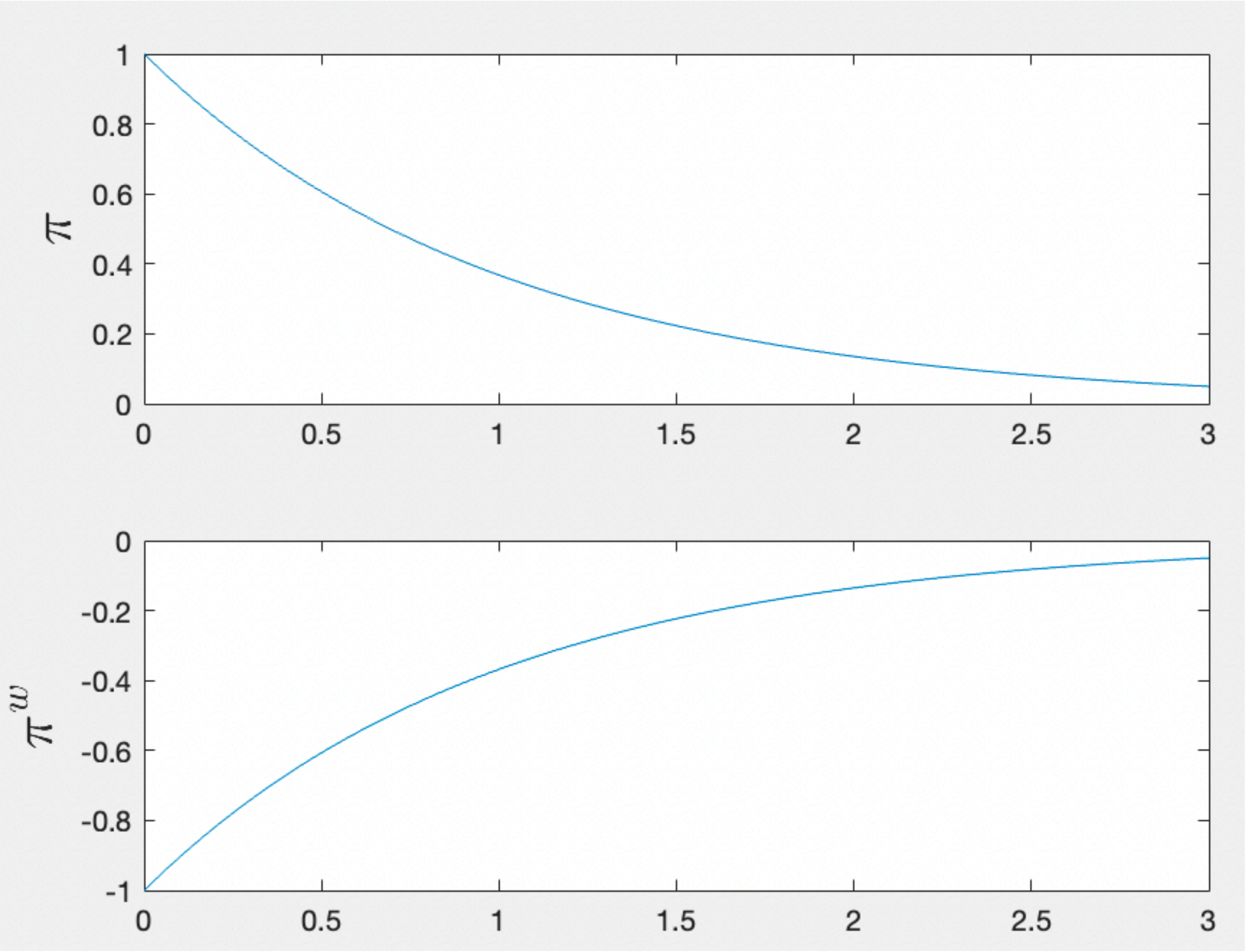
$$\dot{W}_t = \lambda_w(a_{wt} - \omega_t)$$

$$(\omega_t = w_t - p_t)$$

Example 1: No Disagreement

$$a_{pt} = -a_{wt} = \Delta > 0$$

$$\omega_0 = 0$$



Wage-Price Example

$$\dot{P}_t = \lambda_p(a_{pt} + \omega_t)$$

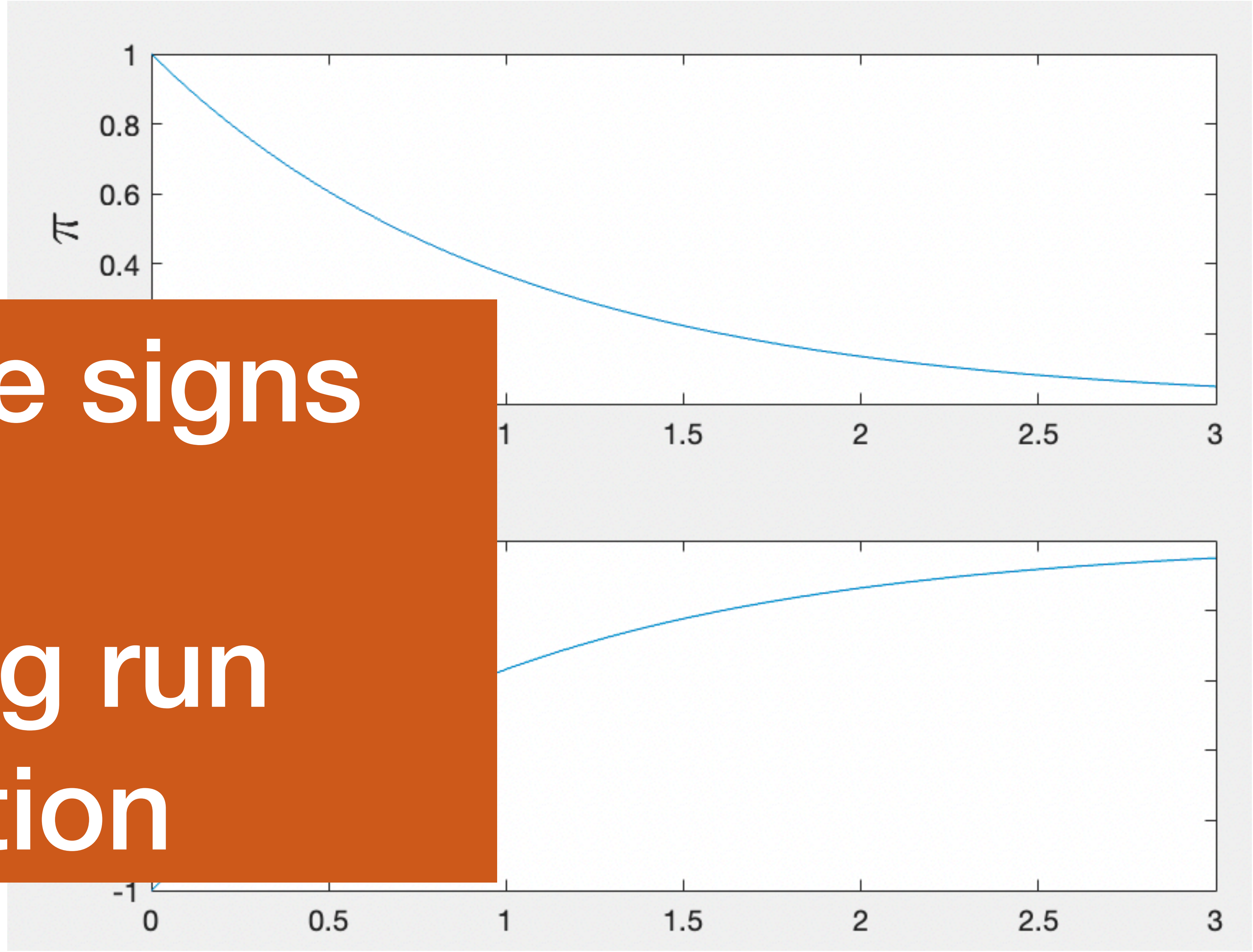
$$\dot{W}_t = \lambda_w(a_{wt} - \omega_t)$$

$$(\omega_t = w_t - p_t)$$

Example 1: No Disagreement

$$a_{pt} = -a_{wt} = \Delta > 0$$

$$\omega_0 = 0$$



Opposite signs

+

No long run inflation

Wage-Price Example

$$\dot{P}_t = \lambda_p(a_{pt} + \omega_t)$$

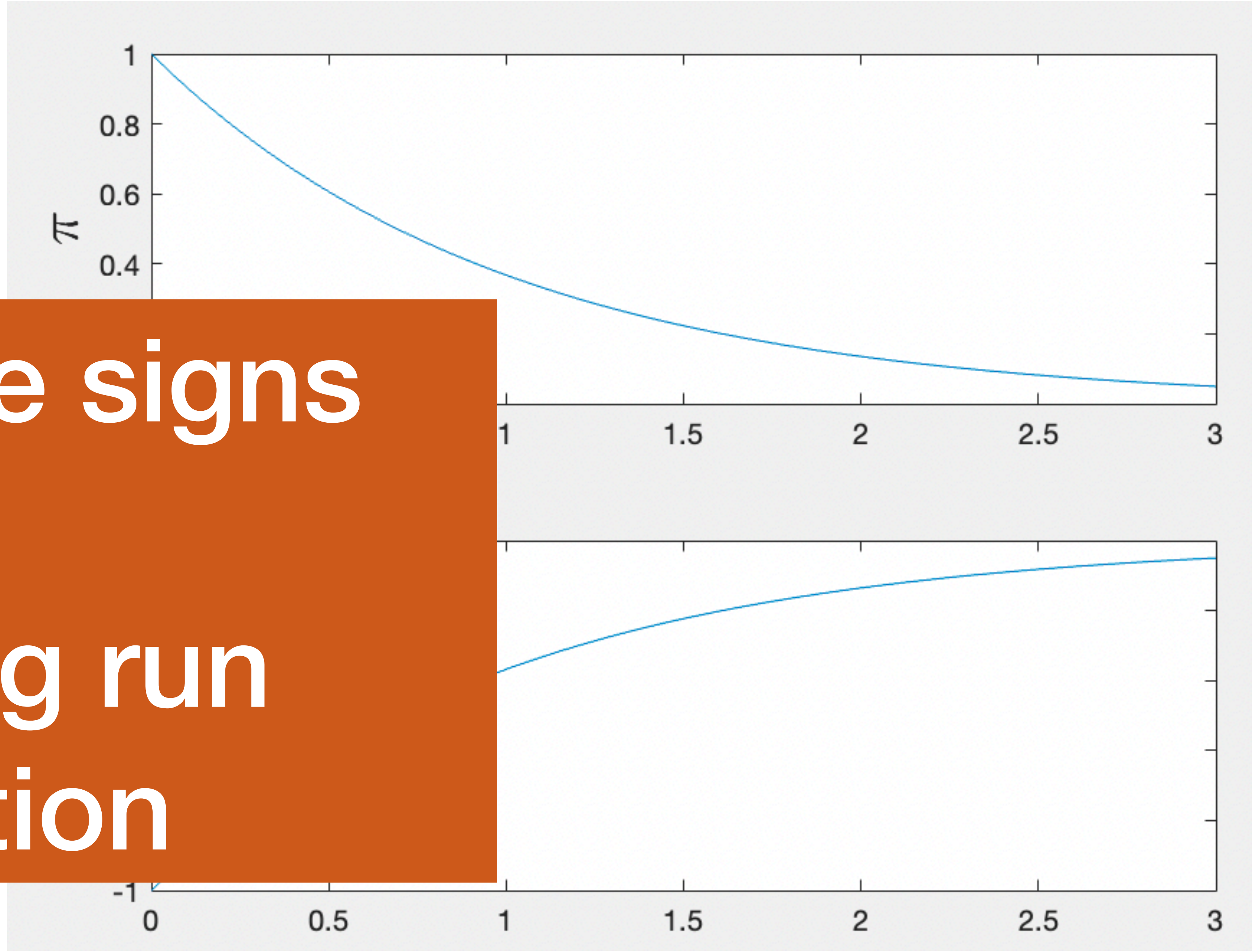
$$\dot{W}_t = \lambda_w(a_{wt} - \omega_t)$$

