Fiscal Stimulus with Supply Constraints

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Motivation

- Pandemic experience challenges our understanding of inflation
  - Disconnect between prices and wages (Bernanke and Blanchard, 2023)
  - Contrast with baseline New-Keynesian model
- Recent evidence suggests that technological constraints affect firms' price setting
  - Convex supply curves: price response to demand shocks depends on capacity utilization (Boehm and Pandalai-Nayar, 2022)
  - Large increases in demand lead firms to invest to overcome supply constraints (Iltzezki, 2024)
- Reconsidering how we model the supply side of the economy is a promising avenue for progress

This paper

- Macroeconomic model with occasionally binding supply constraints
  - Firms have limited ability to scale up production quickly
  - Endogenous markups of prices over wages
- Study fiscal Phillips multiplier
  - Change in inflation caused by a fiscal stimulus rising output by 1 percent (Barnichon and Mesters, 2023)
- Simple model with analytic results
  - Complementary to quantitative frameworks proposed by Boehm and Pandalai-Nayar (2022), Di Giovanni et al. (2024), Comin et al. (2024),...

Preview of results

- Binding supply constraints increase fiscal Phillips multiplier
  - Large fiscal stimulus implemented in times of supply disruptions is especially inflationary
- Multi-sector economy: high fiscal Phillips multiplier if
  - Government expenditure targets some specific sectors
  - Stimulus coincides with sectoral reallocation of private expenditure
- Investment and technology upgrading: intertemporal inflation trade-off
  - Persistent fiscal stimulus causes transitory rise in inflation
  - Productivity rises in the medium run, containing inflationary pressures

Outline of the talk

1. Baseline model
2. A first look at the fiscal Phillips multiplier
3. Multi-sector economy
4. Investment and technology upgrading

Households

- Representative household with expected lifetime utility

$$\sum_{t=0}^{\infty} \beta^t \log(C_t)$$

- Budget constraint

$$P_t C_t + B_{t+1} = W_t L_t + D_t - T_t + (1 + i_{t-1}) B_t,$$

- Optimal saving behavior

$$C_t = \frac{C_{t+1} \pi_{t+1}}{\beta(1 + i_t)} \quad \text{where} \quad \frac{1 + i_t}{\pi_{t+1}} \equiv 1 + r_t$$

- Desired labor supply $\bar{L}$, but $L_t \neq \bar{L}$ possible due to wage rigidities

$$W_t = W \qquad \text{for all} \quad t$$

Firms and production

- Unit mass of competitive firms, perform tasks A and B to produce

$$Y_t = \left(\frac{L_{A,t}}{\alpha}\right)^{\alpha} \left(\frac{L_{B,t}}{1-\alpha}\right)^{1-\alpha}$$

- Technological constraint on labor that can be allocated to task B

$$L_{B,t} \leq (1-\alpha)\bar{Y}_t$$

- This supply constraint binds when $Y_t > \bar{Y}_t$
  - $\uparrow Y_t$: surge in demand
  - $\downarrow \bar{Y}_t$: reduced access to inputs complementary to labor

Firms and production

- Denote $L_t = L_{A,t} + L_{B,t}$

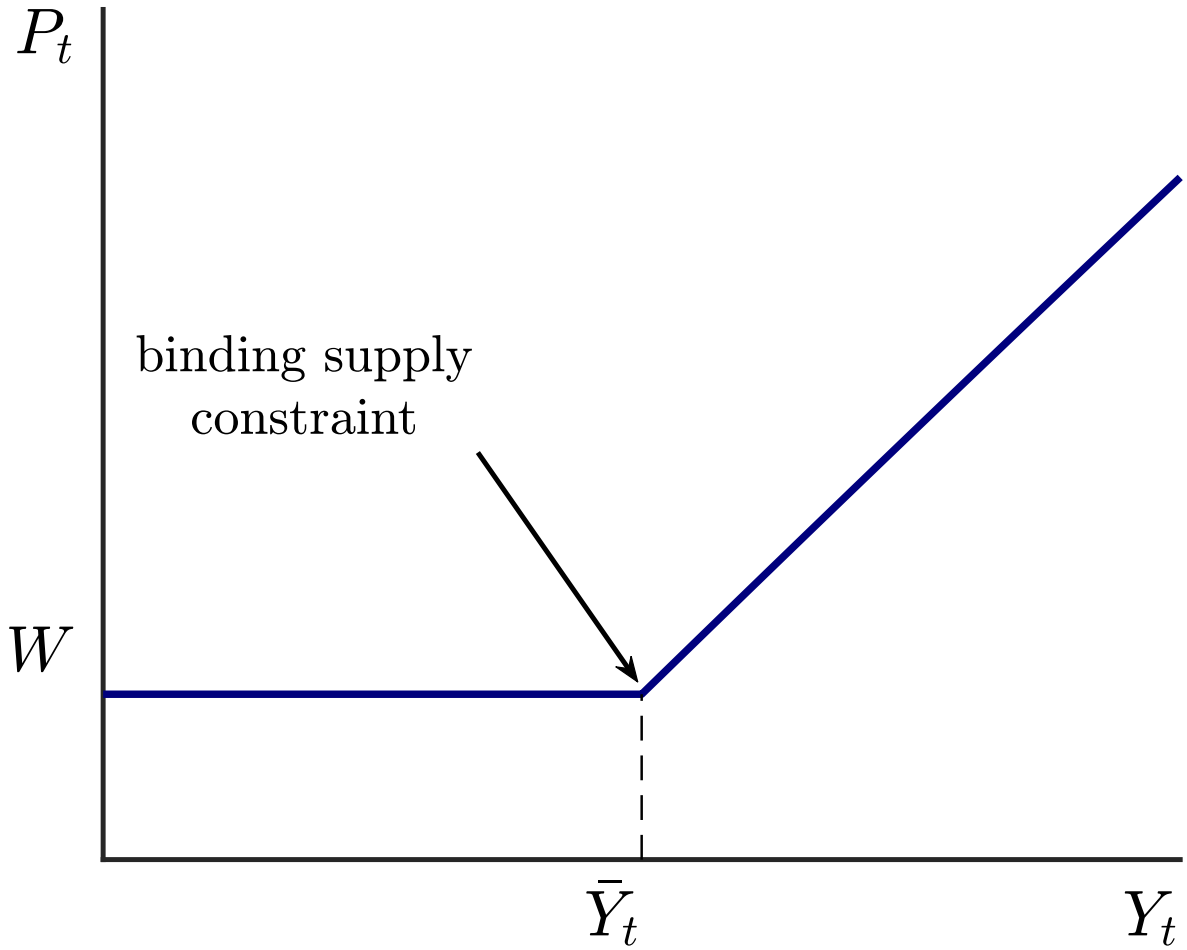
$$Y_t = \begin{cases} L_t & \text{if } Y_t \leq \bar{Y}_t \\ \left(\frac{L_t - (1-\alpha)\bar{Y}_t}{\alpha \bar{Y}_t} \right)^{\alpha} \bar{Y}_t & \text{if } Y_t > \bar{Y}_t \end{cases}$$

