The Inflationary Effects of Sectoral Reallocation

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Inflation: Drivers and Dynamics
Fact 1: Sudden Shift in Consumption Expenditures

Real Consumption Expenditures

Goods Nominal Share

Index (2019q4=100)
Fact 2: Rise in Inflation

The graph illustrates the percentage change in inflation, year-on-year, from 2010q1 to 2021q4. The inflation data is divided into three categories: (Total), Goods, and Services. The graph shows a notable rise in inflation, particularly in the latter years, indicating higher costs and price increases in both goods and services.
Fact 3: Fall in Employment

The chart shows the index of employment over time from 2010q1 to 2021q4. The index is normalized to 2019q4 = 100. The employment data includes Total Employment, Employment Goods, and Employment Services.

- Employment (Total) is represented by a black line.
- Employment Goods is represented by a blue line.
- Employment Services is represented by a red line.

The index shows a general upward trend until 2019q4, followed by a significant drop due to the COVID-Demand Shock.
Fact 4: Increased Industry-level Dispersion

Real Gross Output (Detrended)
How Does Demand Reallocation Affect Inflation?

We study reallocation in New Keynesian model with

1. multi-sector input-output structure
2. costly input adjustment (hiring costs)
3. heterogeneous price rigidity across sectors

We estimate the model with three shocks:

1. Preference shift from services to goods ("COVID demand shock")
2. Sector-specific TFP shocks
3. Aggregate Labor Supply Shock ("Great Resignation")
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How Do Reallocation Shocks Affect Inflation?

Main Results:

- Demand reallocation explain a large portion of the rise in US inflation
  1. Hiring frictions $\Rightarrow$ goods sectors struggle to expand/services sectors cut employment sharply $\Rightarrow$ ↑ inflation
  2. Goods prices more flexible than services $\Rightarrow$ ↑↑ inflation

- Demand reallocation also explains a lot of cross-sectional developments

- TFP shocks and labor supply shock shock explain much less of aggregate inflation

- Model Experiments:
  - Sharp shift in demand back to services may be inflationary
  - Inflationary effects of reallocation depend on expected persistence
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Model Summary: Households

- Households consume goods and services
- Each are a bundle of output of the N sectors of the economy
- Time-varying preferences for goods/services (demand reallocation shock)

\[ C_t = \left( \frac{C^g_t}{\omega_t} \right)^{\omega_t} \left( \frac{C^s_t}{1 - \omega_t} \right)^{1 - \omega_t} \]
Model Summary: Households

- Households consume goods and services
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- Supply labor to firms (labor supply shock)

\[ U(C, N) = \frac{C^{1-\gamma}}{1-\gamma} - \chi_t \frac{N^{1+\psi}}{1+\psi} \]
Model Summary: Firms

In each sector there are 3 types of firms:

1. Representative Competitive Producer
2. Monopolistically Competitive Firms
3. Labor agencies
In each sector there are 3 types of firms:

1. **Representative Competitive Producer**
2. **Monopolistically Competitive Firms** *(sectoral productivity shocks)*

\[
Y_t^i = A_t^i \left( \frac{1}{\epsilon_Y} (M_t^i)^{\frac{\epsilon_Y - 1}{\epsilon_Y}} + (1 - \alpha) \frac{1}{\epsilon_Y} (L_t^i)^{\frac{\epsilon_Y - 1}{\epsilon_Y}} \right)^{\frac{\epsilon_Y}{\epsilon_Y - 1}} 
\]

\[
M_t^i = \left( \sum_{j=1}^{N} \Gamma_{i,j}^{\epsilon_M} (M_{j,t}^i)^{\frac{\epsilon_M - 1}{\epsilon_M}} \right)^{\frac{\epsilon_M}{\epsilon_M - 1}} 
\]

3. **Labor agencies**
Model Summary: Firms

In each sector there are 3 types of firms:

