GLOBAL NETWORKS AND INFLATION

CEPR Finland, June 2023

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Research Agenda

- diGiovanni, Kalemli-Ozcan, Silva, Yildirim, **ECB-Sintra**'22 "Global Supply Chain Pressures, Trade, and Inflation"
- diGiovanni, Kalemli-Ozcan, Silva, Yildirim, **AER P&P**'23a "Quantifying the Inflationary Impact of Fiscal Stimulus"
- diGiovanni, Kalemli-Ozcan, Silva, Yildirim, **NBER WP forthcoming**'23b "The Inflationary Implications of Sectoral Shock Transmission across the Global Production Network"

Inflation in the age of Covid-19

- Since early 2020 large swings in economic activity characterized by:
  - Collapse and rebound in domestic demand, GDP, and international trade
  - Consumption substitution across sectors (goods for services and back)
  - Labor shortages across sectors/countries (pandemic/lockdowns and recovery)

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- Result: **highest inflation of last four decades!**

- Key question: **Can monetary policy be effective in bringing down inflation?**

  To answer, we need to quantify:

  1. Drivers of the current inflation

  2. International dimension

Quantification of Inflation Drivers based on a Structural Model

- Approach: Try to mimic real-life 2021 events as much as we can
  - Co-existence of slack and inflation
  - Output lower than potential $\Rightarrow$ cannot be all demand shocks
  - Timing and sectoral heterogeneity: Goods vs services, sectoral inflation becoming broad based

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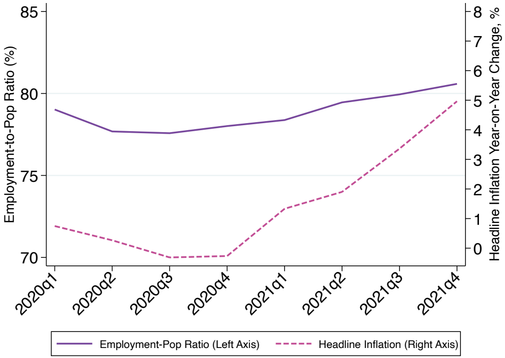
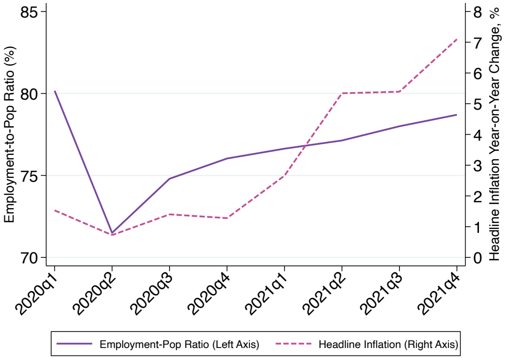
  Important to focus on:
  - Covid is a set of disaggregated demand and supply shocks with asymmetric recovery
  - Sectoral imbalances and labor shortages—demand (slack) and supply (tight) constrained sectors
  - Global and local supply chain disruptions—sectoral shifts in consumption demand connected with sectoral production using intermediate inputs and labor

Simultaneous Slack and Inflation

(a) Euro Area

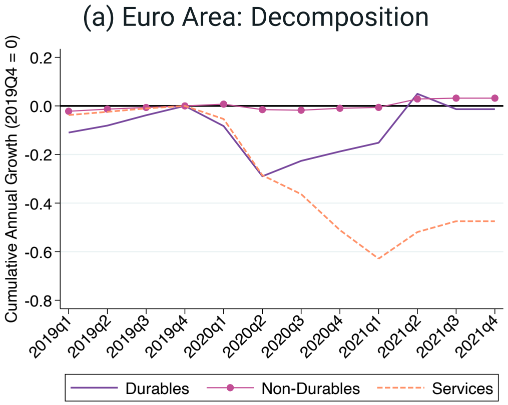


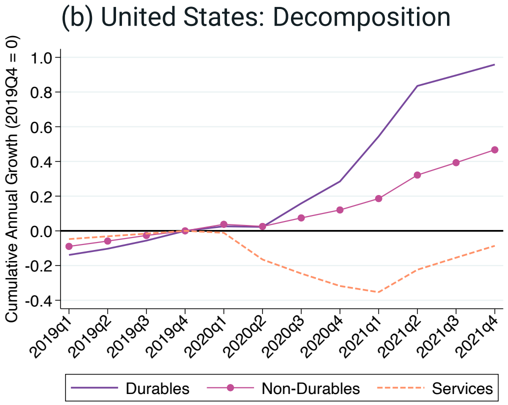
(b) United States



Source: FRED

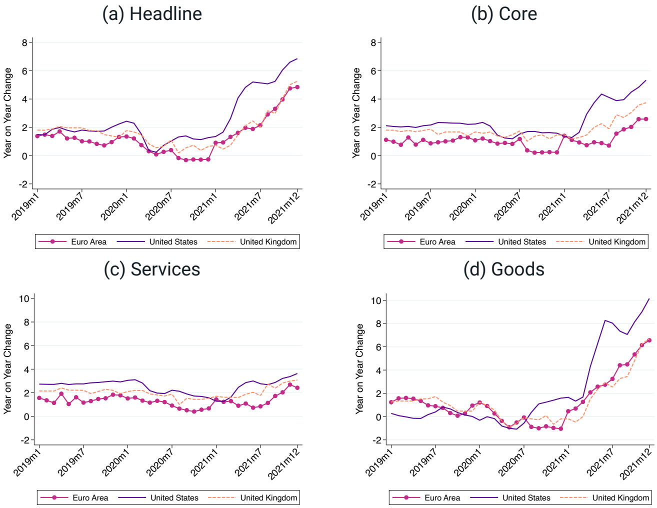
Larger declines in consumption, faster recovery in durables





Notes: Seasonally-adjusted real private consumption. Source: OECD Quarterly National Accounts.

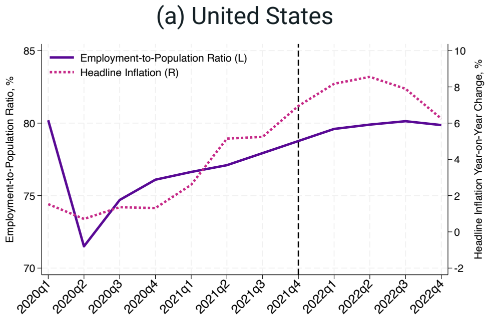
Inflation in goods picked up earlier than inflation in services

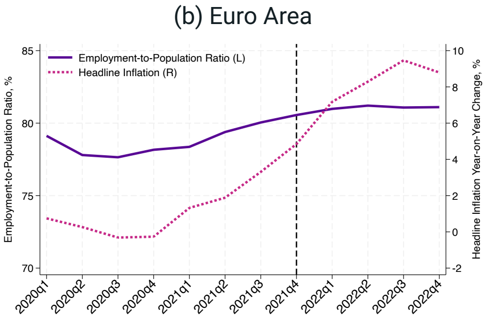


Source: FRED.