- Price equal to marginal cost

$$P_t = \begin{cases} W & \text{if } Y_t \leq \bar{Y}_t \\ W \left(\frac{Y_t}{\bar{Y}_t} \right)^{\frac{1-\alpha}{\alpha}} & \text{if } Y_t > \bar{Y}_t \end{cases}$$

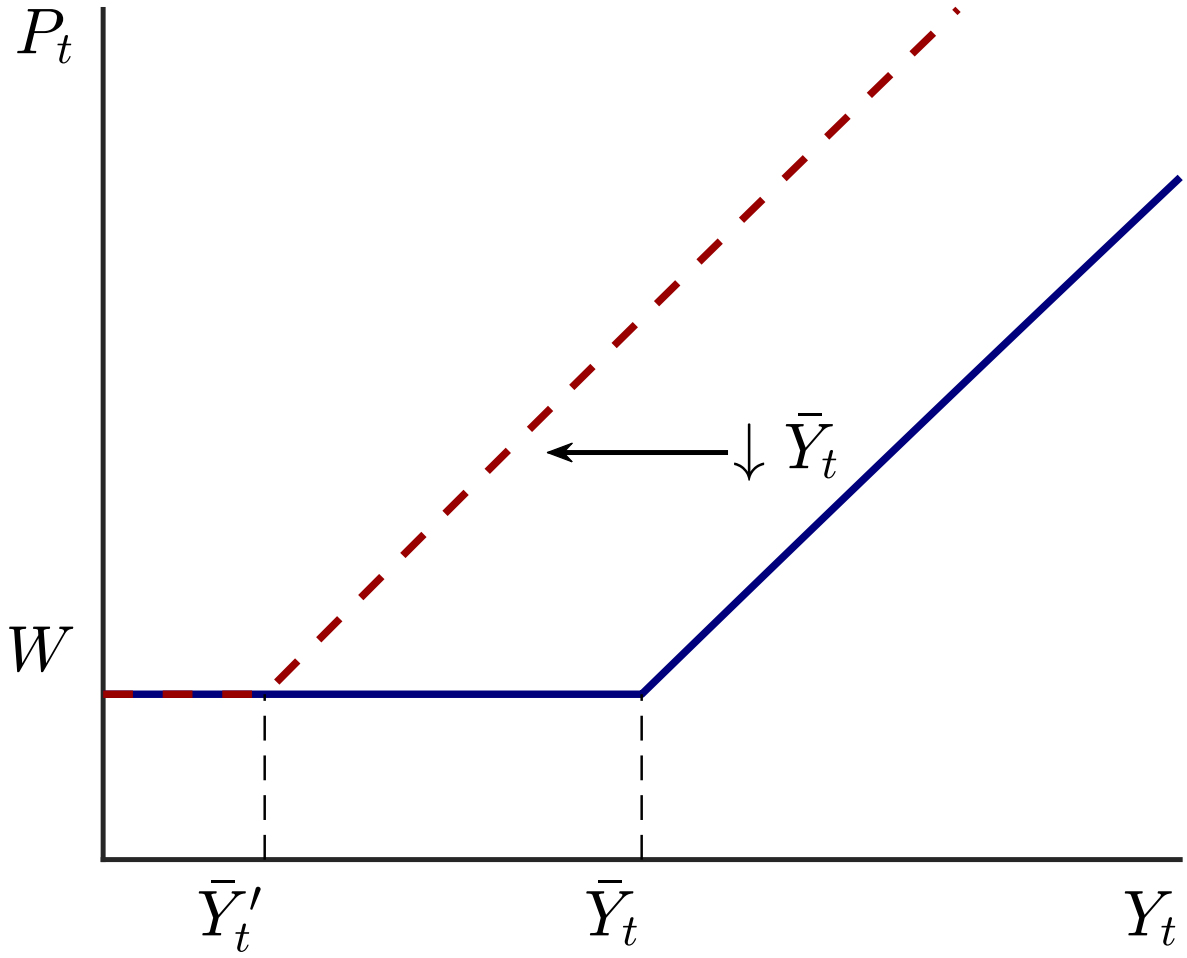
- Binding supply constraint $\rightarrow$ endogenous markup of price over wage