1. Representative Competitive Producer
2. Monopolistically Competitive Firms
3. Labor agencies (hiring costs)

\[
\text{Profits} = P_t^L L_t^i - W_t L_t^i \left(1 + \mathbb{1}(L_t^i > L_{t-1}^i) \frac{c}{2} \left(\frac{L_t^i}{L_{t-1}^i} - 1\right)^2\right)
\]
Taking the Model to the Data: Calibration

- **Calibrated Parameters**
  - Some parameters set to standard values ($\beta, \gamma, \phi, \psi$ etc)
  - Use $N = 66$ private industries
  - Factor shares/consumption shares: BEA I-O Tables & PCE Bridge
  - Sector price stickiness from Pasten, Schoenle and Weber (2020):
    - Key feature: goods prices more flexible than services

- **Calibrated Shocks**
  1. Demand reallocation shock $\uparrow \omega_t$: match $\uparrow$ in goods expenditure share
  2. Sectoral Productivity shocks $\Delta A_t$: calibrated to sectoral TFP data
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Taking the Model to the Data: Estimation

- Estimated Parameters
  - Production function elasticities ($\epsilon_M$ and $\epsilon_Y$)
  - Hiring costs ($c$)

- Estimated Shocks
  1. Labor supply shock ($\uparrow \chi_t$)

Estimated parameters/shocks chosen to minimize distance between model and data:

1. Cross-section of prices/output/labor
2. Aggregate employment
3. Goods inflation - services inflation
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COVID Demand Reallocation Shock ($\omega_t$)

- Preference for Goods: $\omega_t$
- Sectoral Price Levels
- Sectoral Employment
- Inflation (yoy)
- Consumption
- Employment

Baseline vs. No Hiring Costs

Aggregate, Goods, and Services

Percentage Points, Percent, Percentage Points, Percent, Percent, Percent
COVID Demand Reallocation Shock ($\omega_t$)

Preference for Goods: $\omega_t$

Sectoral Price Levels

Sectoral Employment

Inflation (yoy)

Consumption

Employment

Baseline  No Hiring Costs

Aggregate  Goods  Services
COVID Demand Reallocation Shock ($\uparrow \omega_t$)

Preference for Goods: $\omega_t$

Sectoral Price Levels

Sectoral Employment

Inflation (yoy)

Consumption

Employment
COVID Demand Reallocation Shock: Cross-Section

Details
Industry Dispersion in Price and Output Growth

For some industries, price and quantity dynamics are hard to explain with the dynamics following demand reallocation shock:
Adding TFP Shocks and Labor Supply Shocks

- We measure evolution of TFP at the industry level between 2019 and 2021 and feed estimated idiosyncratic TFP into model.
- We estimate the size of the aggregate labor supply shock required to match decline in aggregate employment.
All Three Shocks: Aggregates

- Sectoral Productivity
- Sectoral Price Levels
- Sectoral Employment
- Inflation (yoy)
- Consumption
- Employment

- Aggregate
- Goods
- Services

TFP Shocks
Labor Supply Shock
All Three Shocks: Cross-Section
What if demand shifts back unexpectedly?

- We have assumed demand reallocation shock is persistent ($\rho = 0.975$)
- Now assume that this falls to $\rho = 0.5$ after 8 quarters

→

- Inflation rises again: services sectors had cut employment too much and now face hiring costs
Reversal Experiment

Preference for Goods: $\omega_t$

Sectoral Price Levels

Sectoral Employment

Inflation (yoy)

Consumption

Employment

Faster Reversal
Baseline
Aggregate
Goods
Services
What if demand reallocation was surprisingly persistent?