Updated Stylized Facts

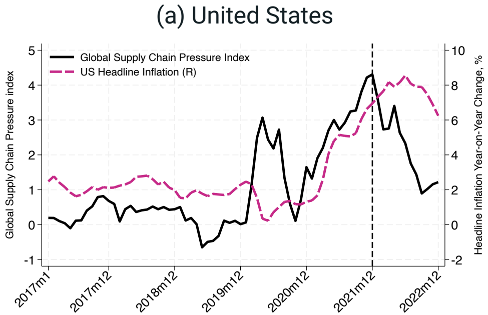
Simultaneous slack and inflation

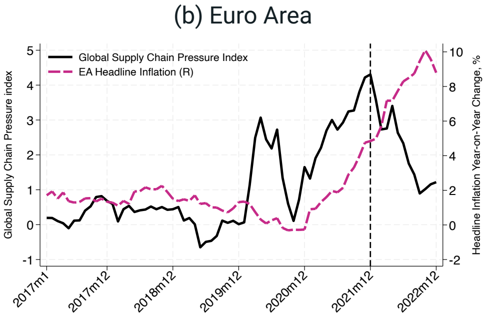




Source: FRED

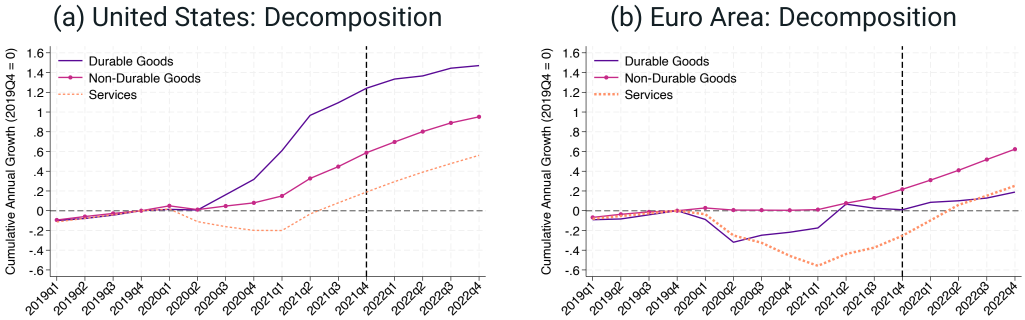
Simultaneous increase in inflation and supply chain pressures





Source: FRBNY, FRED.

Substitution between goods and services consumption



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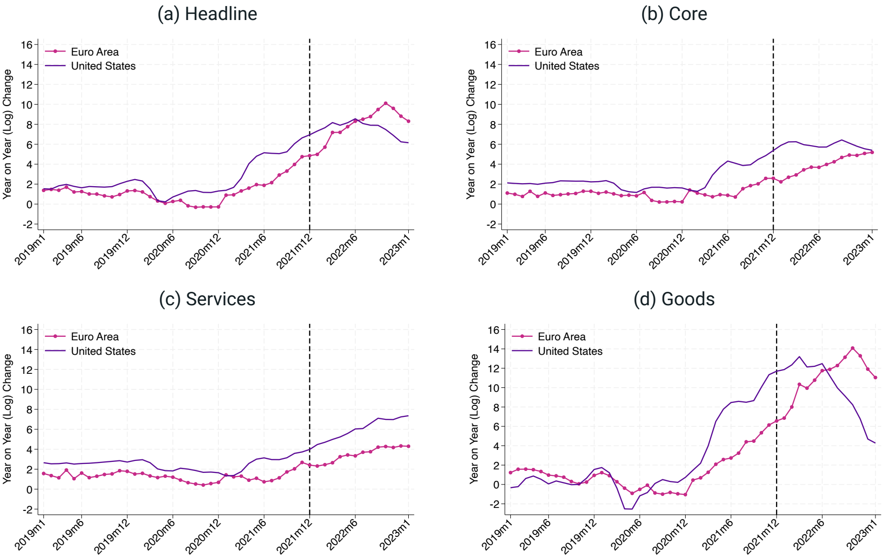
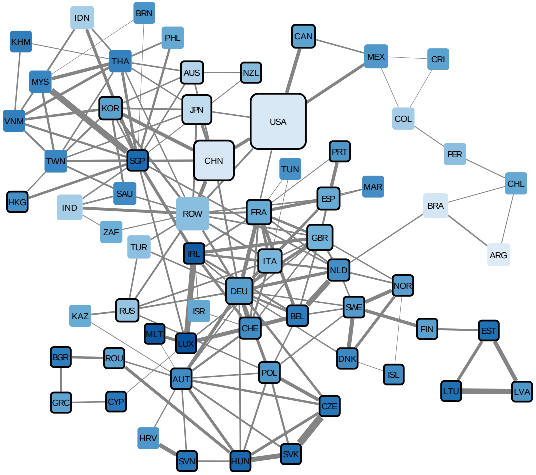
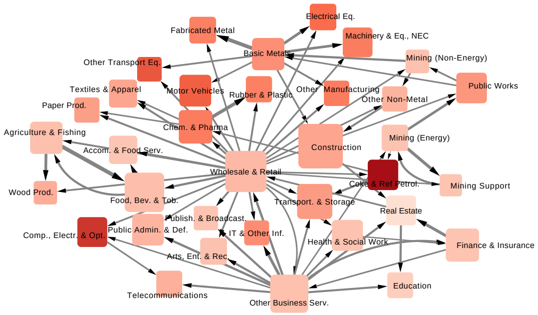


Source: FRED.

Production Network is Global



(a) 65 Countries



(b) 45 Industries

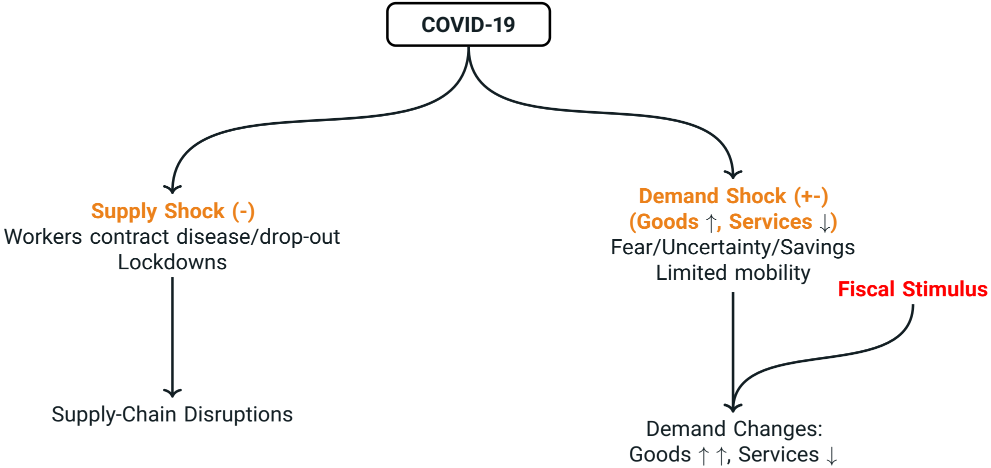
Supply-Demand Imbalances $\uparrow$ with Fiscal Stimulus via Global Network

COVID-19

Supply Shock (-)
Workers contract disease/drop-out
Lockdowns

Demand Shock (+-)
(Goods $\uparrow$, Services $\downarrow$)
Fear/Uncertainty/Savings
Limited mobility