Convex supply curves



- Price increases steeply with output when supply constraint binds, as documented empirically by Boehm and Pandalai-Nayar (AER 2022)

Convex supply curves



- Shocks to $\bar{Y}_t$ shift the steep portion of the supply curves (Balleer and Noeller, 2023)

Fiscal/monetary policy and market clearing

- Fiscal authority sets a path for government consumption G_t

$$P_t G_t = T_t$$

- Monetary policy holds real rate constant

$$1 + r_t = 1/\beta \rightarrow C_t = C$$

- Market clearing

$$Y_t = C + G_t$$

- In steady state

$$Y = \bar{L} = C + G$$

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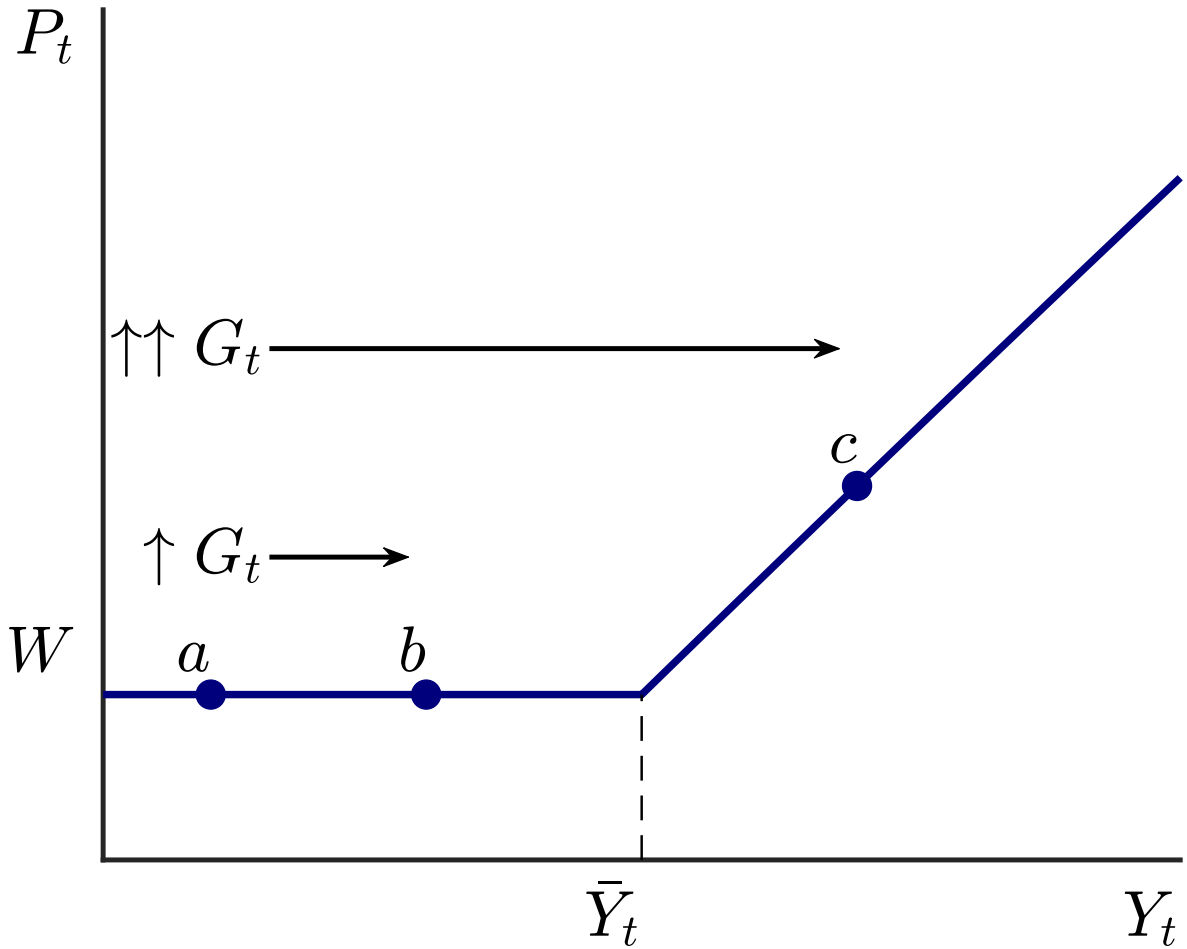
Supply constraints and the fiscal Phillips multiplier