$(\omega_t = w_t - p_t)$

Example 1: No Disagreement

$$a_{pt} = -a_{wt} = \Delta > 0$$

$$\omega_0 = 0$$



Opposite signs

+

No long run inflation

Example 2: Disagreement

$$a_{pt} = \Delta > 0 = a_{wt}$$

$$\omega_0 = 0$$

Wage-Price Example

$$\dot{P}_t = \lambda_p(a_{pt} + \omega_t)$$

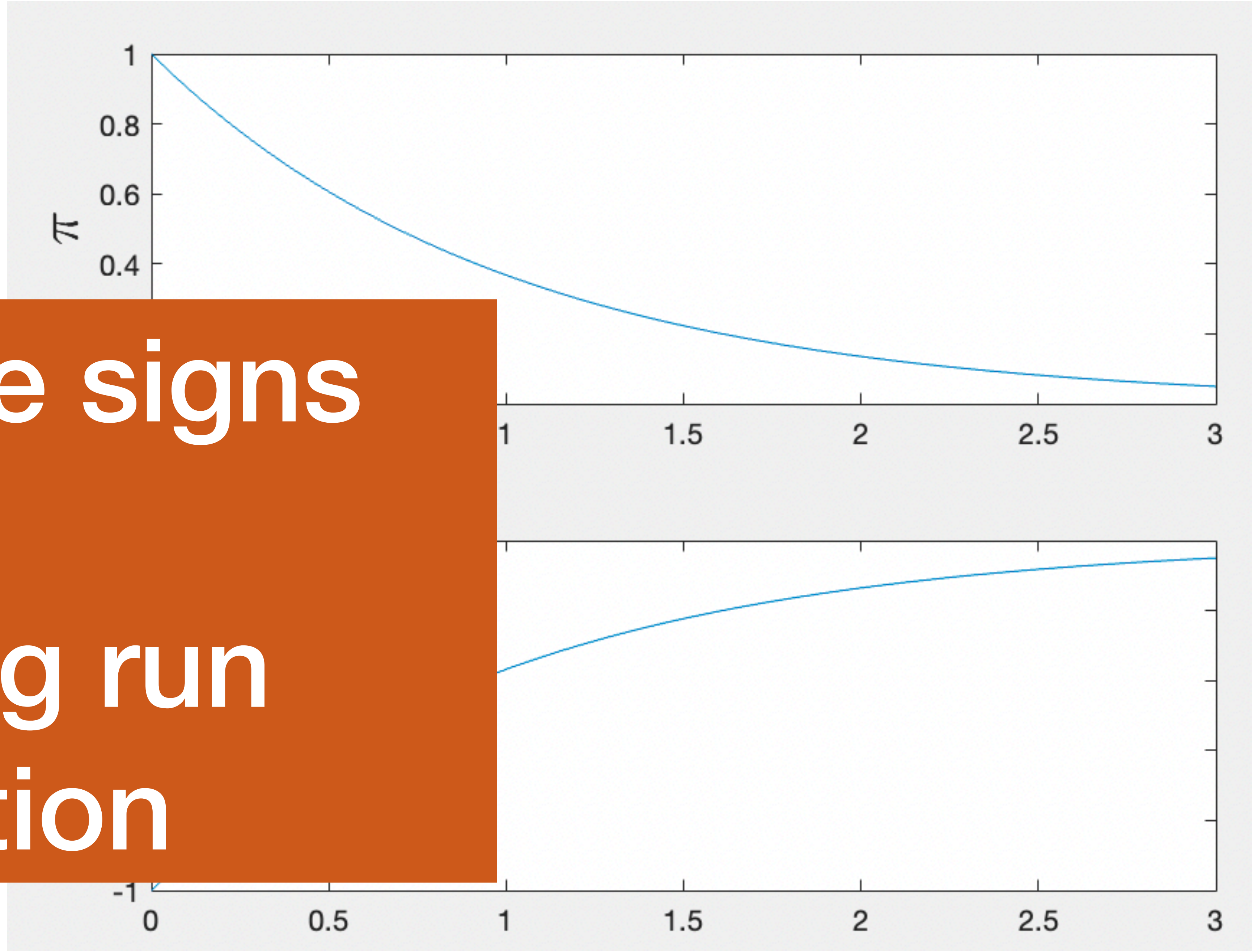
$$\dot{W}_t = \lambda_w(a_{wt} - \omega_t)$$

$$(\omega_t = w_t - p_t)$$

Example 1: No Disagreement

$$a_{pt} = -a_{wt} = \Delta > 0$$

$$\omega_0 = 0$$



Opposite signs

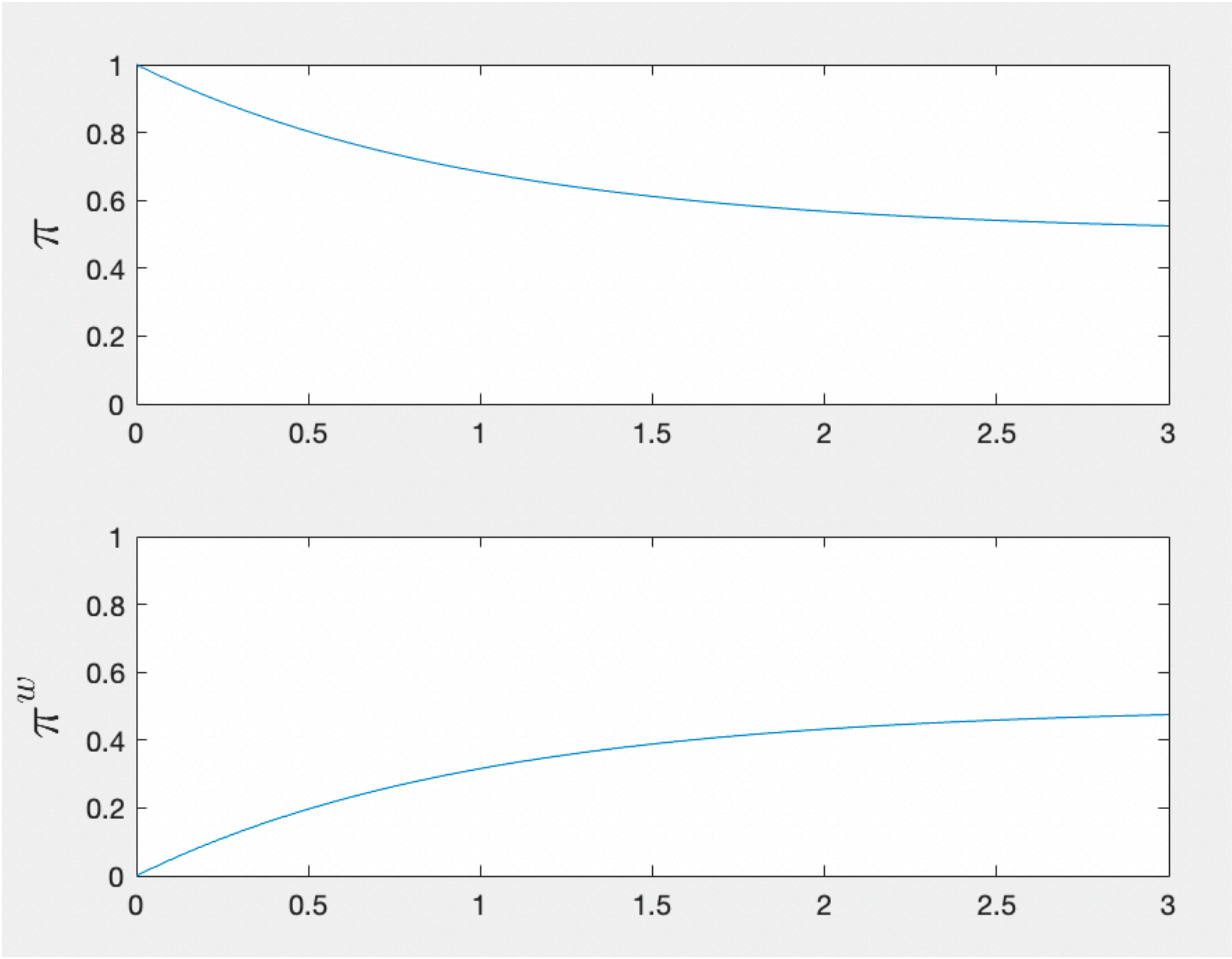
+

No long run inflation

Example 2: Disagreement

$$a_{pt} = \Delta > 0 = a_{wt}$$

$$\omega_0 = 0$$



Wage-Price Example

$$\dot{P}_t = \lambda_p(a_{pt} + \omega_t)$$

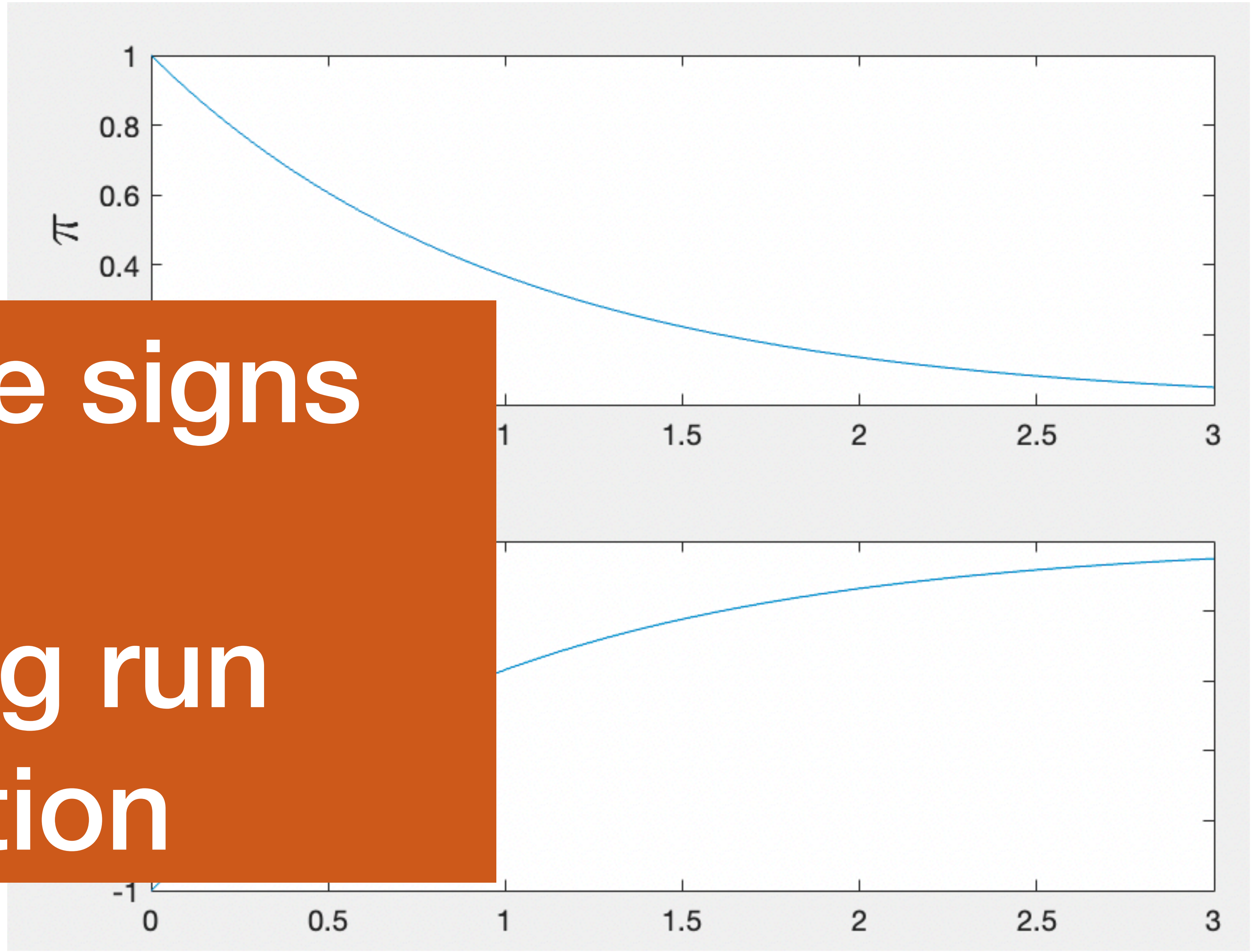
$$\dot{W}_t = \lambda_w(a_{wt} - \omega_t)$$