Supply-Demand Imbalances ↑ with Fiscal Stimulus via Global Network



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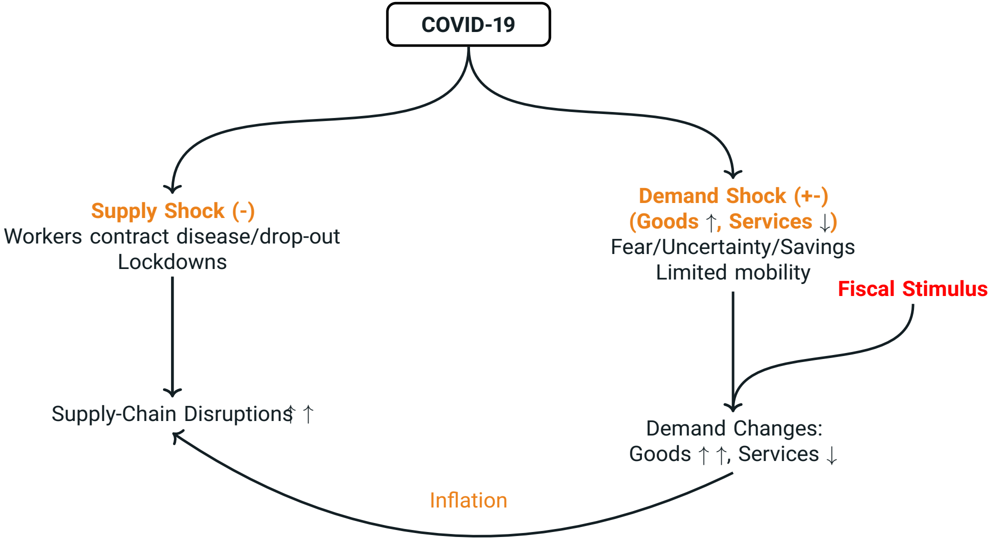


Related literature

- **Theory-closed**: Inflation, Production Networks, Sectoral Demand and Supply Shocks

  Baqaee and Farhi (2022), La'O and Tahbaz-Salehi (2022), Rubbo (2022), Afrouzi and Bhattarai (2022), Pasten, Schoenle, and Weber (2020)

  Theory-closed/open: Inflation, Demand and Supply Shocks

  Guerrieri, Lorenzoni, Straub, and Werning (2021, 2022), Amiti, Heise, Karahan, and Sahin (2022), Ferrante, Graves, and Iacovello (2022)

- **Theory-open**
  - Production Networks and Trade with Supply Shocks

    Bonadio, Huo, Levchenko, and Pandalai-Nayar (2021), Boehm and Pandalai-Nayar (2022)
  - Production Networks and Trade with Demand and Supply Shocks

    Çakmaklı, Demiralp, Kalemli-Özcan, Yeşiltaş, Yıldırım (2022), Gourinchas, Kalemli-Özcan, Penciakova, Sander (2021)

- **Existing Empirical Work on Inflation**: Reduced form regressions, VAR sign restrictions

  Jorda, Liu, Nechio, and Rivera-Reyes (2022), LaBelle and Santacreu (2022), Shapiro (2022) . . .

$\Longrightarrow$ **Our contribution:** a structural model with unrestricted I-O linkages and elasticities of substitution to quantify inflation drivers during Covid-19 collapse and recovery

Model

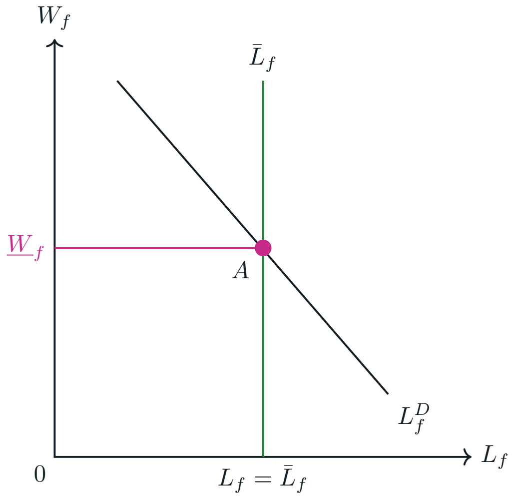
Inflation in a Network-Macro Model

- Based on Baqaee and Farhi (2022, AER) (w/simplifications)
  - Two period closed economy model
  - Ricardian households with perfect foresight
  - Multiple sectors that produce using factors and intermediate inputs
  - Perfect competition in factors and good markets
  - Downward nominal wage rigidity, Zero-lower bound.

- Model allows for rich set of shocks $\Rightarrow$ Can run counterfactuals.
  - Aggregate demand: $\mathrm{d}\log\zeta$
  - Sectoral demand: $\mathrm{d}\kappa_i$
  - Sectoral factor supply: $\mathrm{d}\log\bar{L}_f$

Labor Market during 2019Q4– 2021Q4

- $\bar{L}_f$: Potential level for factor f. Decrease due to workers getting sick, shutdowns, etc.



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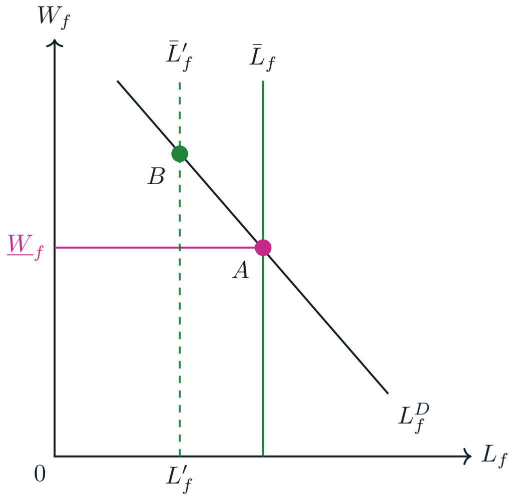

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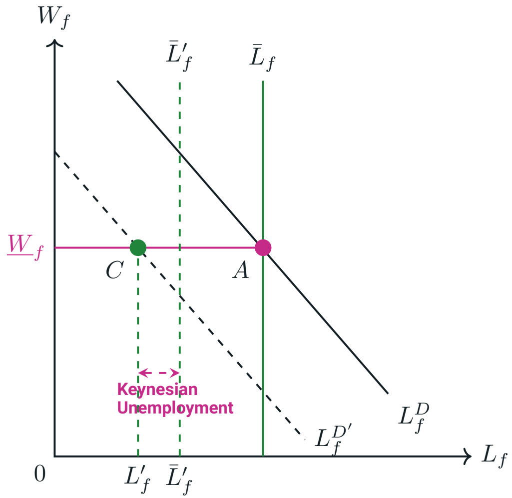
- Difference between $\bar{L}_f$ and L_f: Keynesian unemployment



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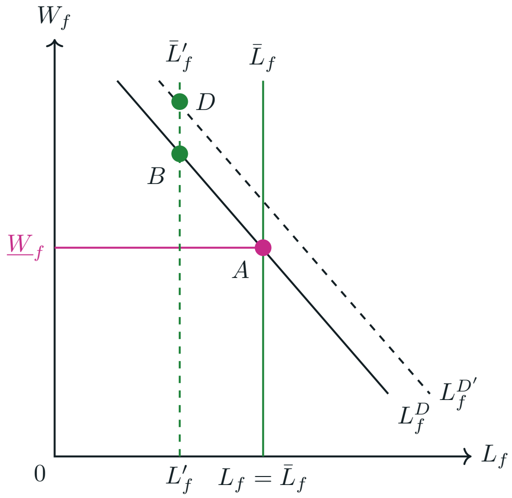
- During recovery – point D: where these unemployment gaps are closed (heterogeneous across sectors, may not be back to 2019 but still inflationary).