- Constant fiscal multiplier $\partial Y_t / \partial G_t = 1$
- Fiscal Phillips multiplier is state dependent

$$\frac{\partial P_t}{\partial Y_t}\frac{Y_t}{P_t} = \begin{cases} 0 & \text{if } Y_t \leq \bar{Y}_t \\ \frac{1-\alpha}{\alpha} & \text{if } Y_t > \bar{Y}_t \end{cases}$$

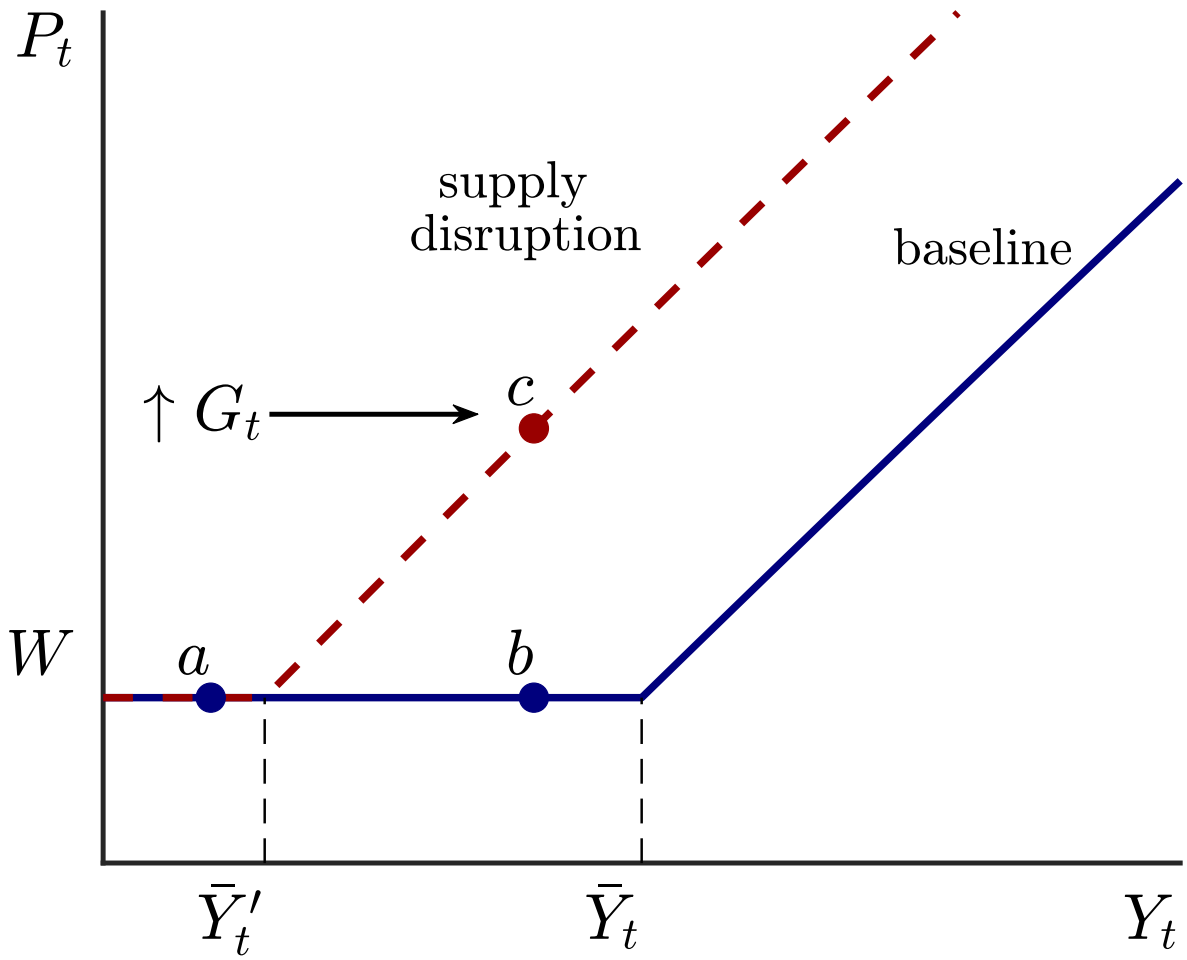
- Empirical estimates by Boehm and Pandalai-Nayar (2022)
  - $\frac{\partial P_t}{\partial Y_t}\frac{Y_t}{P_t} \approx 0$ for capacity utilization below 15th percentile
  - $\frac{\partial P_t}{\partial Y_t}\frac{Y_t}{P_t} = .57$ for capacity utilization above 85th percentile
- Supply constraints important determinant of firms' pricing behavior

Size of fiscal stimulus matters



- Large fiscal stimulus more likely to make supply constraints bind $\rightarrow$ high fiscal Phillips multiplier

Fiscal stimulus in times of supply disruptions



- Higher fiscal Phillips multiplier during supply disruptions ($\downarrow \bar{Y}_t$)