$$(\omega_t = w_t - p_t)$$

Example 1: No Disagreement

$$a_{pt} = -a_{wt} = \Delta > 0$$

$$\omega_0 = 0$$

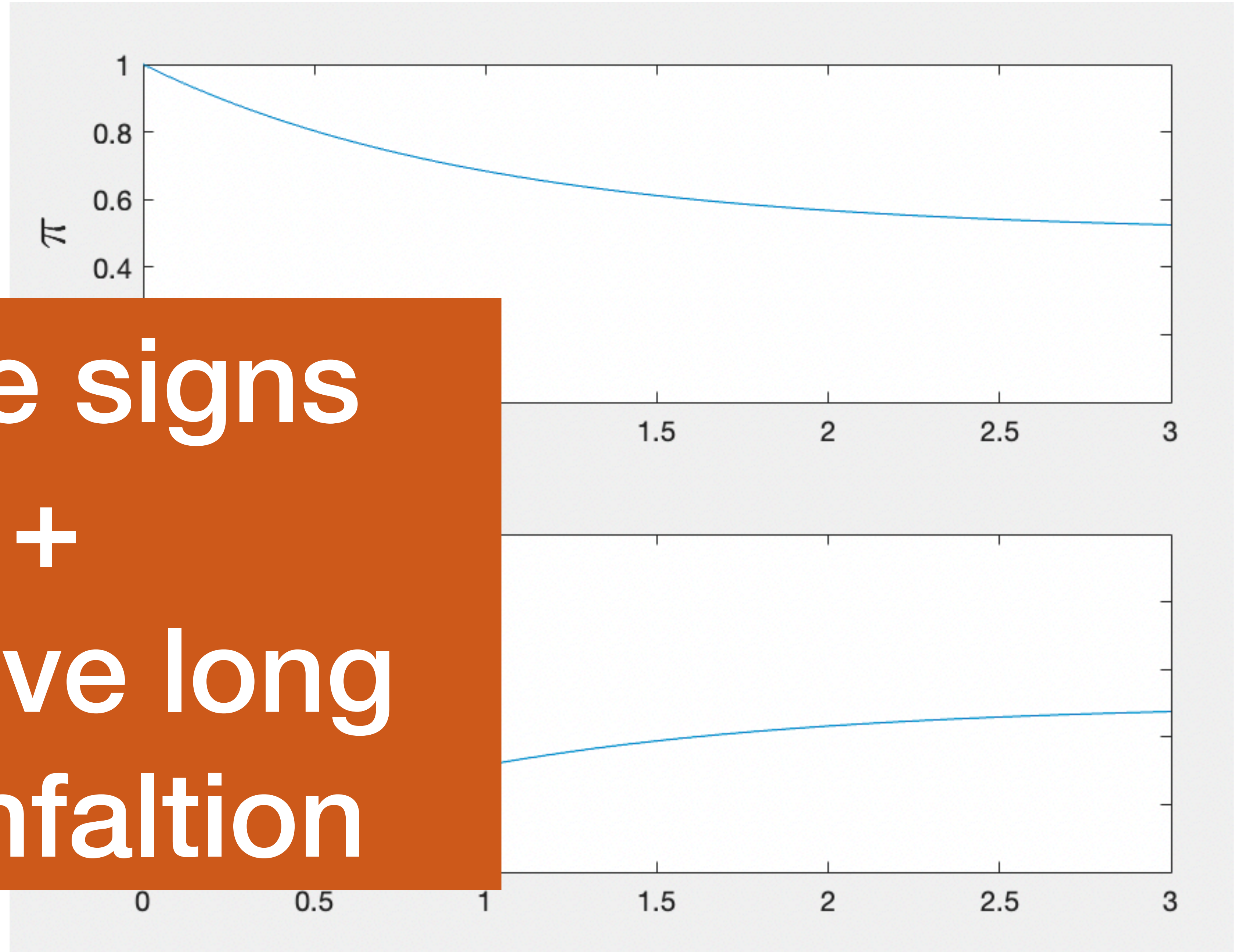


Opposite signs
+
No long run inflation

Example 2: Disagreement

$$a_{pt} = \Delta > 0 = a_{wt}$$

$$\omega_0 = 0$$

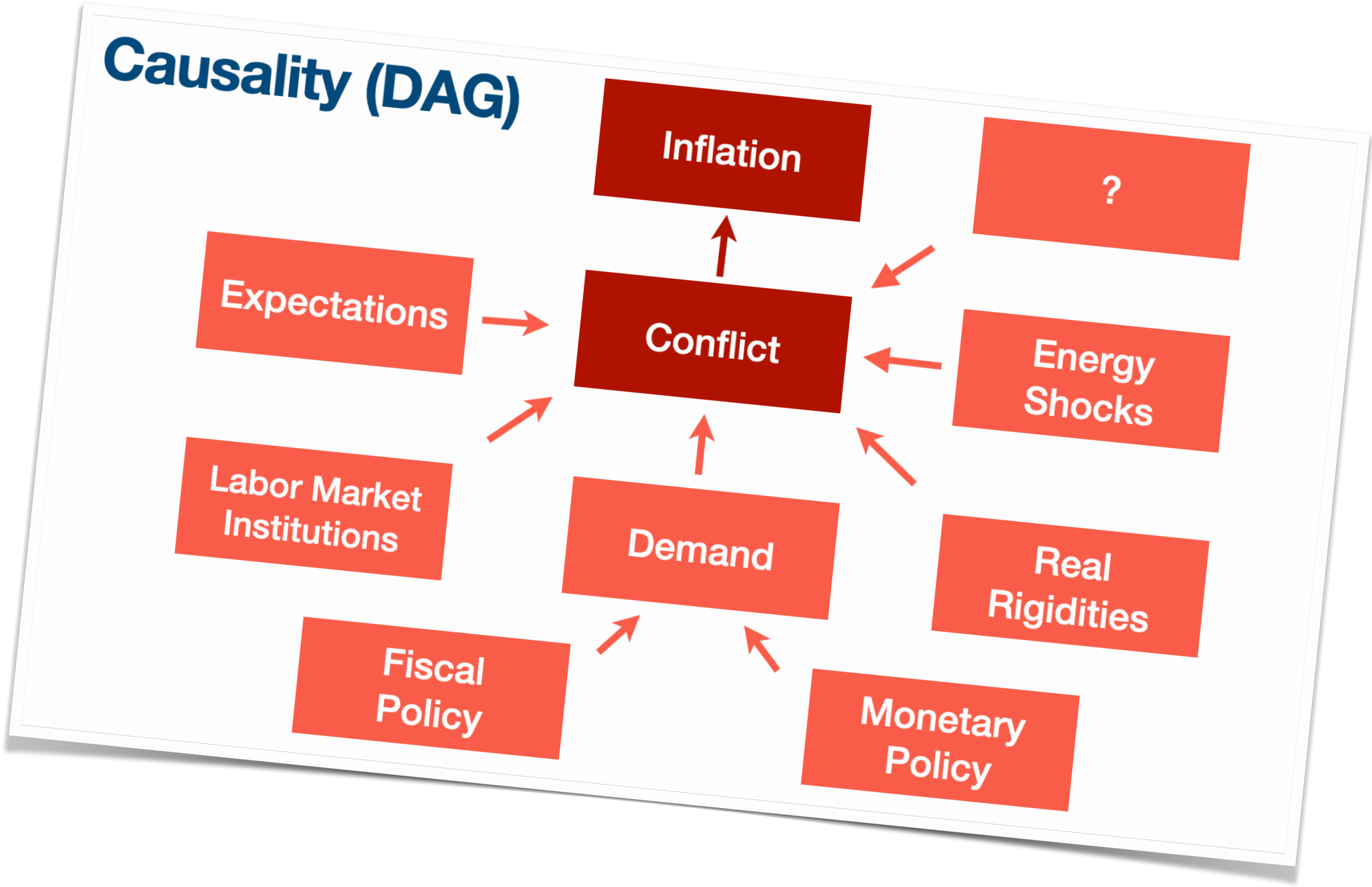


Same signs
+
Positive long run infaltion

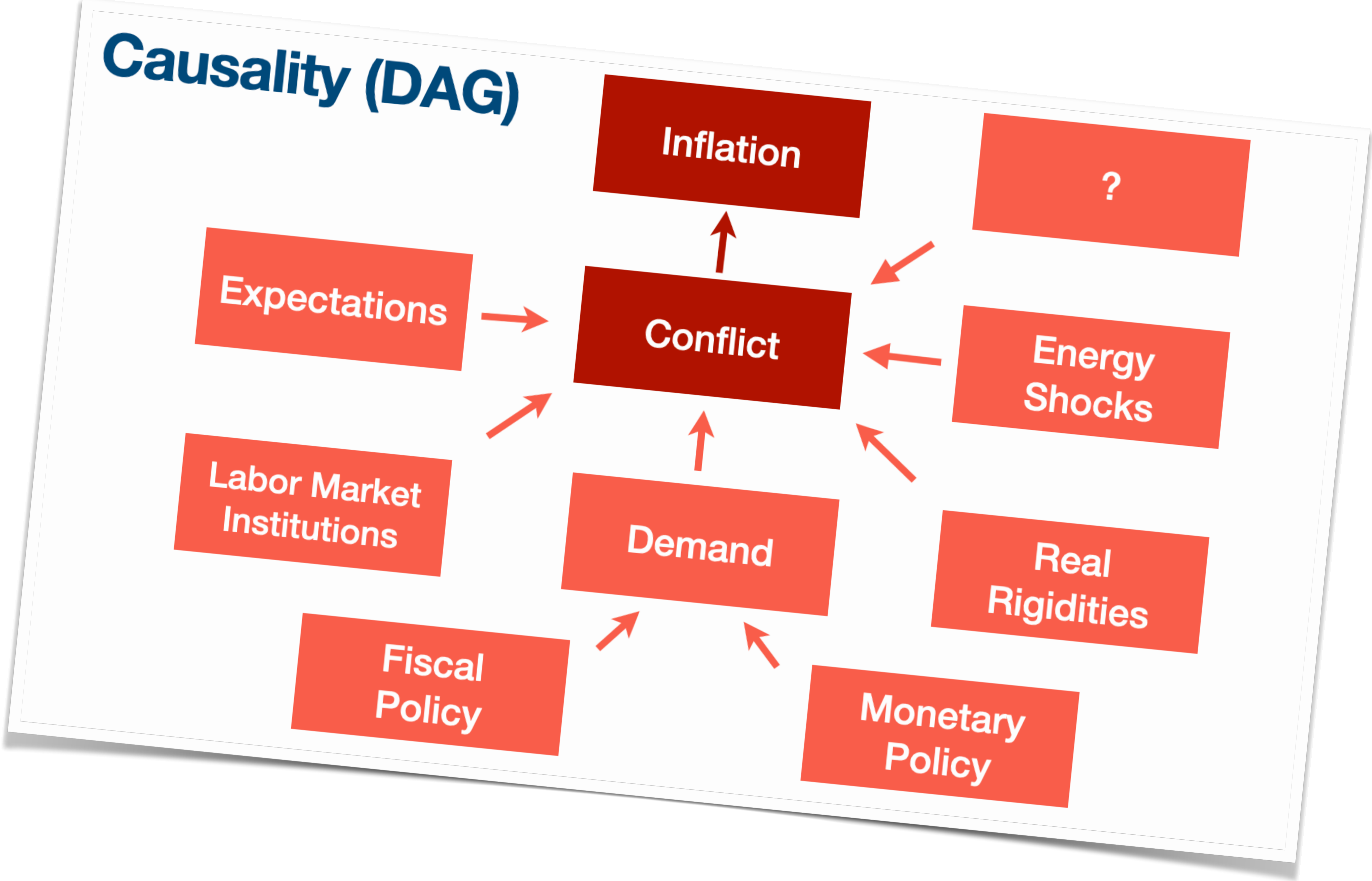
Model of Aspirations?