Inflation

Agg. Shock Details | Good Prices | All pieces

- In the model, to a first-order, CPI inflation is

$$\mathrm{d}\log CPI = \underbrace{\mathrm{d}\log \zeta}_{\text{Aggregate Demand Shift}} - \underbrace{\sum_{i=1}^{N} \lambda_i \mathrm{d}\log A_i}_{\text{Sectoral Technology Changes}} - \underbrace{\sum_{f=1}^{F} \Lambda_f \mathrm{d}\log L_f}_{\text{Sectoral Employment Eq. Changes}}$$

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  - Decreases in employment are always inflationary regardless of the reason
  - Sectoral demand shocks ($\mathrm{d}\kappa_i$) affects inflation only through sectoral employment.
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- We set $\mathrm{d}\log A_i = 0$ for all i.
    - Recent evidence suggests little changes in aggregate/sectoral productivity w/no labor reallocation across sectors (Fernald and Li, 2022)
    - Focus on sectoral labor shocks to account for shortages and demand-supply imbalances

Quantification

Shocks

Calibration | F Markets | Model Structure

1. Sectoral Demand Shocks ($\mathrm{d}\kappa_i$): Observed expenditure shares changes.
    - US Data: BEA sectoral personal consumption expenditure
    - Euro Area Data: Three sectors data from OECD Quarterly National Accounts
2. Sectoral Potential Supply Shocks ($\mathrm{d}\log \bar{L}_f$): Observed changes in total hours worked.
    - US Data: BLS tables.
    - Euro Area Data: EuroStat.

Shocks

Calibration | F Markets | Model Structure

3. Aggregate Demand Shocks ($\mathrm{d}\log\zeta$): Backed out from

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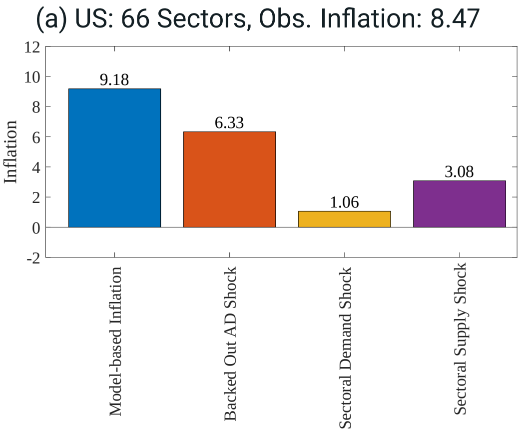
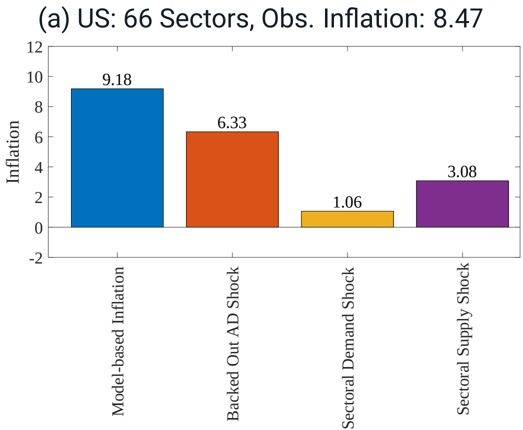
- US Network Data: FRED, 2015 BEA IO Tables, BLS.
- Euro Area Network Data: FRED, EuroStat, OECD ICIO 2018.
- Key Parameters
  - Elasticity between value added and intermediate inputs: 0.6 (Atalay, 2017; Carvalho et. al, 2021)
  - Elasticity between labor and capital: 0.6 (Raval, 2019; Oberfield and Raval, 2021)
  - Elasticity among intermediates: 0.2 (Atalay, 2017; Boehm, Flaaen, and Pandalai-Nayar, 2019)

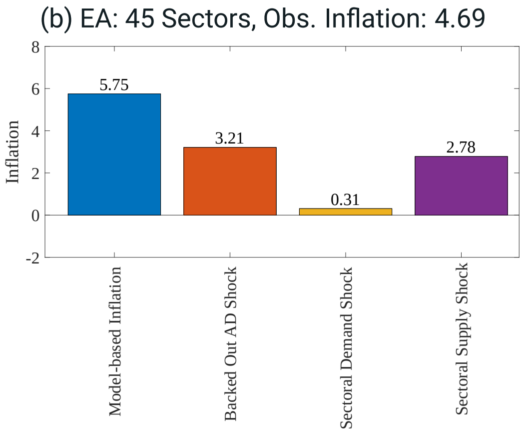
Demand and Supply Drivers of Inflation



Role of Complementarities

Demand and Supply Drivers of Inflation





Role of Complementarities

Open Economy w/fixed exchange rates

Decomposing Inflation in a Multi-Country Model

Details | Model Structure Plot

- We follow Çakmaklı, Demiralp, Kalemli-Özcan, Yeşiltaş, Yıldırım (2021).
- Model is same as the closed economy +
  - Foreign intermediate/consumption goods
  - Trade balance at the country-level.
  - Three countries: Euro Area, United States, and the Rest of the World

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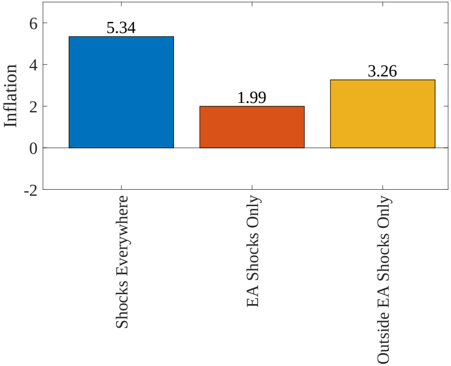

Aggregate demand explains 2/3 of US inflation: How much of this is from fiscal stimulus?

Introduce Government Spending

- Aggregate demand shock now from data – deviation of GDP from trend
- Drop government expenditure from nominal GDP to run counterfactual

$\Rightarrow$ Feed shocks into the model to calculate contributions to inflation

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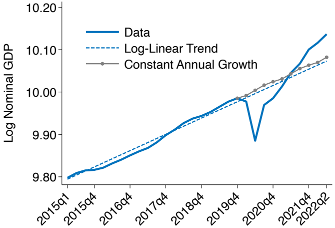
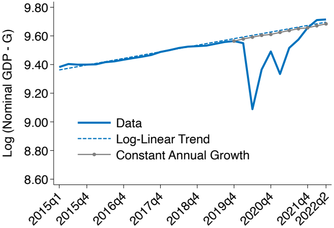
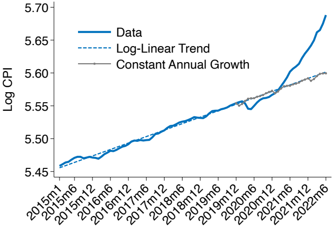


(b) Nominal GDP - Gov. Expenditure



(c) Headline CPI



Source: FRED.

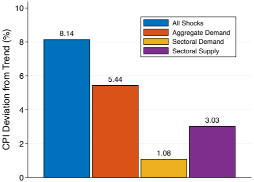
Inflation Dec 2019 to June 2022

Actual per annum CPI inflation is 9 percent as of June 2022; percent change in prices since December 2019 is 14.35.