Two remarks

- Supply constraints act as markup shocks of prices over wages
  - Wages do not reflect marginal costs when supply constraints bind
  - Key difference w.r.t. baseline New-Keynesian model (and models with downward wage rigidities)
- Supply constraints may explain why US pandemic stimulus coincided with rise in prices given wages (Bernanke and Blanchard, 2023)
  - US fiscal stimulus was large and accompanied by pandemic disruptions $\rightarrow$ high fiscal Phillips multiplier

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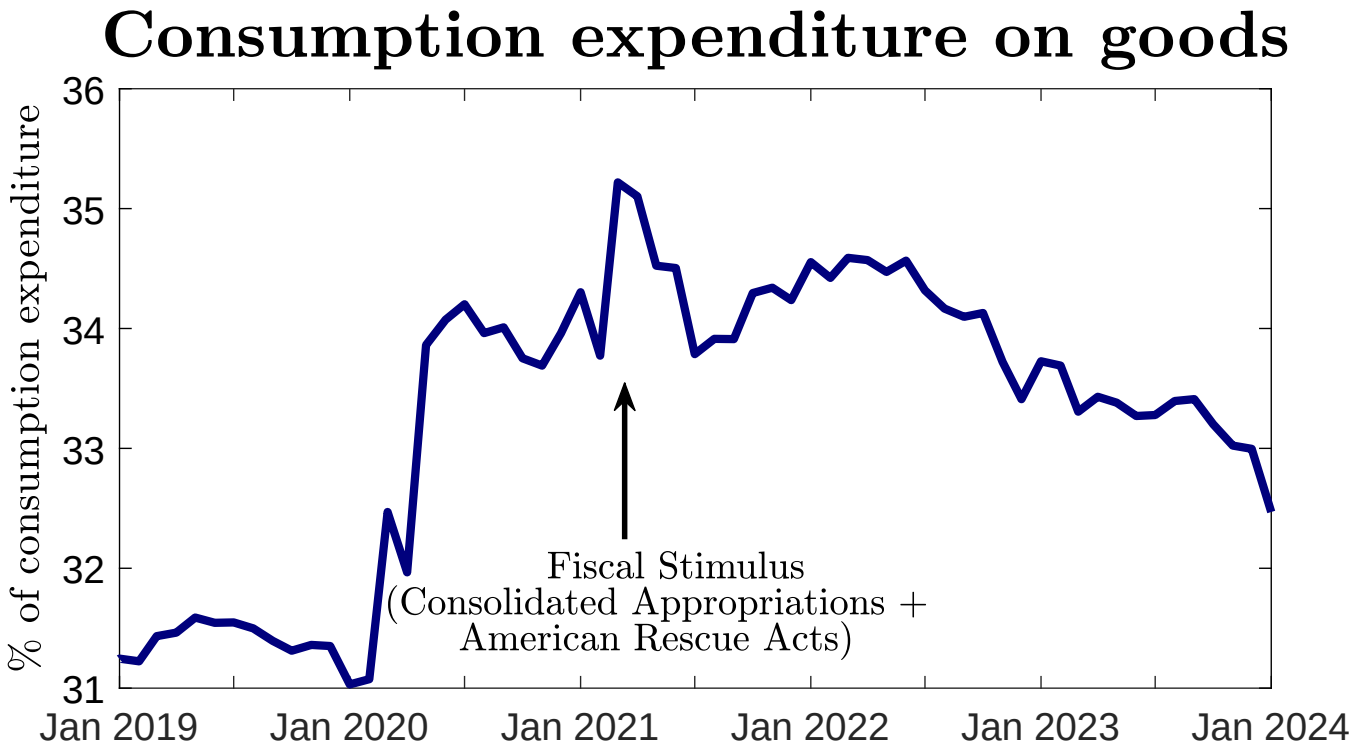
Share of consumption expenditure on goods in the US



- Rebalancing of expenditure from services to manufactured goods (contagion risk + fiscal stimulus?)

A multi-sector economy

- Two sectors: manufacturing m and services s

$$C_t = \left(\frac{C_t^m}{\omega_t}\right)^{\omega_t} \left(\frac{C_t^s}{1-\omega_t}\right)^{1-\omega_t}$$