Model of Aspirations?

- We take $\{a_t\}$ as given…
  - exogenous? No!…
  - … determined by full model



Model of Aspirations?



- We take $\{a_t\}$ as given…
  - exogenous? No!…
  - … determined by full model
- Wage-Price Example (standard model)

$$a_w = \text{mrs} + \text{union markup} + \text{expected inflation}$$

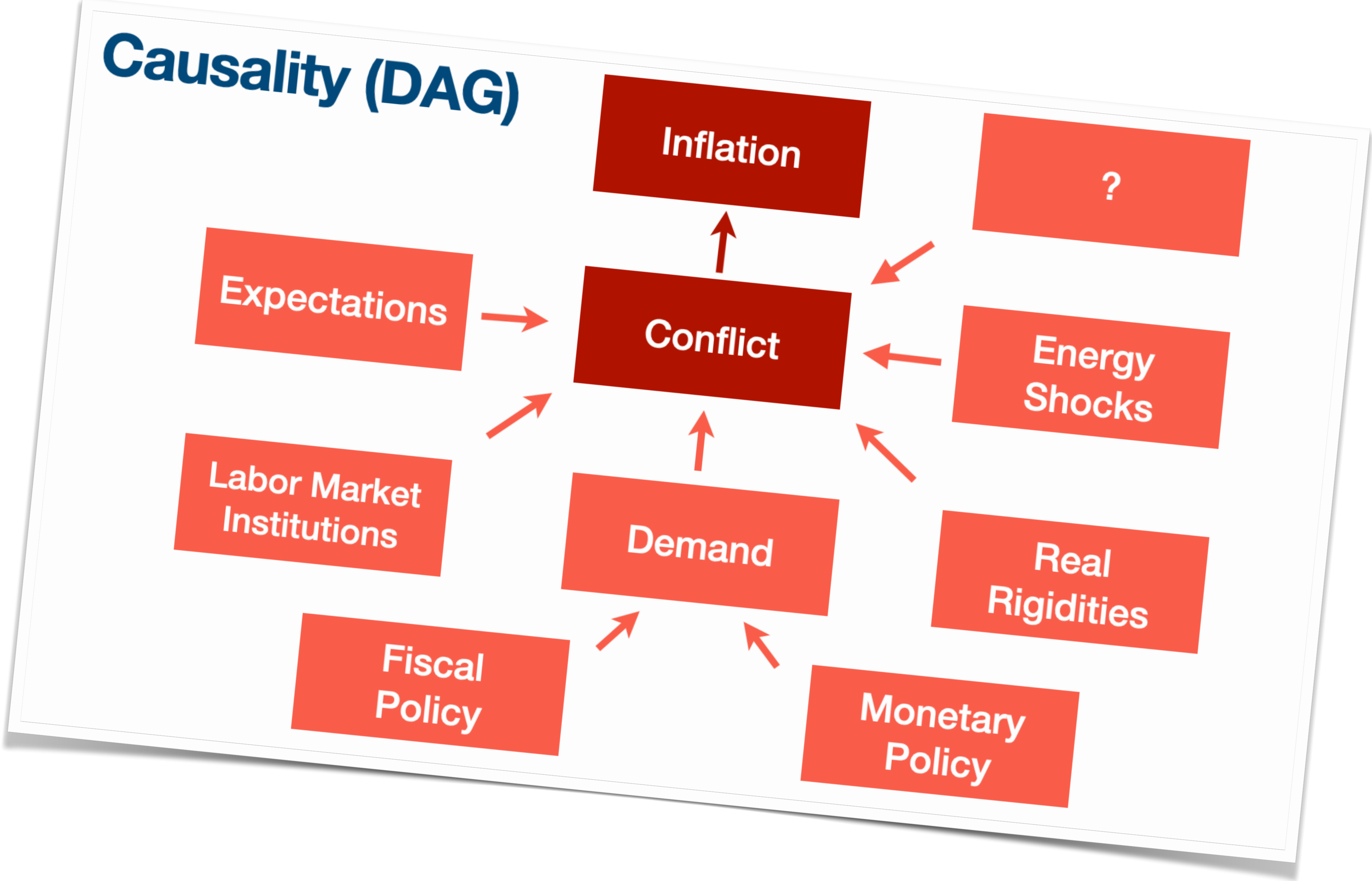
$$a_p = -\,\text{mpl} + \text{firm markup} + \text{expected inflation}$$

Model of Aspirations?

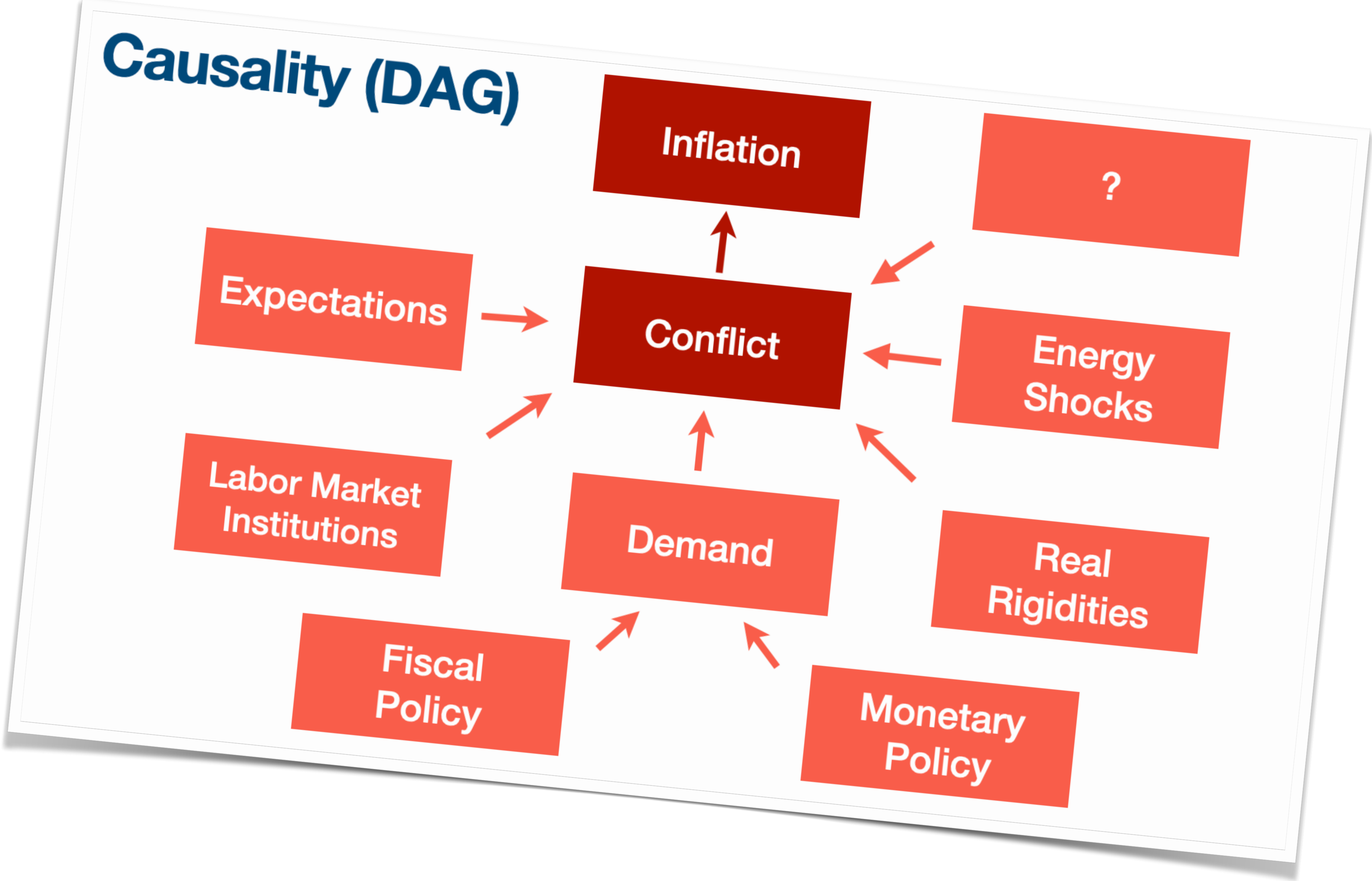
- We take $\{a_t\}$ as given…
  - exogenous? No!…
  - … determined by full model
- Wage-Price Example (standard model)

$$a_w = \text{mrs} + \text{union markup} + \text{expected inflation}$$

$$a_p = -\,\text{mpl} + \text{firm markup} \ + \text{expected inflation}$$



Model of Aspirations?



- We take $\{a_t\}$ as given…
  - exogenous? No!…
  - … determined by full model
- Wage-Price Example (standard model)

$$a_w = \text{mrs} + \text{union markup} + \text{expected inflation}$$

$$a_p = -\,\text{mpl} + \text{firm markup} + \text{expected inflation}$$

- Other possibilities?
  - real wage rigidities (Blanchard-Gali)
  - … ?

Inflation Expectations $(\hat{a}, \pi^e) \rightarrow a$

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

Inflation Expectations $(\hat{a}, \pi^e) \to a$

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

$$\rightarrow \quad a_{nt} = \hat{\mathbb{E}}_{nt} \int_t^\infty e^{-(\rho+\lambda_n)(s-t)}((\rho + \lambda_n)\hat{a}_{ns} + \sum_{n'} m_{nn'} \pi_{n's})ds$$

Inflation Expectations $(\hat{a}, \pi^e) \to a$

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

$$\rightarrow \quad a_{nt} = \hat{\mathbb{E}}_{nt} \int_t^\infty e^{-(\rho+\lambda_n)(s-t)}((\rho + \lambda_n)\hat{a}_{ns} + \sum_{n'} m_{nn'} \pi_{n's})ds$$

Steady State Example

$$a_n = \hat{a}_n + \frac{\sum_{n'} m_{nn'} \pi^e_{nn'}}{\rho + \lambda_n}$$

Inflation Expectations $(\hat{a}, \pi^e) \to a$

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

$$\to \quad a_{nt} = \hat{\mathbb{E}}_{nt} \int_t^\infty e^{-(\rho+\lambda_n)(s-t)}((\rho + \lambda_n)\hat{a}_{ns} + \sum_{n'} m_{nn'} \pi_{n's})ds$$

Steady State Example

$$a_n = \hat{a}_n + \frac{\sum_{n'} m_{nn'} \pi^e_{nn'}}{\rho + \lambda_n} \quad \to \quad \gamma' a = \gamma' \hat{a} + \gamma' \frac{\sum_{n'} m_{nn'} \pi^e_{nn'}}{\rho + \lambda_n}$$

Conflict

Rational Expectations $\pi^e = \pi$

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

Rational Expectations $\pi^e = \pi$

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

$$\longrightarrow \rho \dot{P} = \hat{\Lambda} \left(\hat{a} - AP \right) + \ddot{P}$$

Rational Expectations $\pi^e = \pi$

Rational Expectations $\pi^e = \pi$

$$\boxed{\hat{\Pi}_t^C = \frac{1}{\bar{D}} \int_0^\infty e^{-\rho s} \gamma' \hat{a}_{t+s}\, ds}$$