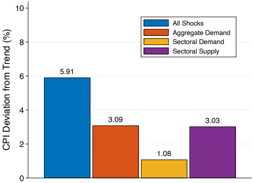
Model can predict actual inflation! 13.17 and 14.18!
Backed out AD shock vs GDP data gives the same result
Fiscal stimulus is 1/2 to 2/3 of the AD effect

Deviation from Trend

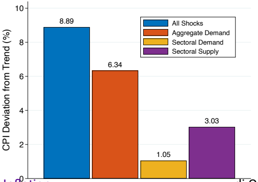
(a) Nominal GDP: Constant Growth rate



(b) No Government Expenditure: Constant Growth Rate



(c) Nominal GDP: Log-Linear



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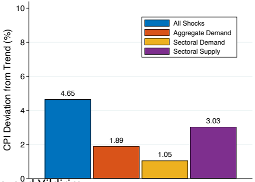


Open economoy w/flexible exchange rates

First-order approximation of domestic CPI inflation: open economy

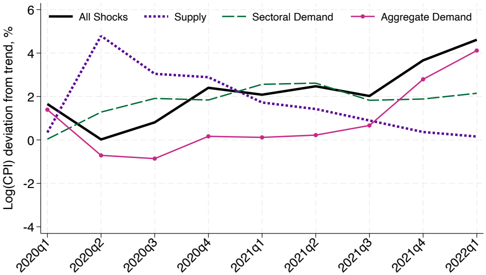
Factor shares are governed by $\boldsymbol{\Omega}^F$.
We can define country-level Domar weights for all factors globally as:
$\boldsymbol{\Lambda}^n \equiv (\boldsymbol{\Omega}^F)^T \boldsymbol{\lambda}^n$
Then the CPI in country n can be written as:

$$\mathrm{d}\log CPI^n = \underbrace{\mathrm{d}\log \zeta^n}_{\text{AD shock}} - (\boldsymbol{\Lambda}^n)^T \mathrm{d}\log \boldsymbol{L} - (\boldsymbol{\lambda}^n)^T \mathrm{d}\log \boldsymbol{A}$$

- Labor shortages, at home and abroad, are inflationary domestically
- Positive productivity changes everywhere, $\mathrm{d}\log \boldsymbol{A}$, are deflationary
- AD Shock includes both domestic AD shocks and exchange rate change

Inflation Drivers over Time 2020-2022

(a) United States



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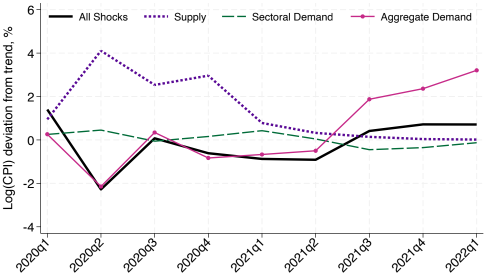

Conclusion

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- **Supply shocks are important!**
  - Supply shocks account for 1/2 of observed EA inflation, 1/3 of observed US inflation
  - Foreign shocks account for 2/3 of the Euro Area inflation w/fixed exchange rate
  - Inflation spillovers between US-EA are lower with floating exchange rates

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- **Demand stimulus in a supply constrained world, in any country, has larger inflationary effects in that country and globally**
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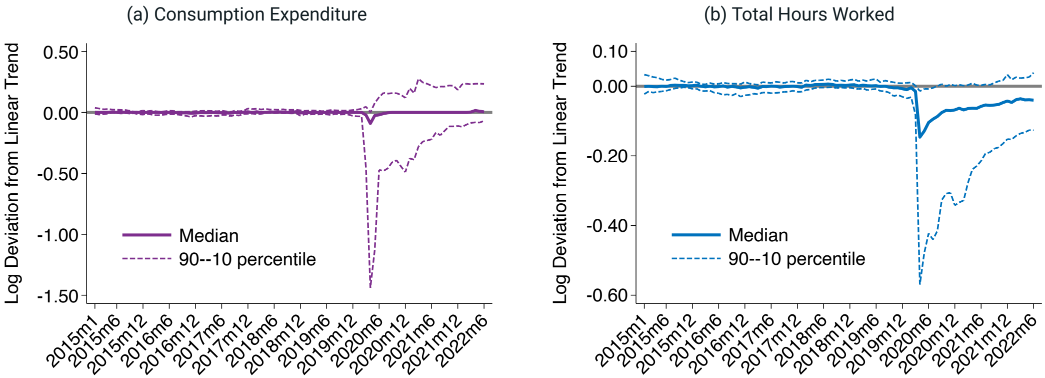
  - Monetary policy can tame inflation by contracting aggregate demand, however, there will remain an upward pressure on price growth with sectoral supply shocks and bottlenecks
- A network model with asymmetric sectoral supply and demand shocks $\Rightarrow$ sectoral cost-push shocks $\Rightarrow$ inflation

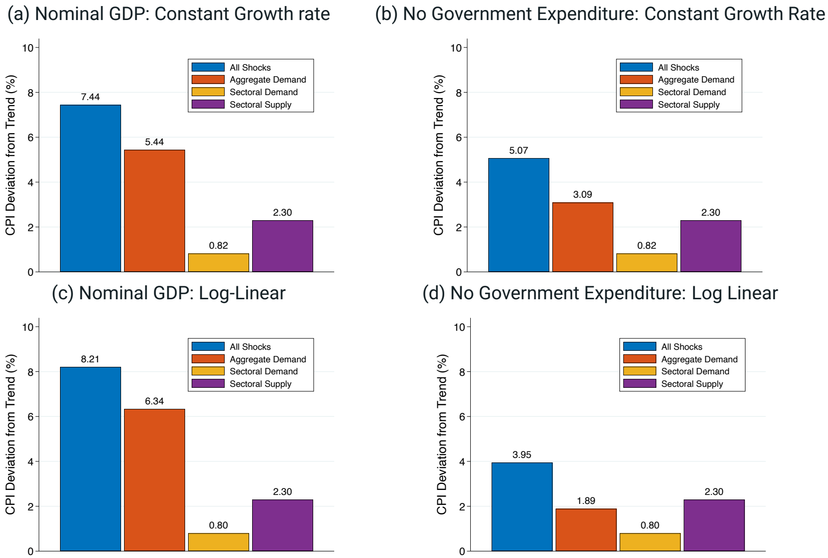
Backup Slides

Cross-Section



Source: BLS, BEA.

CPI Deviation from trend June 2022: Hand-to-Mouth, 0.3.



Source: FRED.

CPI Deviation from trend June 2022: Hand-to-Mouth, 0.3.

	Constant Annual Growth		Log-linear shocks	
	Full	No Gov.	Full	No Gov.
All shocks	7.44	5.07	8.21	3.95
AD shock	5.44	3.09	6.34	1.89
SD shocks	0.82	0.82	0.80	0.80
SS shocks	2.30	2.30	2.30	2.30

Observed Data: 2019Q4 – 2021Q4

	All Sectors - Percent changes			
	Consumption	Hours Worked	Headline CPI	Nominal Wages
Euro Area	-7.54	-1.48	4.69	5.01
United States	-0.72	-2.14	8.47	7.85

Source: FRED and Eurostat.

Demand or Supply?

The New York Times

Consumer Demand Has Been Key Driver of Inflation in the U.S.

Research has found that Americans' spending during the pandemic accounted for about 60% of inflation from 2019-21.

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THE WALL STREET JOURNAL.

CENTRAL BANKS RESEARCH

NY Fed Ties Much of Inflation Surge to Supply Problems

Aug. 24, 2022 2:00 pm ET | WSJ PRO

SAVE PRINT TEXT

A notable amount of the surge in inflation in the U.S. in the wake of the onset of the coronavirus pandemic is supply related, a report Wednesday from the Federal Reserve Bank of New York said. "Our work shows that inflation in the U.S. would have been 6 percent instead of 9 percent at the end of 2021 without supply bottlenecks," Julian di Giovanni, a bank researcher, wrote in the report. "Put differently, fiscal stimulus and other

FT FINANCIAL TIMES

FT Alphaville Economic forecasting + Add to myFT

The NY Fed vs Larry Summers

Prime eco beef

Open Econ Details

Closing Open Economy Model

Back

- Following Baqaee and Farhi (2022, Eq. 12)

$$\alpha_c \mathrm{d}\log p_{0c} e_c GDP + \beta_c \mathrm{d}\log e_c = 0$$

p_{0c} price of consumption good in country c, GDP is the nominal gross domestic product in base country's units and e_c is the exchange rate of country c.