$$P_t = (P_t^m)^{\omega_t} (P_t^s)^{1-\omega_t}$$

- Sector-specific supply constraints

$$\bar{Y}_t^m = \omega \bar{Y}$$

$$\bar{Y}_t^s = (1-\omega)\bar{Y}$$

- Fiscal policy is now defined as a path of G_t^m and G_t^s

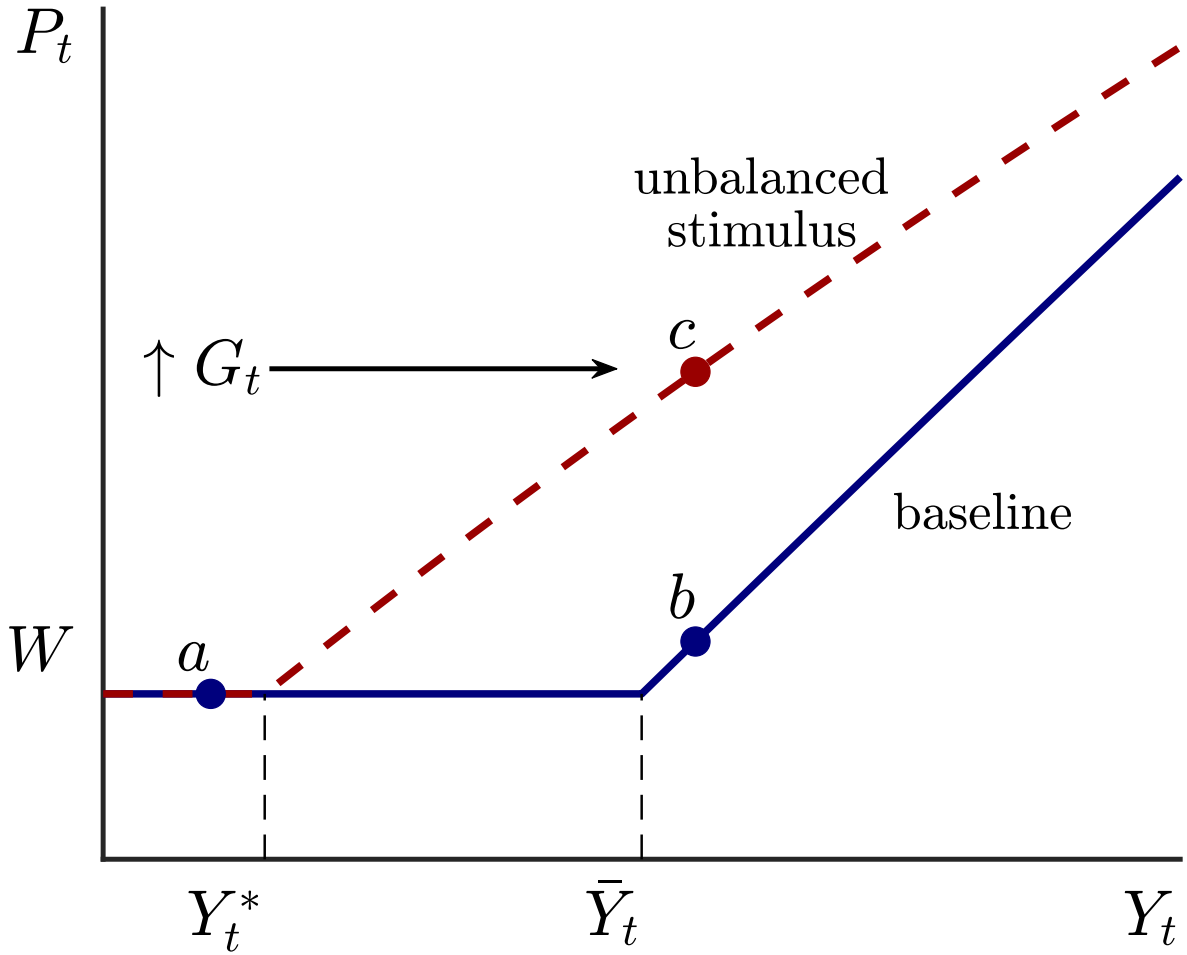
$$G_t = \frac{P_t^m}{P_t} G_t^m + \frac{P_t^s}{P_t} G_t^s$$

An unbalanced fiscal stimulus

- Suppose that private expenditure is stable ($\omega_t = \omega$)
- Fiscal stimulus fully targets manufacturing

$$Y_t = C + \underbrace{G^s + \frac{P_t^m}{P_t} G_t^m}_{G_t}$$

Fiscal Phillips multiplier: unbalanced stimulus



- Higher fiscal Phillips multiplier if stimulus is unbalanced

An unbalanced fiscal stimulus

- Suppose that private expenditure is stable ($\omega_t = \omega$)
- Fiscal stimulus fully targets manufacturing

$$Y_t = C + \underbrace{G^s + \frac{P_t^m}{P_t} G_t^m}_{G_t}$$

- Composition of fiscal stimulus matters
  - Cox et al. (2024): structural differences in sectoral price stickiness
  - This paper: price stickiness is endogenous and depends on supply constraints