Rational Expectations $\pi^e = \pi$

$$\boxed{\hat{\Pi}^C_t = \frac{1}{\bar{D}} \int_0^\infty e^{-\rho s} \gamma' \hat{a}_{t+s}\, ds}$$

$$\bar{P}_t = \sum_n \hat{\psi}_n P_{nt}$$

$$\dot{\bar{P}}_t = \sum_n \psi_n \pi_{nt} = \Pi^C_t$$

Generalized Price-Wage Inflation is Conflict

Rational Expectations $\pi^e = \pi$

$$\boxed{\hat{\Pi}^C_t = \frac{1}{\bar{D}} \int_0^\infty e^{-\rho s} \gamma' \hat{a}_{t+s} \, ds}$$

$$\bar{P}_t = \sum_n \hat{\psi}_n P_{nt}$$

$$\dot{\bar{P}}_t = \sum_n \psi_n \pi_{nt} = \Pi^C_t$$

Generalized Price-Wage Inflation is Conflict

$$\frac{1}{T} \int_0^T \pi_{nt} \to \Pi^C_t$$

Average or Persistent Inflation is Conflict

- Stylized Model
- General Framework
- Applications ← **Now!**

Wage Price Spirals

Wage Price Spirals

- What is a wage price spiral? A shock or alternative model?
  - NO: mechanism, at work also in standard NK models

Wage Price Spirals

- What is a wage price spiral? A shock or alternative model?
  - NO: mechanism, at work also in standard NK models
- Can we gauge if mechanism is at work by looking at W/P?
  - NO: total power of mechanism vs. relative power on W and P

Wage Price Spirals

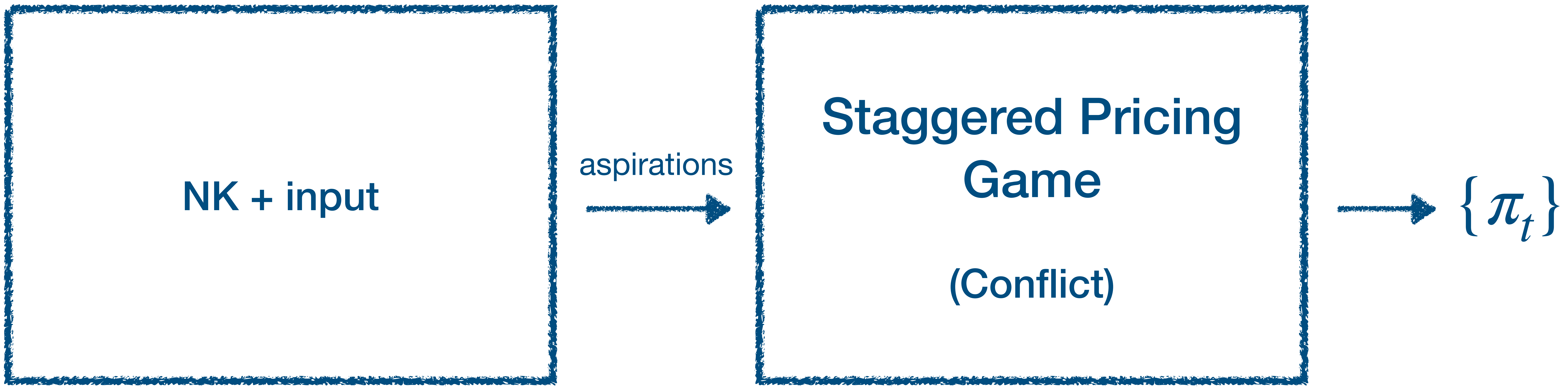
- What is a wage price spiral? A shock or alternative model?
  - NO: mechanism, at work also in standard NK models
- Can we gauge if mechanism is at work by looking at W/P?
  - NO: total power of mechanism vs. relative power on W and P
- Does W/P tell us about shocks?
  - NO: Demand & Supply shocks can ↑inflation and ↓W/P

Wage Price Spirals

- What is a wage price spiral? A shock or alternative model?
  - NO: mechanism, at work also in standard NK models
- Can we gauge if mechanism is at work by looking at W/P?
  - NO: total power of mechanism vs. relative power on W and P
- Does W/P tell us about shocks?
  - NO: Demand & Supply shocks can ↑inflation and ↓W/P
- Optimistic perspective: wage price spiral but inflation falling

Conflict → Specific Model

- Build on previous conflict framework
- Specialize to NK model with some features…
  - price and wage stickiness (as before)
  - output: labor AND input
    (supply constrained, energy, chips, lumber, etc)



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

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

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

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

$$Y_{jt}=F\left(L_{jt},X_{jt}\right)\equiv\left(a_L L_{jt}^{\frac{\epsilon-1}{\epsilon}}+a_X X_{jt}^{\frac{\epsilon-1}{\epsilon}}\right)^{\frac{\epsilon}{\epsilon-1}} \qquad L_{jt}=\left(\int_0^1 L_{jkt}^{1-1/\zeta}dk\right)^{\frac{1}{1-1/\zeta}}$$

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

$$Y_{jt}=F\left(L_{jt},X_{jt}\right)\equiv\left(a_L L_{jt}^{\frac{\epsilon-1}{\epsilon}}+a_X X_{jt}^{\frac{\epsilon-1}{\epsilon}}\right)^{\frac{\epsilon}{\epsilon-1}} \qquad L_{jt}=\left(\int_0^1 L_{jkt}^{1-1/\zeta}dk\right)^{\frac{1}{1-1/\zeta}}$$

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

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

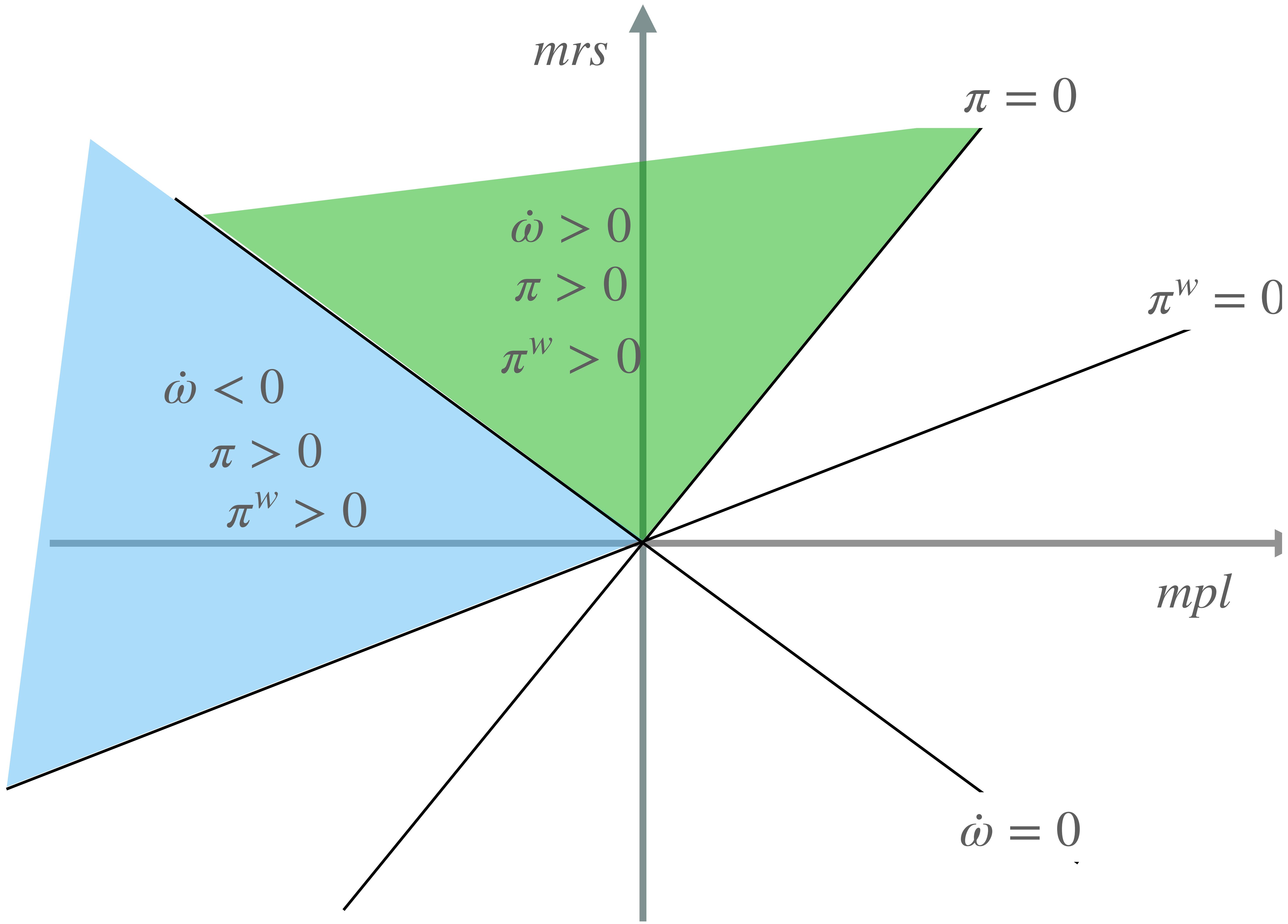
$$\int_0^\infty e^{-\rho t}\left(\frac{1}{1-\sigma}C_t^{1-\sigma}-\frac{\Phi_t}{1+\eta}\int_0^1 N_{jt}^{1+\eta}dj\right)dt,$$

$$Y_{jt}=F\left(L_{jt},X_{jt}\right)\equiv\left(a_L L_{jt}^{\frac{\epsilon-1}{\epsilon}}+a_X X_{jt}^{\frac{\epsilon-1}{\epsilon}}\right)^{\frac{\epsilon}{\epsilon-1}} \qquad L_{jt}=\left(\int_0^1 L_{jkt}^{1-1/\zeta}dk\right)^{\frac{1}{1-1/\zeta}}$$

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

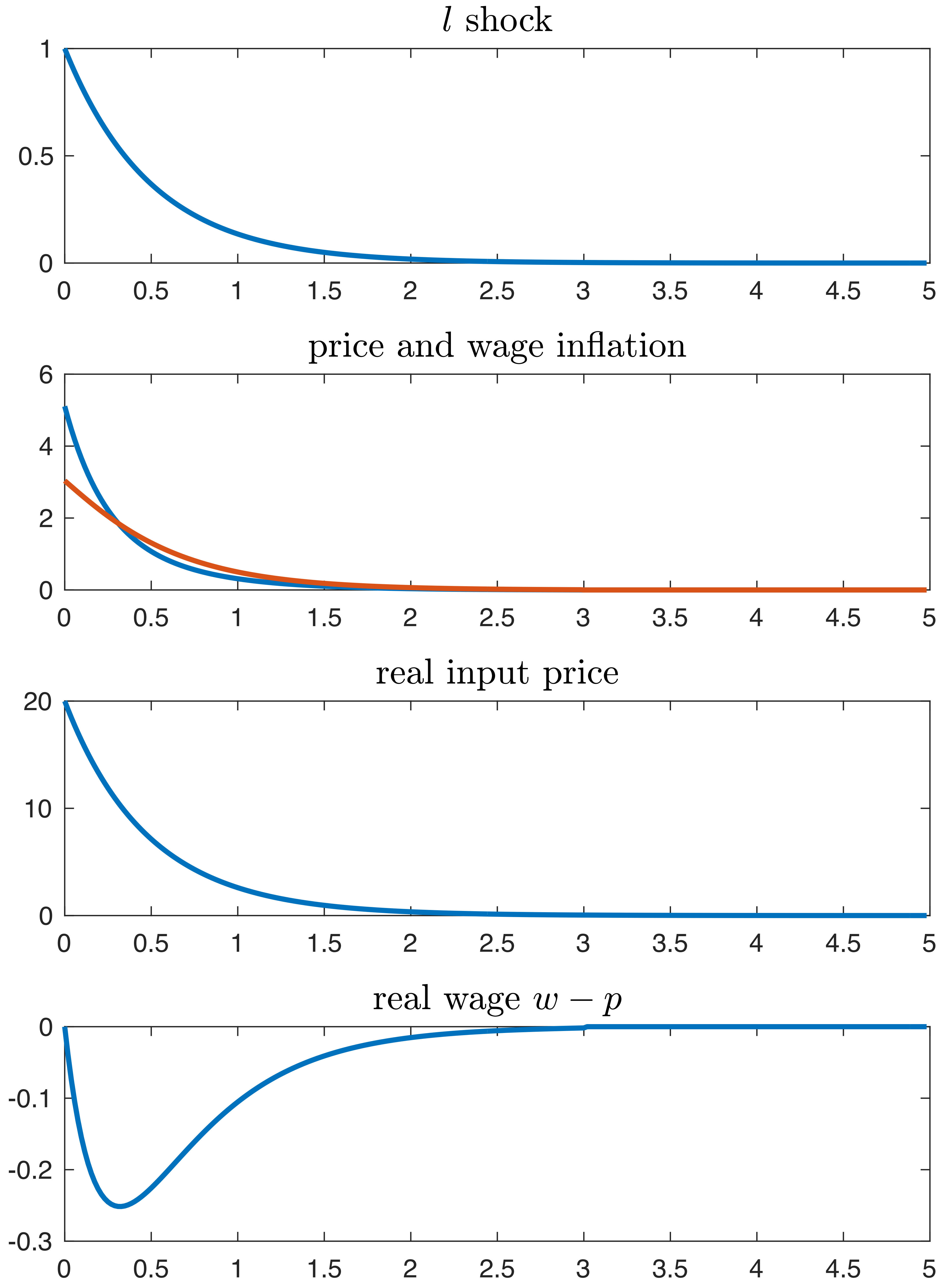
$$w_t^*=\left(\rho+\lambda_w\right)\int_t^\infty e^{-\left(\rho+\lambda_w\right)(\tau-t)}\left(p_\tau+mrs_{\tau,t}\right)d\tau$$