- Downward rigidity is imposed at the US dollar level. Hence,

$$\mathrm{d}\log w_{fc} \geq -\mathrm{d}\log e_c$$

- We experiment with different $\alpha_c, \beta_c \implies$ results do not significantly depend on this.

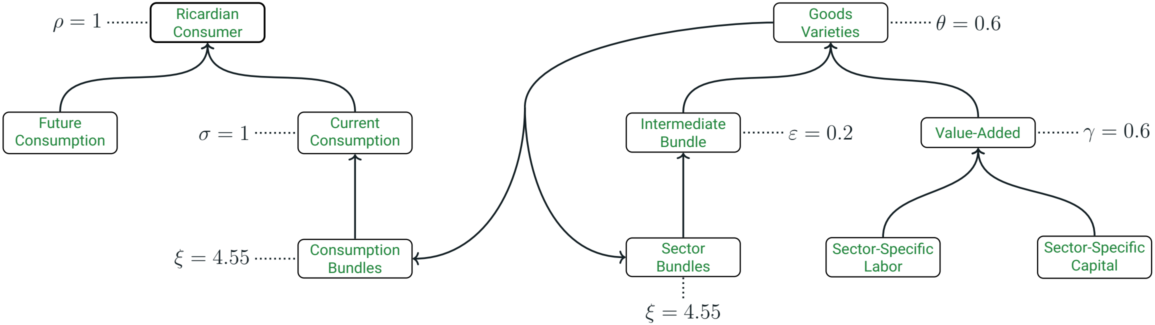
Open-Economy Model Calibration

Back

	Value	Description
Elasticities		
ϵ	0.2	Elasticity of substitution across intermediate inputs
θ	0.6	Elasticity of substitution between factors and intermediates
γ	0.6	Elasticity of substition between factors
ξ	4.55	Elasticity of substitution between foreign and intermediate goods in production and consumption
σ	1	Elasticity of substitution between consumption goods within period
ρ	1	Intertemporal elasticity of substitution
At initial steady-state		
β	0.5	Weight on future utility
i	0	Interest rate
$P_c = P_c^*$	1	steady state values of price index in each country c. both present and future (*)
$C_c = C_c^* = Y_c^* = Y_c^*$	$\frac{\text{GDP}_c}{\text{GDP}}$	real GDP share of each country c in the world GDP.
$\boldsymbol{\Lambda}$		Factor shares from Input-Output Tables
$\boldsymbol{\lambda}$		Domar Weights from Input-Output Tables
$\boldsymbol{\kappa}$		Consumption Shares from Input-Output Tables
Rest of the World Shocks		
$d\log\zeta = d\log(1-\beta)/\beta$		Match the level so that the predicted inflation in the Euro Area falls between the values reported in closed economy exercise.
$d\log\boldsymbol{L}$		Match using population weighted Oxford Stringency Index (Hale et al ,2021).
$d\log\boldsymbol{\kappa}$		Match changes in sectoral consumption expenditure for countries outside the Euro Area and United States

Model Overview

From Çakmaklı et al. 2021, 2022, Back



Sectoral Shares IO Tables

	Output	VA	Final Demand	Imports	Exports
United States					
Durables	0.06	0.05	0.08	0.31	0.22
Non-Durables	0.13	0.08	0.08	0.29	0.25
Services	0.81	0.87	0.83	0.40	0.52
Euro Area					
Durables	0.11	0.07	0.12	0.20	0.22
Non-Durables	0.16	0.10	0.10	0.32	0.35
Services	0.73	0.83	0.78	0.48	0.43
United Kingdom					
Durables	0.06	0.04	0.07	0.20	0.16
Non-Durables	0.10	0.07	0.09	0.24	0.20
Services	0.84	0.89	0.85	0.56	0.64
World					
Durables	0.09	0.06	0.10	0.21	0.21
Non-Durables	0.20	0.14	0.12	0.35	0.44
Services	0.71	0.79	0.78	0.45	0.35

Bems, Johnson, and Yi (2010) Back

- For a sector j in country m, its output, y_{jm}, must satisfy

$$y_{jm} = \sum_c \sum_k x_{kc,jm} + \sum_c x_{0c,jm}$$

- As in Bems, Johnson, and Yi (2010)
  - Leontieff production functions and preferences $\Longrightarrow$ intermediate input and final demand are sector-specific and not source-specific.
- Changes in output in each (sector,country) pair then

$$\hat{y}_{jm} = \sum_c \sum_k \frac{p_{jm} x_{kc,jm}}{p_{jm} y_{jm}} \hat{y}_{kc} + \sum_c \frac{p_{jm} x_{0c,jm}}{p_{jm} y_{jm}} \hat{x}_{0c,jm}$$

$$\Longrightarrow \underbrace{\hat{\boldsymbol{y}}}_{\Delta \text{ in Gross Output}} = \underbrace{\boldsymbol{S}}_{\text{Global IO Matrix}} \times \underbrace{\boldsymbol{M}}_{\text{Sales to Final Use}} \times \underbrace{\hat{\boldsymbol{x}}}_{\Delta \text{ in final demand}}$$

Elasticities of imports and exports to GDP Back

We use implied changes in gross output $\hat{y}_{jm}$ to get for each country m

$$\hat{Q}_m = \sum_j \frac{Y_{jm}}{Y_m} \hat{y}_{jm}, \tag{1}$$

$$\widehat{VA}_m = \sum_j \frac{VA_{jm}}{VA_m} \hat{y}_{jm}, \tag{2}$$

$$\widehat{EX}_m = \sum_{m \neq x} \sum_j \left[\sum_k \left(\frac{M_{kc,jm}}{EX_m} \right) \hat{y}_{kc} + \left(\frac{D_{c,jm}}{EX_m} \right) \hat{x}_{0c,j} \right], \tag{3}$$

$$\widehat{IM}_m = \sum_{m \neq x} \sum_j \left[\sum_k \left(\frac{M_{jm,kc}}{IM_m} \right) \hat{y}_{jm} + \left(\frac{D_{m,jk}}{IM_m} \right) \hat{x}_{0m,j} \right]. \tag{4}$$