- We assumed persistence of demand reallocation shock known on impact
- Now assume that everyone thought it was \( \rho = 0.5 \) for first 8 quarters
- Households and firms are repeatedly surprised about the persistence for two years (true persistence still \( \rho = 0.975 \))

→

- **Demand reallocation less inflationary**: services sectors cut employment less and prices more
Unexpected Persistence

Preference for Goods: $\omega_t$

Sectoral Price Levels

Sectoral Employment

Inflation (yoy)

Consumption

Employment

- Percentage Points
- Percent
- Percent
- Percent
- Aggregate
- Goods
- Services
Conclusion

- Demand reallocation explains a large portion of the rise in US inflation
- Demand reallocation can also explain cross-sectional developments
- TFP shocks and labor supply shock explain less of aggregate inflation
**Model: Households**

- Consume goods and services
- Each are a bundle of output of the N sectors of the economy
- Time-varying preferences for goods services (reallocation shock)
- Supply labor to firms
Households problem:

$$\max E_t \sum_{i=0}^{\infty} \frac{C_{t+i}^{1-\gamma}}{1-\gamma} - \chi_t \frac{(N_{t+i})^{1+\psi}}{1+\psi}$$  \hspace{1cm} (1)$$

where

$$C_t = \left( \frac{C_t^g}{\omega_t} \right)^{\omega_t} \left( \frac{C_{s,t}}{1-\omega_t} \right)^{1-\omega_t}$$  \hspace{1cm} (2)$$

$$C_t^g = \prod_{i=1}^{N} \left( \frac{C_{i,t}^g}{\gamma_i^g} \right)^{\gamma_i^g} \text{ and } C_t^s = \prod_{i=1}^{N} \left( \frac{C_{i,t}^s}{\gamma_i^s} \right)^{\gamma_i^s}$$  \hspace{1cm} (3)$$

subject to

$$P_t C_t + B_{t+1} = W_t N_t + (1+i_t)B_t + \text{Profits}_t$$  \hspace{1cm} (4)$$
Model: Firms

In each sector there are 3 types of firms:

1. Representative Competitive Producer
2. Monopolistically Competitive Firms
3. Labor Agencies
Model: Monopolistically Competitive Firms

\[ Y_t^i = A_t^i \left( \alpha \frac{1}{\epsilon_Y} (M_t^i)^{\frac{\epsilon_Y-1}{\epsilon_Y}} + (1 - \alpha) \frac{1}{\epsilon_Y} (L_t^i)^{\frac{\epsilon_Y-1}{\epsilon_Y}} \right)^{\frac{\epsilon_Y}{\epsilon_Y-1}} \]  

\[ M_t^i = \left( \sum_{j=1}^{N} \Gamma_{i,j}^{\frac{1}{\epsilon_M}} (M_{j,t}^i)^{\frac{\epsilon_M-1}{\epsilon_M}} \right)^{\frac{\epsilon_M}{\epsilon_M-1}} \]  

Sector-specific Rotemberg price adjustment costs \((\kappa_i)\) →

\[ 1 - \epsilon + \epsilon \frac{MC_t^i}{P_t^i} - \kappa_i (\Pi_t^i - 1) \Pi_t^i + E_t \left( M_{t+1} \Pi_{t+1}^i (\Pi_{t+1}^i - 1) \frac{Y_{t+1}^i}{Y_t^i} \right) = 0 \]
Model: Monopolistically Competitive Firms

\[ Y_t^i = A_t^i \left( \alpha \frac{1}{e^Y} (M_t^i) \frac{e^Y - 1}{e^Y} + (1 - \alpha) \frac{1}{e^Y} (L_t^i) \frac{e^Y - 1}{e^Y} \right)^{\frac{e^Y}{e^Y - 1}} \]  

(5)

\[ M_t^i = \left( \sum_{j=1}^{N} \Gamma_{i,j}^M (M_{j,t}^i) \frac{e^M - 1}{e^M} \right)^{\frac{e^M}{e^M - 1}} \]  

(6)

Sector-specific Rotemberg price adjustment costs \((\kappa_i)\) →

\[ 1 - \epsilon + \epsilon \frac{MC_t^i}{P_t^i} - \kappa_i (\Pi_t^i - 1) \Pi_t^i + E_t \left( M_{t+1} \Pi_{t+1}^i (\Pi_{t+1}^i - 1) \frac{Y_{t+1}^i}{Y_t^i} \right) = 0 \]  