Shocks and Real Wage



Supply Constrained Demand Shock

- Explore…
  - monetary policy mistake increases demand temporarily



Real Wage Falls…

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

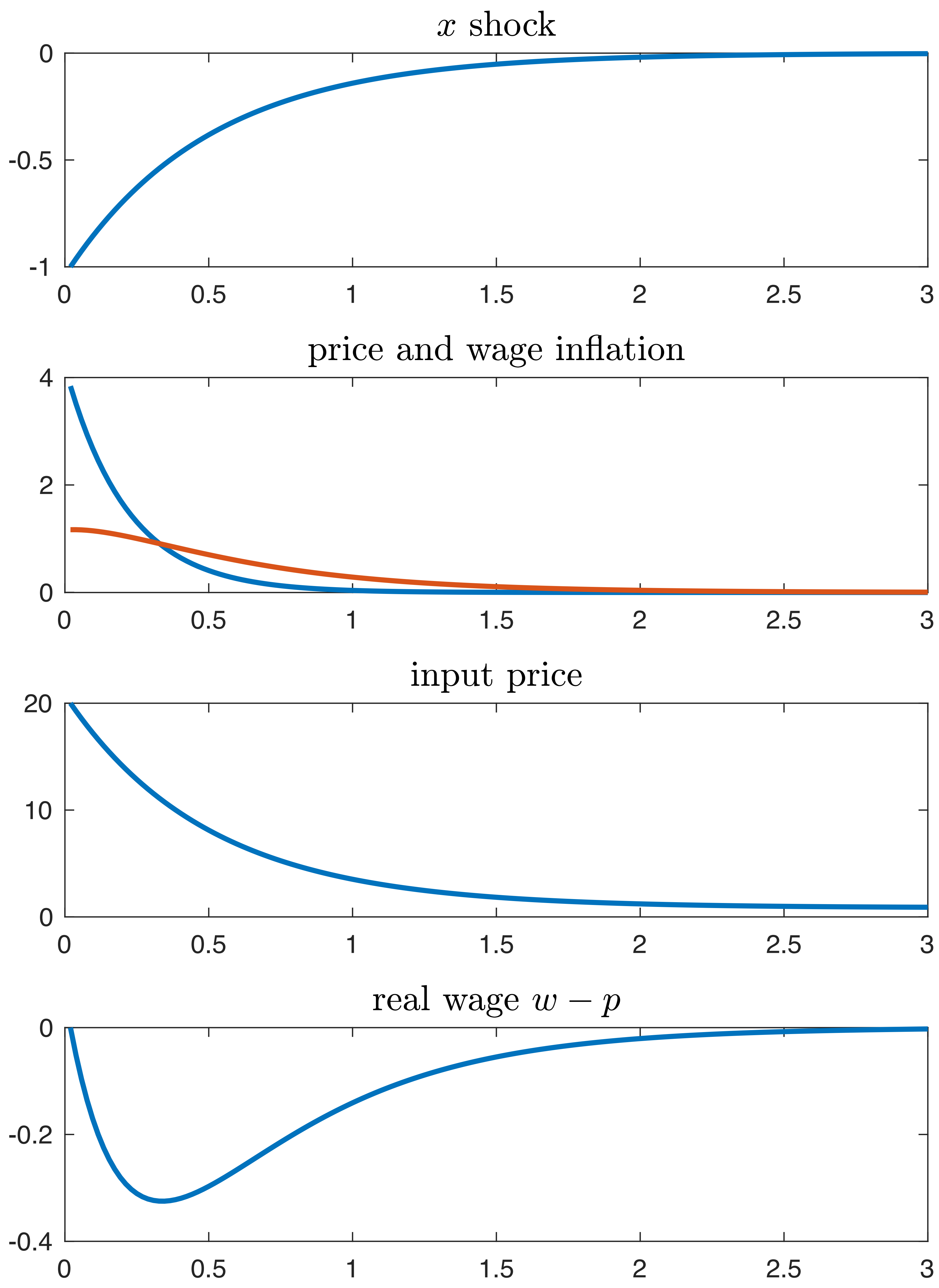
Relatively weak response of real wage demands to hot labor market

Supply Shock

- Availability of input falls temporarily
- Two different responses of monetary policy captured by path
- Response: keep y on original path (zero)

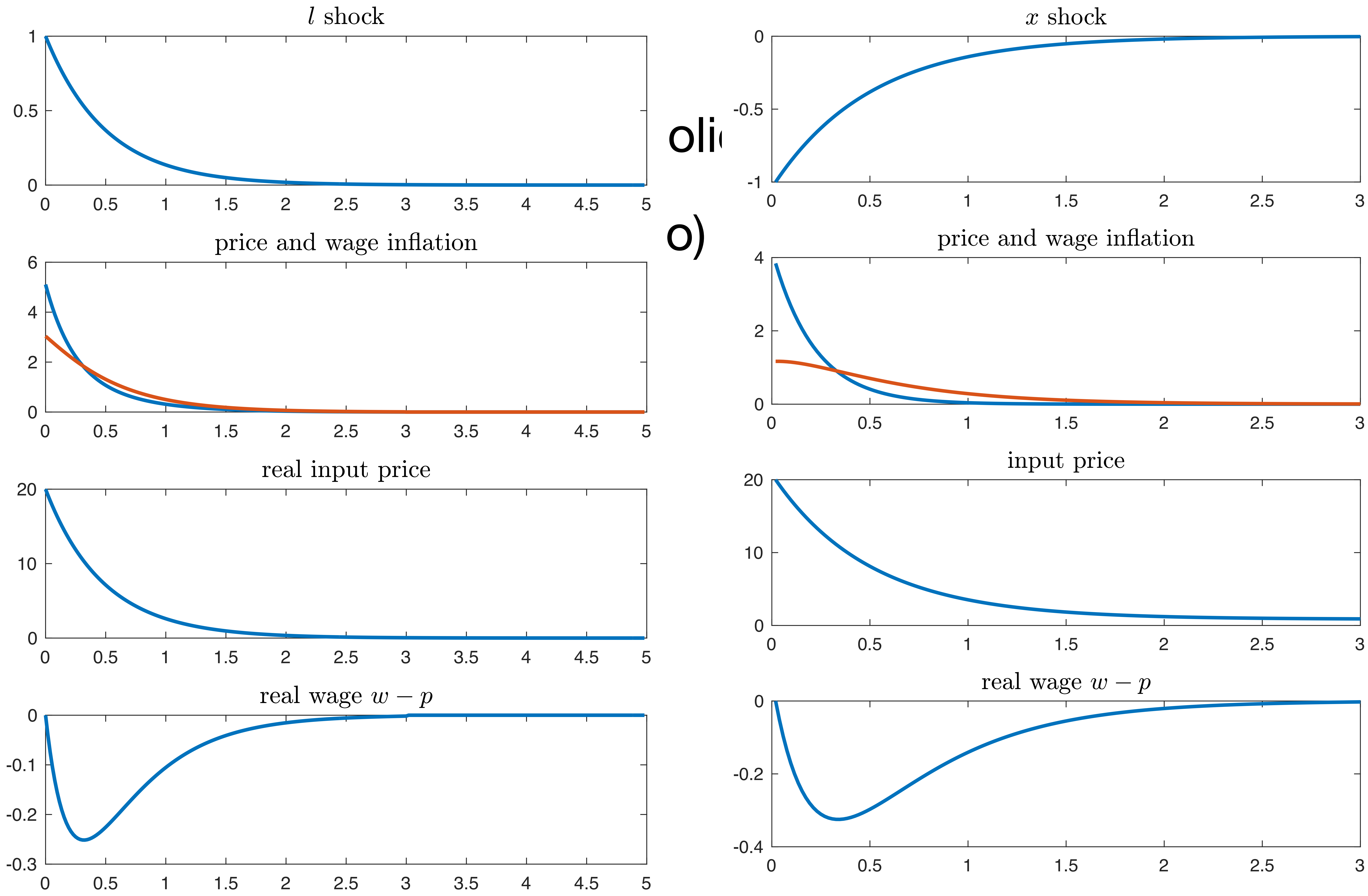
Supply Shock

- Availability of input falls temporarily
- Two different responses of monetary poli
- Response: keep y on original path (zero)



Supply Shock

- Availabi
- Two diff   oli
- Respon   o)



Why Does Inflation Fall when Wages Rise?

- Price inflation can fall with higher wage inflation
- Price of other input falls (negative inflation)…
  … supply constraints easing…
  … also: profit margin high, room for real wages to recover;
- Wage increases already partially priced in
  (forward-looking rational expectations)