Trade Elasticities Decomposition

Back

Panel A. Great Financial Crisis

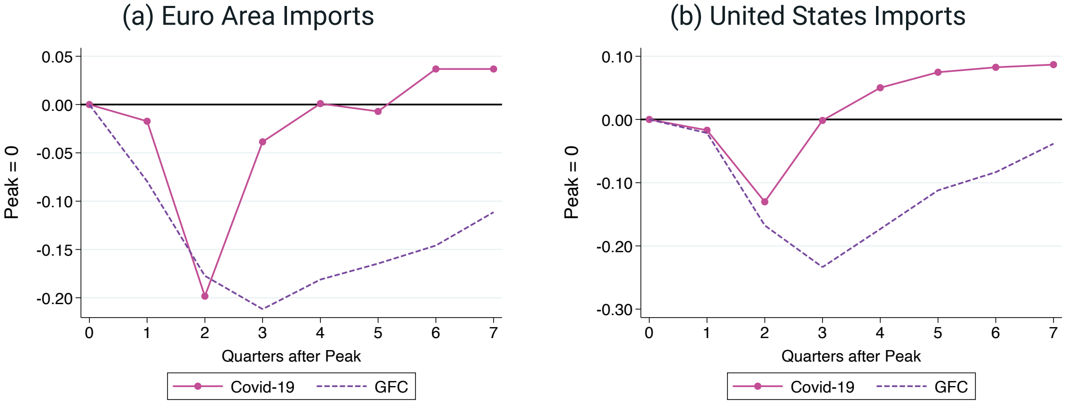
	Collapse				Recovery			
	Imports		Exports		Imports		Exports	
	Inter. (1)	Final (2)	Inter. (3)	Final (4)	Inter. (5)	Final (6)	Inter. (7)	Final (8)
United States	1.88	3.53	1.53	2.00	1.43	1.95	1.87	2.36
Euro Area	1.31	1.45	1.64	2.58	1.19	0.52	2.27	2.53
United Kingdom	1.04	1.51	0.36	0.43	0.91	0.83	0.52	0.45
World	1.36	1.98	1.36	1.98	1.27	1.39	1.27	1.39

Panel B. Covid-19 Pandemic

	Collapse				Recovery			
	Imports		Exports		Imports		Exports	
	Inter. (1)	Final (2)	Inter. (3)	Final (4)	Inter. (5)	Final (6)	Inter. (7)	Final (8)
United States	0.80	0.39	1.06	1.14	1.16	1.48	1.19	1.29
Euro Area	0.86	0.89	0.77	0.72	1.05	1.03	1.14	1.18
United Kingdom	0.90	0.88	0.54	0.50	0.95	1.04	0.65	0.64
World	0.92	0.84	0.92	0.84	1.03	1.09	1.03	1.09

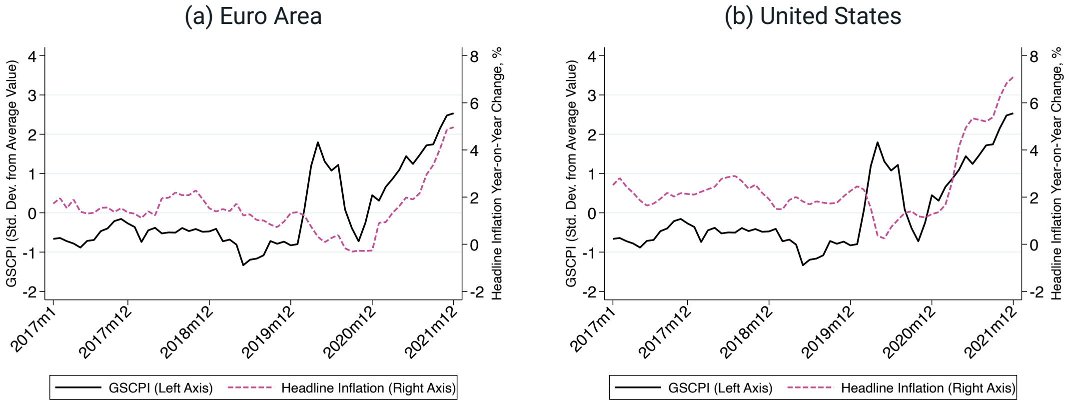
Data Details

Country heterogeneity in trade collapse and recovery relative to 2008–2009



Notes: Merchandise trade (goods trade). Sourced: World Trade Organization .

Simultaneous Increase in Inflation and Supply Chain pressures



Source: FRBNY, FRED.

Closed Economy Details

Households

- Ricardian consumer with perfect foresight and preferences over N goods.
- Consumer solves

$$
\begin{aligned}
\max_{\{x_{0i}\}_{i=1}^{N}} \quad & (1-\beta)\log U(C) + \beta \log U(C^*) \\
\text{subject to} \quad & U(C) = \frac{C^{1-\sigma}-1}{1-\sigma} \\
& C = \prod_{i=1}^{N} x_{0i}^{\kappa_i} \\
& PC + \frac{P^* C^*}{1+i} = \sum_{f\in F} w_f L_f + \frac{I^*}{1+i}
\end{aligned}
\tag{5}
$$

Household Optimality Conditions

- Intratemporal consumption

$$x_{0i} = \kappa_i \frac{PC}{p_i} = \kappa_i \frac{E}{p_i} \tag{6}$$

$$P = \prod_{i=1}^{N} \left(\frac{p_i}{\kappa_i} \right)^{\kappa_i} \tag{7}$$

- Intertemporal Consumption (Euler Equation)

$$C = \left(\frac{\beta}{1-\beta} \frac{P(1+i)}{P^*} \right)^{-\frac{1}{\sigma}} C^*$$

Sectors

- Firms choose inputs to minimize costs

$$\min_{\{L_{if}\}_{f=1}^{F},\{X_{ij}\}_{j=1}^{N}} \quad \sum_f W_f L_{if} + \sum_j P_j X_{ij}$$
$$\text{s.t.} \quad y_i = A_i G_i(\{X_{ij}\}_{j\in N}, \{L_{if}\}_{f\in F}) \tag{8}$$

Firms' Optimality Conditions

- *Optimized* total costs

$$TC_i(\{p_i\}_{i=1}^N, \{w_f\}_{f=1}^F, A_i, y_i) = \mathcal{MC}_i(\{p_i\}_{i=1}^N, \{w_f\}_{f=1}^F, A_i)y_i$$

- Efficient and competitive economy: marginal cost pricing

$$p_i = \mathcal{MC}_i(\{p_i\}_{i=1}^N, \{w_f\}_{f=1}^F, A_i)$$

Markets Clearing

Plots Example

- Goods Market Clearing

$$y_i = x_{0i} + \sum_{j=1}^{N} X_{ji} \qquad \text{for } i = 1, 2, ..., N \tag{9}$$

- Factors Market Clearing

$$\bar{L}_f \geq L_f = \sum_{i=1}^{N} L_{if}, \quad W_f \geq \bar{W}_f, \quad \left(\bar{L}_f - \sum_{i=1}^{N} L_{if}\right)(W_f - \bar{W}_f) = 0 \qquad \forall f \in F \tag{10}$$

  - If $\bar{L}_f = L_f \iff W_f \geq \bar{W}_f \implies$ a factor is *supply-constrained.*
  - If $\bar{L}_f > L_f \iff W_f = \bar{W}_f \implies$ a factor is *demand-constrained.*

A Road to CPI inflation: Supply Side Determination of Good Prices

Back

- CPI Inflation: weighted average of *good price changes*

$$\mathrm{d}\log P = \sum_{i=1}^{N} \kappa_i \mathrm{d}\log p_i \tag{11}$$

- Changes in good prices satisfy

$$d\log p_i = -\sum_{k=1}^{N} \Psi_{ik} d\log A_k + \sum_{k=1}^{N} \Psi_{ik} \sum_{f=1}^{F} \Omega_{kf} d\log w_f \tag{12}$$

  Ψ_{ik} importance of producer k as a supplier to i both directly and indirectly.
  Ω_{kf} cost-share of factor f for producer k.

- Given technology and factor prices changes, good prices are entirely determined by the supply side.