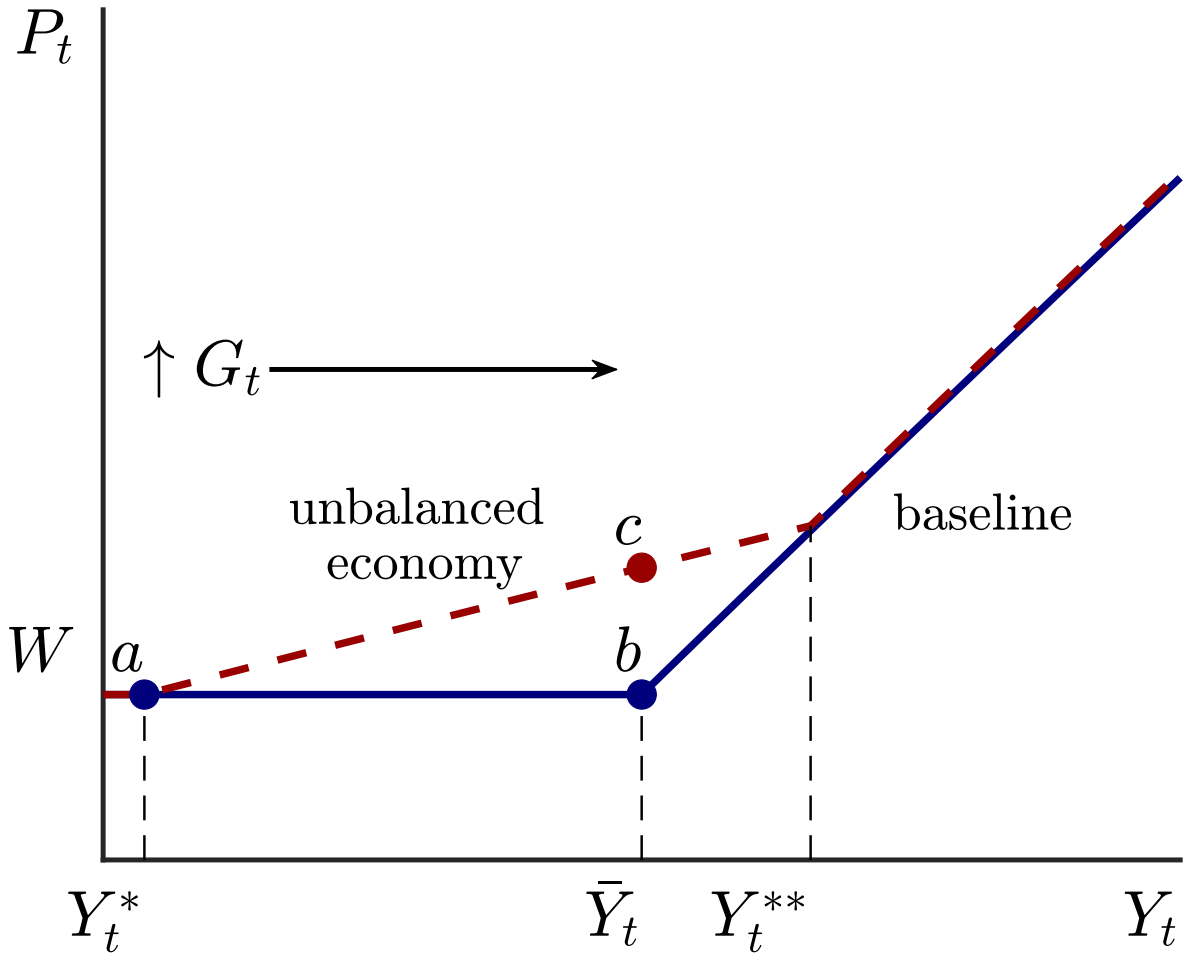
Fiscal stimulus in an unbalanced economy

- Government has same expenditure shares as private sector

$$G_t = \left(\frac{G_t^m}{\omega_t}\right)^{\omega_t} \left(\frac{G_t^s}{1-\omega_t}\right)^{1-\omega_t}$$

- Reallocation shock: exp. on manufacturing rises temporarily ($\omega_t > \omega$)

Fiscal Phillips multiplier: unbalanced economy



- Higher fiscal Phillips multiplier if stimulus implemented in an unbalanced economy

Fiscal stimulus in an unbalanced economy

- Government has same expenditure shares as private sector

$$G_t = \left(\frac{G_t^m}{\omega_t}\right)^{\omega_t} \left(\frac{G_t^s}{1-\omega_t}\right)^{1-\omega_t}$$

- Reallocation shock: exp. on manufacturing rises temporarily ($\omega_t > \omega$)
- Supply constraints bind in the high-demand sector
  - Worse inflation/output trade-off (Guerrieri et al. 2022, Fornaro and Romei, 2023)
  - Higher fiscal Phillips multiplier

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Some empirical evidence from WWII

- Iltzezki (2024): public purchases of military airplanes during WWII
  - Pushed aircraft manufacturers against supply constraints
  - Aircraft manufacturers reacted by investing to upgrade their technologies and increase their productive capacity
- While this evidence refers to a specific event, the notion that firms will adjust to surges in demand by investing to relax their supply constraints seems quite natural

Investing in productive capacity

- Firms can invest to relax future supply constraints

$$\bar{Y}_{t+1} = \bar{Y}_t + \chi I_t$$

- Firms choose investment to maximize profits

$$\sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t \left(Y_t - \frac{W}{P_t} L_t - I_t\right)$$

$$Y_t - \frac{W}{P_t} L_t = \max\left[\bar{Y}_t (1-\alpha)\left(\left(\frac{P_t}{W}\right)^{\frac{\alpha}{1-\alpha}} - \frac{W}{P_t}\right), 0\right]$$

- Optimal investment (strict equality if $I_t > 0$)

$$\frac{1}{\chi} \geq \sum_{\tau=t+1}^{\infty} \left(\frac{1}{1+r}\right)^{\tau-t} \max\left[(1-\alpha)\left(\left(\frac{P_\tau}{W}\right)^{\frac{\alpha}{1-\alpha}} - \frac{W}{P_\tau}\right), 0\right]$$