Conclusions

Conclusions

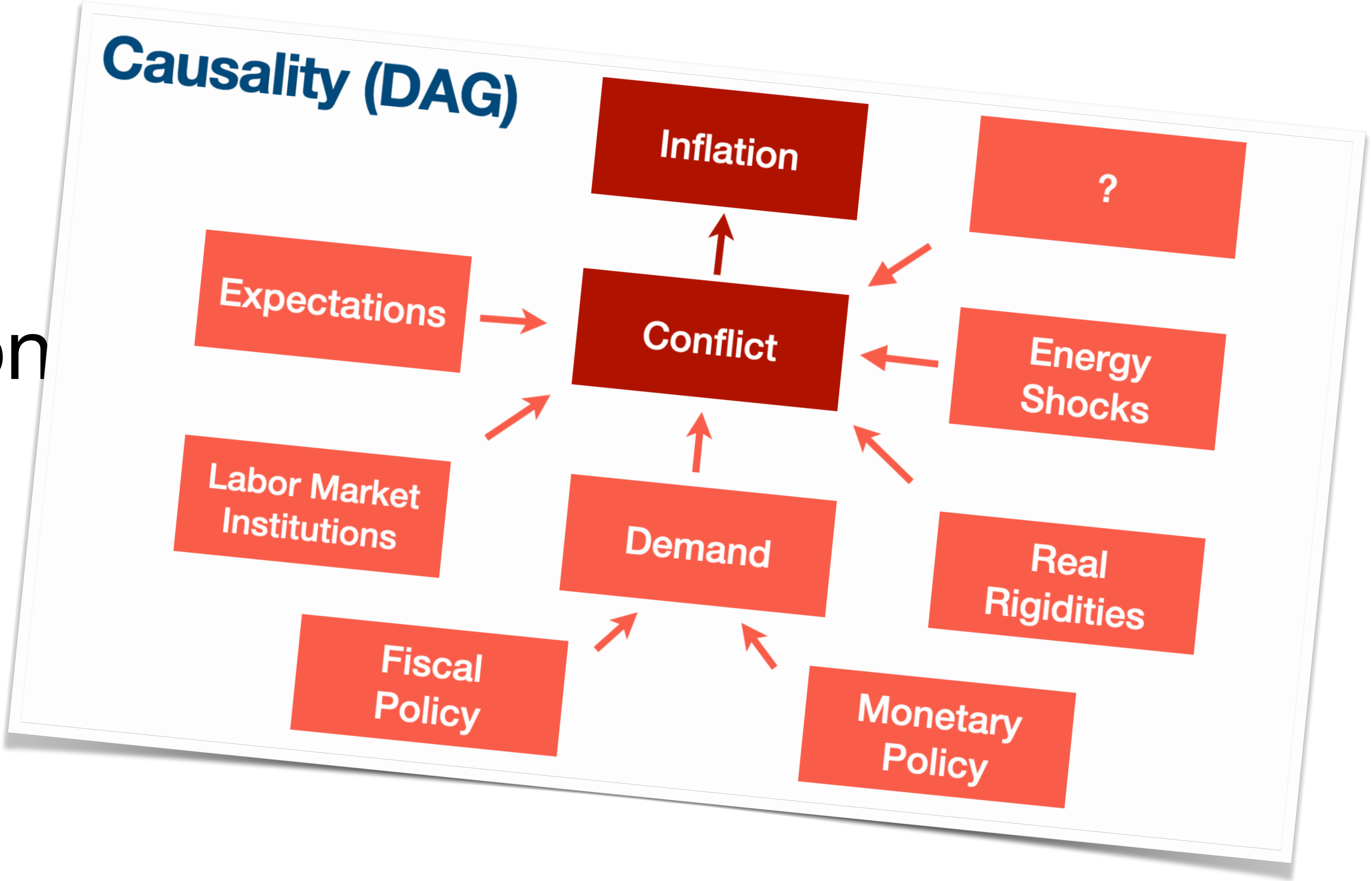
- Conflict…
  - useful way to think, research and teach inflation
  - Mechanism for inflation: intuitive (important!)

Conclusions

- Conflict…
  - useful way to think, research and teach inflation
  - Mechanism for inflation: intuitive (important!)
- Provide general yet simple framework…
  - fits many traditional models…
  - … helps think of new ones or outside the box

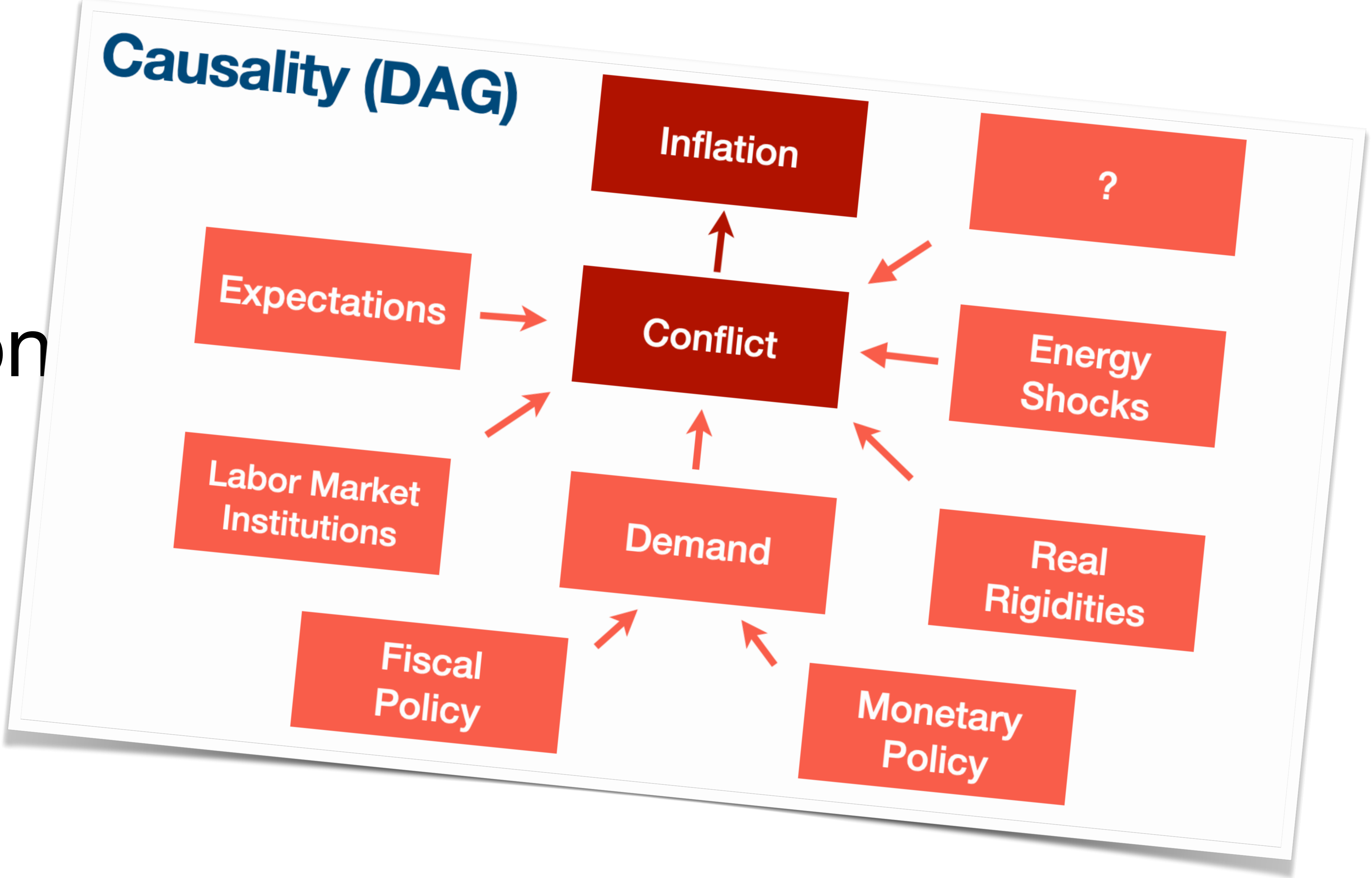
Conclusions

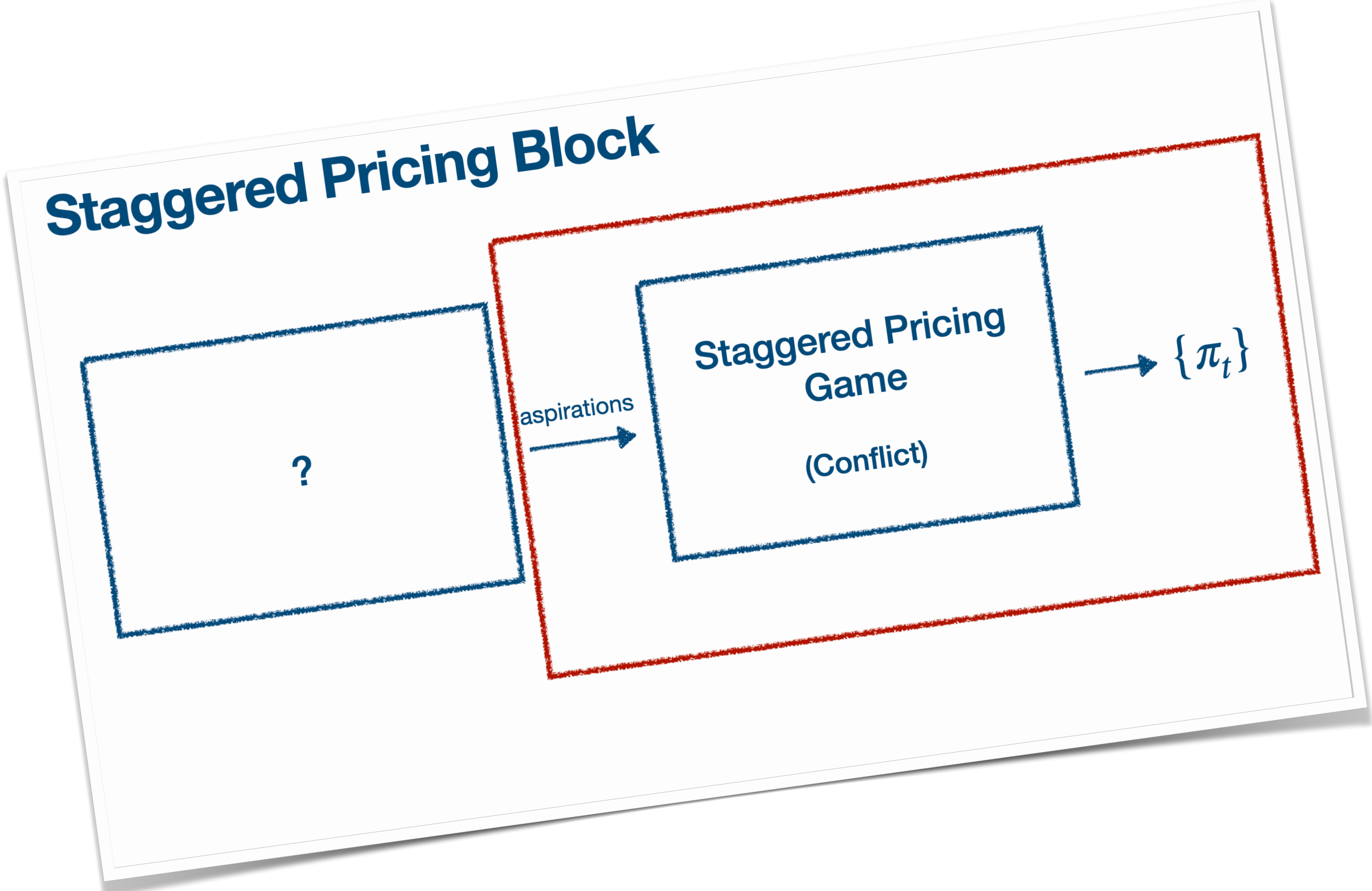
- Conflict…
  - useful way to think, research and teach inflation
  - Mechanism for inflation: intuitive (important!)
- Provide general yet simple framework…
  - fits many traditional models…
  - … helps think of new ones or outside the box



Conclusions

- Conflict…
  - useful way to think, research and teach inflation
  - Mechanism for inflation: intuitive (important!)
- Provide general yet simple framework…
  - fits many traditional models…
  - … helps think of new ones or outside the box





Adding Money

- Needed: motivate the use of money, give it some edge…
- Split each period into an interval with [0,1] instants
  - Fraction $1 - \delta$ instants as before
  - Fraction δ are "disasters"
    - buyer has no endowment
    - cannot trade via barter
    - … but can buy at nominal prices using money!
- Monetary policy: fixed M

Adding Money

Adding Money

- Well known: hard to keep track of money distribution

Adding Money

- Well known: hard to keep track of money distribution
- Here…
  - M initially held by buyers
  - only buyers get disaster shock
  - buyers want to spend cash only during disasters (guess & verify)
  - buyers want to spend all their cash during disasters (guess & verify)

Adding Money

- Well known: hard to keep track of money distribution
- Here…
  - M initially held by buyers
  - only buyers get disaster shock
  - buyers want to spend cash only during disasters (guess & verify)
  - buyers want to spend all their cash during disasters (guess & verify)
- Additive utility