(7)
Model: Labor Agencies

- Labor agency in each sector hires labor from HHs at $W_t$ and supplies it to monopolistically competitive firms at $P_{t}^{L,i}$

- Subject to convex hiring costs

$$V_t(L_{t-1}^i) = \max_{L_t^i} P_{t}^{L,i} L_t^i - W_t L_t^i \left(1 + \mathbb{1}(L_t^i > L_{t-1}^i) \frac{c}{2} \left(\frac{L_t^i}{L_{t-1}^i} - 1\right)^2\right) + E_t[M_{t+1} V_{t+1}(L_t^i)]$$ (8)
Monteary Policy and Equilibrium

Monetary policy follows a standard Taylor rule.

\[ \log(i_{t+1}) = \log(R_{ss}) + \phi \log \Pi_t \]  

(9)

where \( \Pi_t = \frac{P_t}{P_{t-1}} \). Goods market clearing:

\[ Y_t^i = C^g_{i,t} + C^s_{i,t} + \sum_{j=1}^{N} M^j_{i,t} \quad \forall i \]  

(10)

Labor market clearing:

\[ \sum_{j=1}^{N} L_t^i \left(1 + 1(L_t^i > L_{t-1}^i) \frac{c}{2} \left( \frac{L_t^i}{L_{t-1}^i} - 1 \right)^2 \right) = N_t \]  

(11)
TFP Shocks: Aggregates

1. Introduction
2. Model
3. COVID-Demand Shock
4. All Shocks
5. Extensions
Conclusion
Appendix

- Sectoral Productivity
- Sectoral Price Levels
- Sectoral Employment
- Inflation (yoy)
- Consumption
- Employment

- Aggregate
- Goods
- Services
TFP Shocks: Cross-section

Industry Prices, Data (% change 19Q4-21Q4)

-30 -20 -10 0 10 20 30 40 50

Industry Output, Data (% change 19Q4-21Q4)

-35 -30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30 35

Industry Prices, Model

-20 0 20 40 60

Industry Output, Model

-40 -20 0 20

All Shocks
Labor Supply Shock: Aggregates

Disutility of Labor Supply

Sectoral Price Levels

Sectoral Employment

Inflation (yoy)

Consumption

Employment

All Shocks
Labor Supply Shock: Cross-section

Industry Prices, Data (% change 19Q4-21Q4)

Industry Output, Data (% change 19Q4-21Q4)

Industry Prices, Model

Industry Output, Model
## Parameters

<table>
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<tr>
<th>Calibrated Parameters/Shocks</th>
<th>Value</th>
<th>Target/Source</th>
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<td>$\gamma$</td>
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<tr>
<td>$\chi$</td>
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<td>Goods Expenditure Share</td>
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<tr>
<td>$\alpha$</td>
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<td>Pasten, Schoenle &amp; Weber (2020)</td>
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<td>$\kappa_i$</td>
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<td>Pasten, Schoenle &amp; Weber (2020)</td>
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<td>$\rho_\omega$</td>
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<td>Path of Goods Expenditure Share</td>
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<td>$\Delta A_t$</td>
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<td>$\Delta \chi$</td>
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Both I-O and Het Price Stickiness Important

- No IO, No Lab Adj Costs
  - corr (all) = N/A
  - corr (goods) = N/A
  - corr (services) = N/A

- No IO, Hom Price Adj Costs
  - corr (all) = 0.34
  - corr (goods) = 0.15
  - corr (services) = 0.04

- No IO, Het Price Adj Costs
  - corr (all) = 0.39
  - corr (goods) = 0.56
  - corr (services) = 0.04

- IO, Hom Price Adj Costs
  - corr (all) = 0.43
  - corr (goods) = 0.18
  - corr (services) = 0.35

- IO, Het Price Adj Costs (Baseline)
  - corr (all) = 0.56
  - corr (goods) = 0.41
  - corr (services) = 0.36