Fiscal stimulus and the intertemporal inflation trade-off

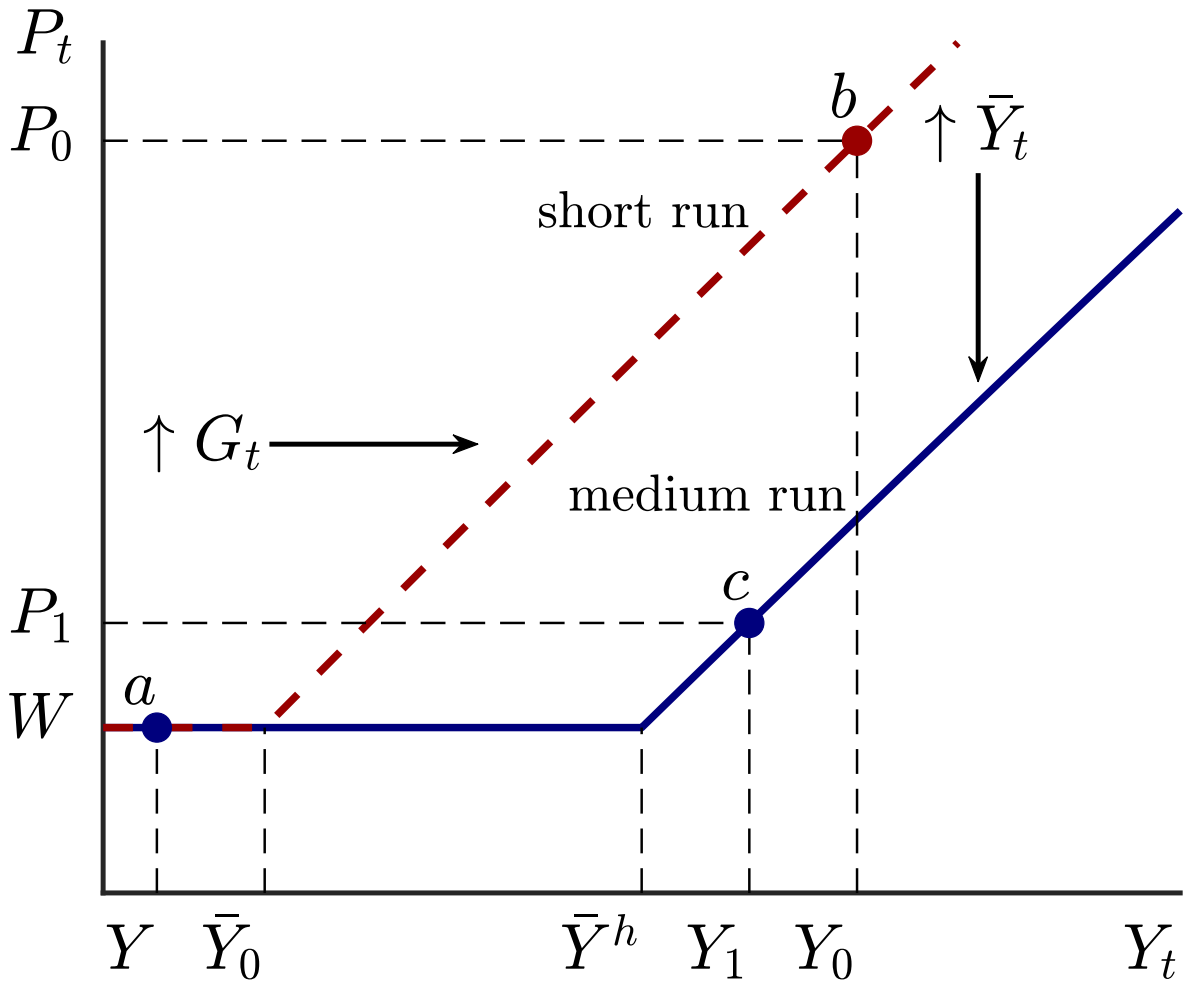
- Persistent fiscal stimulus

$$G_t = \begin{cases} G^h > G & \text{if } t \leq T \\ G & \text{if } t > T \end{cases}$$

- If G^h is sufficiently large
  - Investment boom in period $t = 0$
  - Rise in $\bar{Y}_t$ from period $t = 1$ on
- Price level evolves according to

$$P_t = \begin{cases} W \left(\frac{C+G^h+I_0}{\bar{Y}_0} \right)^{\frac{1-\alpha}{\alpha}} > W & \text{if } t = 0 \\ W \left(\frac{C+G^h}{\bar{Y}^h} \right)^{\frac{1-\alpha}{\alpha}} < P_0 & \text{if } 0 < t \leq T \\ W & \text{if } t > T \end{cases}$$

Fiscal stimulus and the intertemporal inflation trade-off



- Investment exacerbates inflation in the short run, but higher productivity and lower inflation in the medium run

Conclusions

- Supply constraints potentially important for firms' pricing behavior and inflation
  - Fornaro and Romei (2023): international inflation spillovers during pandemic
  - Fornaro, Guerrieri and Reichlin (2024): inflation and monetary policy during energy transition
- Much more theoretical and empirical work is needed to explore the macroeconomic implications of supply constraints