Adding Money

- Well known: hard to keep track of money distribution
- Here…
  - M initially held by buyers
  - only buyers get disaster shock
  - buyers want to spend cash only during disasters (guess & verify)
  - buyers want to spend all their cash during disasters (guess & verify)
- Additive utility

$$u(c, c') = F(c) + H(c')$$

Adding Money

- Well known: hard to keep track of money distribution
- Here…
  - M initially held by buyers
  - only buyers get disaster shock
  - buyers want to spend cash only during disasters (guess & verify)
  - buyers want to spend all their cash during disasters (guess & verify)
- Additive utility

$$u(c, c') = F(c) + H(c') \qquad -H''(c')c'/H'(c') < 1$$

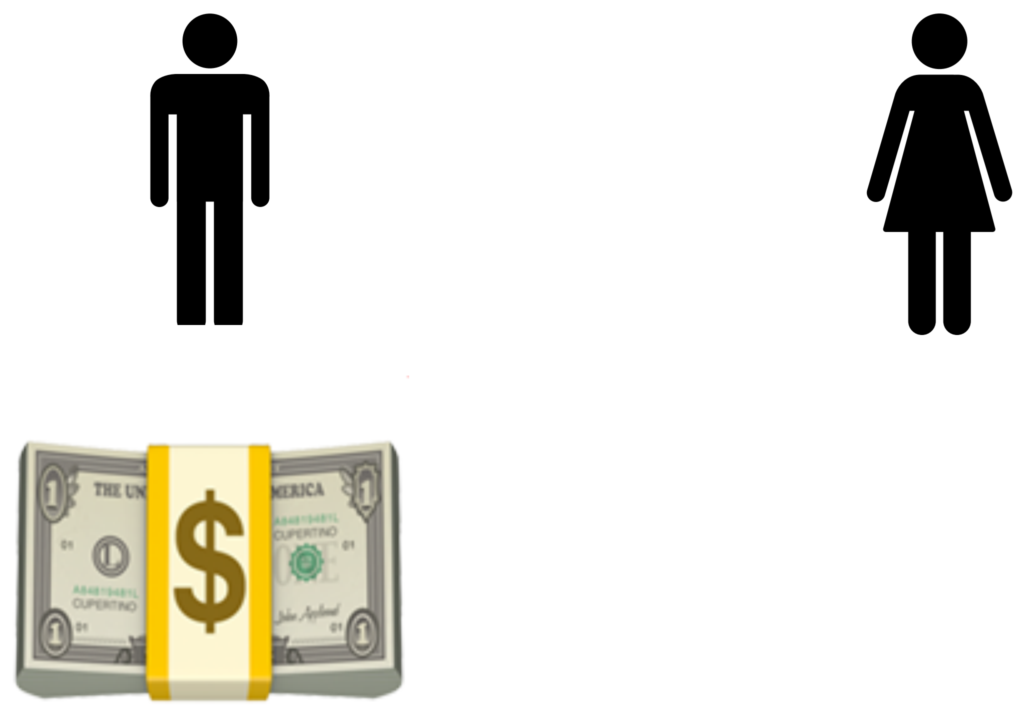
Adding Money

- Well known: hard to keep track of money distribution
- Here…
  - M initially held by buyers
  - only buyers get disaster shock
  - buyers want to spend cash only during disasters (guess & verify)
  - buyers want to spend all their cash during disasters (guess & verify)
- Additive utility

$$u(c, c') = F(c) + H(c') \qquad -H''(c')c'/H'(c') < 1$$

Adding Money

- Well known: hard to keep track of money distribution
- Here…
  - M initially held by buyers
  - only buyers get disaster shock
  - buyers want to spend cash only during disasters (guess & verify)
  - buyers want to spend all their cash during disasters (guess & verify)
- Additive utility

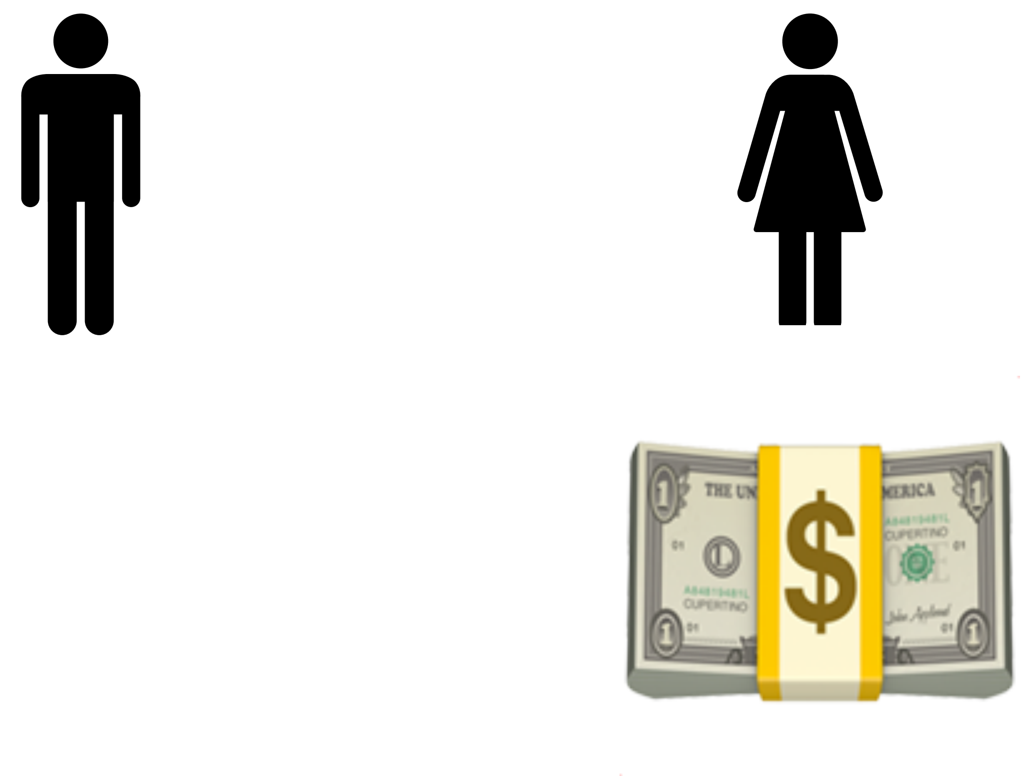


$$u(c, c') = F(c) + H(c')$$

$$-H''(c')c'/H'(c') < 1$$

Adding Money

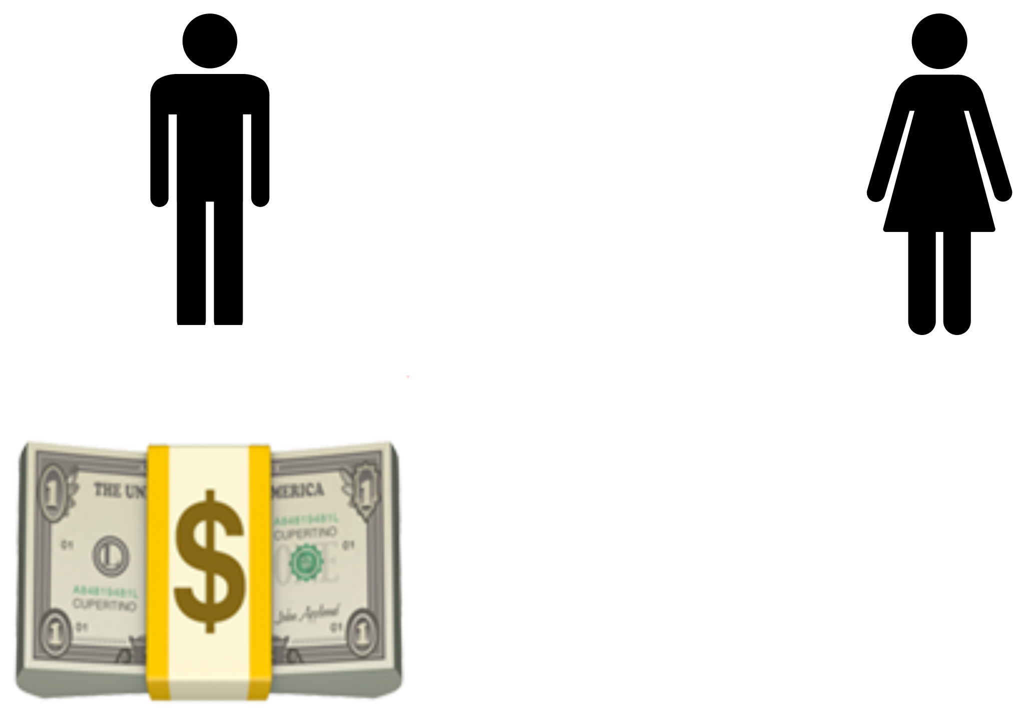
- Well known: hard to keep track of money distribution
- Here…
  - M initially held by buyers
  - only buyers get disaster shock
  - buyers want to spend cash only during disasters (guess & verify)
  - buyers want to spend all their cash during disasters (guess & verify)
- Additive utility



$$u(c, c') = F(c) + H(c') \qquad -H''(c')c'/H'(c') < 1$$

Adding Money

- Well known: hard to keep track of money distribution
- Here…
  - M initially held by buyers
  - only buyers get disaster shock
  - buyers want to spend cash only during disasters (guess & verify)
  - buyers want to spend all their cash during disasters (guess & verify)
- Additive utility



$$u(c, c') = F(c) + H(c') \qquad -H''(c')c'/H'(c') < 1$$

Equilibrium

Equilibrium

$$(1-\delta)v(\tilde{p}_t) + \delta F(1 - m_t/\tilde{p}_t) + \beta\left((1-\delta)V\left(\frac{p_t p_{t+1}}{\tilde{p}_t}\right) + \delta H\left(\frac{m_t}{p_t p_{t+1}}\right)\right)$$

Equilibrium

$$(1-\delta)v(\tilde{p}_t) + \delta F(1 - m_t/\tilde{p}_t) + \beta\left((1-\delta)V\left(\frac{p_t p_{t+1}}{\tilde{p}_t}\right) + \delta H\left(\frac{m_t}{p_t p_{t+1}}\right)\right)$$

$$\longrightarrow \quad v'(p_t)p_t + m_{t+1}\frac{\delta}{1-\delta}u(1-m_{t+1},0) = \beta V'(p_{t+1})p_{t+1}$$

Equilibrium

$$(1-\delta)v(\tilde{p}_t) + \delta F(1 - m_t/\tilde{p}_t) + \beta\left((1-\delta)V\left(\frac{p_t p_{t+1}}{\tilde{p}_t}\right) + \delta H\left(\frac{m_t}{p_t p_{t+1}}\right)\right)$$

$$\longrightarrow \quad v'(p_t)p_t + m_{t+1}\frac{\delta}{1-\delta}u(1-m_{t+1},0) = \beta V'(p_{t+1})p_{t+1}$$

$$H'(m_t)m_t \geq \beta^2 m_{t+2}H'(m_{t+2})$$

Equilibrium

$$(1-\delta)v(\tilde{p}_t) + \delta F(1 - m_t/\tilde{p}_t) + \beta\left((1-\delta)V\left(\frac{p_t p_{t+1}}{\tilde{p}_t}\right) + \delta H\left(\frac{m_t}{p_t p_{t+1}}\right)\right)$$

$$\longrightarrow \quad v'(p_t)p_t + m_{t+1}\frac{\delta}{1-\delta}u(1-m_{t+1},0) = \beta V'(p_{t+1})p_{t+1}$$

$$H'(m_t)m_t \geq \beta^2 m_{t+2}H'(m_{t+2})$$

$$G'(D(p_t)) \leq G'(m_t/p_t)$$

Equilibrium

$$(1-\delta)v(\tilde{p}_t) + \delta F(1 - m_t/\tilde{p}_t) + \beta\left((1-\delta)V\left(\frac{p_t p_{t+1}}{\tilde{p}_t}\right) + \delta H\left(\frac{m_t}{p_t p_{t+1}}\right)\right)$$

$$\longrightarrow \quad v'(p_t)p_t + m_{t+1}\frac{\delta}{1-\delta}u(1-m_{t+1},0) = \beta V'(p_{t+1})p_{t+1}$$

$$H'(m_t)m_t \geq \beta^2 m_{t+2}H'(m_{t+2})$$

$$G'(D(p_t)) \leq G'(m_t/p_t)$$

Result. For all M low enough…

$$\frac{P_t^*}{P_{t-1}^*} > 1$$