A Road to CPI inflation: Demand Side Determination of Factor Prices

Back

- Closed Economy: $GDP = E = PC$.
- Log-linearize Euler Equation and set $\sigma = 1$

$$\mathrm{d}\log PC = -\mathrm{d}\log\frac{\beta}{1-\beta} - \mathrm{d}\log(1+i) + \underbrace{\mathrm{d}\log P^* + \mathrm{d}\log C^*}_{\text{Future Expenditure}} = \mathrm{d}\log\zeta$$

Since β, i, P^*, C^* are *given*, changes in current total expenditure are also exogenous.

- Hence

$$\mathrm{d}\log GDP = -d\log\frac{\beta}{1-\beta} = \mathrm{d}\log\zeta$$

Intuition: Changes in *current* expenditure comes from a relative shift in demand from future to present ($\downarrow \beta$).

A Road to CPI Inflation: Putting Demand and Supply Together

Back

- Supply side goods price changes

$$d\log P = -\sum_{i=1}^{N} \lambda_i d\log A_k + \sum_{f=1}^{F} \Lambda_f d\log w_f; \quad \lambda_i = P_i Q_i / GDP; \quad \Lambda_f = W_f L_f / GDP$$

- Demand side determination of factor prices

$$d\log w_f = d\log \Lambda_f + \mathrm{d}\log GDP - \mathrm{d}\log L_f; \qquad \mathrm{d}\log GDP = \mathrm{d}\log \zeta$$

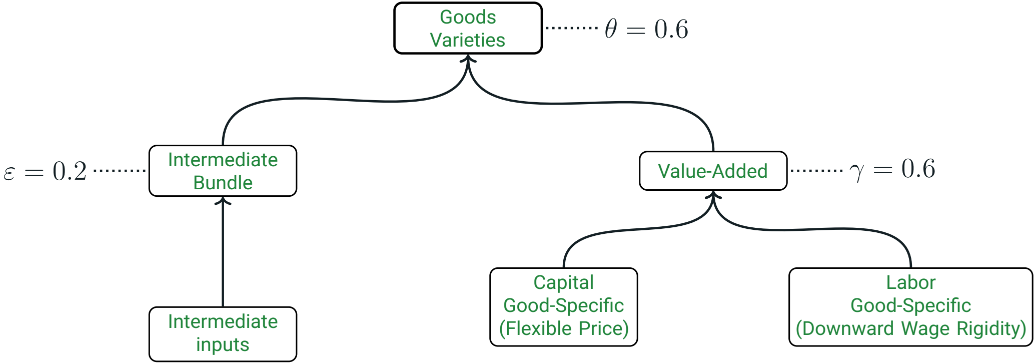
- We set $d\log A_i = 0$ for all i. Therefore,

$$\text{CPI Inflation} = \underbrace{-\sum_{f=1}^{F} \Lambda_f \mathrm{d}\log L_f}_{\text{Changes in Eq. Factor Quant.}} + \underbrace{\mathrm{d}\log \zeta}_{\text{Aggregate Demand Shift}}$$

Quantitative Model Details

Production Structure of Empirical Exercise: Nested CES

Back

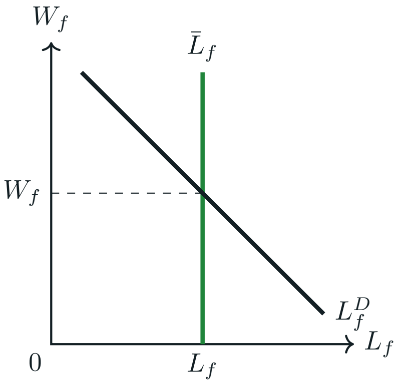


Factor Markets

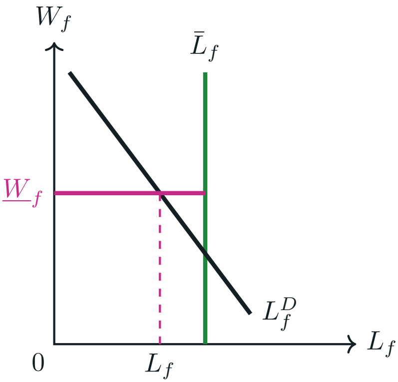
Back

- $2 \times S = F$ factors of production with *exogenous potential supply*.
  - Each sector uses two-sector specific factors of production $\Longrightarrow$ no factor mobility across sectors.

(A) Capital Markets: Supply Constrained



(B) Labor Markets: Potentially Demand Constrained



Closed-Economy Calibration

Back

	Value	Description
Elasticities		
ϵ	0.2	Elasticity of substitution across intermediate inputs
θ	0.6	Elasticity of substitution between factors and intermediates
γ	0.6	Elasticity of substition between factors
σ	1	Elasticity of substitution between consumption goods within period
ρ	1	Intertemporal elasticity of substitution
At initial steady-state		
β	0.5	Weight on future utility
i	0	Interest rate
$C = P = C^* = P^*$	1	steady state values of real GDP and price index both present and future (*)
$\boldsymbol{\Lambda}$		Factor shares from Input-Output Tables
$\boldsymbol{\lambda}$		Domar Weights from Input-Output Tables
$\boldsymbol{\kappa}$		Consumption Shares from Input-Output Tables
Shocks		
$d\log\zeta = d\log(1-\beta)/\beta$		Match backed out aggregate demand shock
$d\log \boldsymbol{L}$		Match sectoral total hours worked change
$d\log \boldsymbol{\kappa}$		Match changes in sectoral consumption expenditure

The Role of Complementarities on Inflation

Back

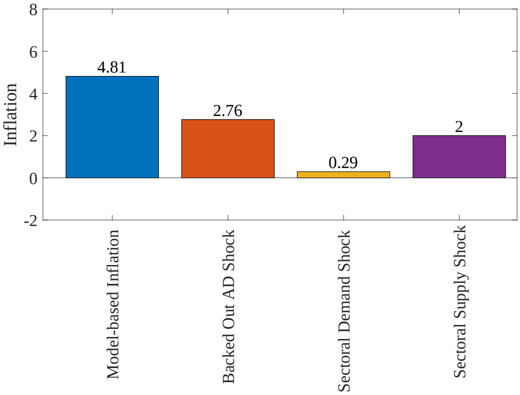
Panel A. United States

	Calibration Model		
Shocks	Cobb-Douglas (1)	Baseline (2)	Leontief (3)
All	8.93	9.18	9.68
Aggregate Demand	6.33	6.33	6.33
Sectoral Demand	1.01	1.06	0.77
Sectoral Supply	2.70	3.08	3.56

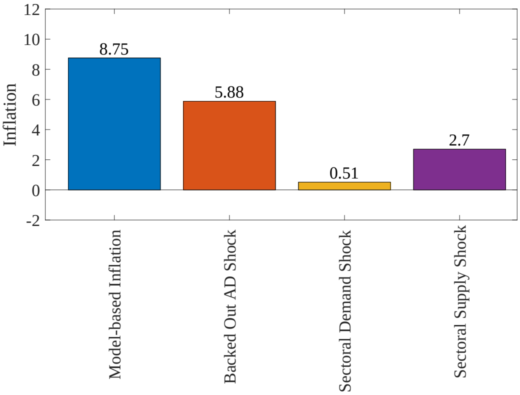
Panel B. Euro Area

	Calibration Model		
Shocks	Cobb-Douglas (1)	Baseline (2)	Leontief (3)
All	5.40	5.75	6.16
Aggregate Demand	3.21	3.21	3.21
Sectoral Demand	0.28	0.31	0.22
Sectoral Supply	2.56	2.78	3.04

Inflation Decomposition with 3 Sectors



(a) EA: 3 Sectors



(b) US: 3 Sectors