Demand Composition
and the Strength of Recoveries

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Harvard, November 2020
Consumer Spending in Recessions

Average of past U.S. recessions

Contribution to Real PCE change (%)

Durables Services + Non-Durables
Consumer Spending in Recessions

1973 (Oil crisis) U.S. recession

Average of past U.S. recessions

Contribution to Real PCE change (%)

Durables  Services  Durables  Services
+ Non-Durables + Non-Durables
Consumer Spending in Recessions

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Average of past U.S. recessions

Covid-19 U.S. recession

Contribution to Real PCE change (%)

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   • Setting: multi-sector NK model + agg. & sectoral supply & demand shocks

   *Note: all sectors symmetric except for durability*
This Paper

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- Prediction: \textbf{weaker recovery} after \textbf{services-led} recession
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- Prediction: **weaker recovery** after **services-led** recession
  Measure: cumulative output impulse response cond’t’l on recession today
  - In simplest model: cycle is V-shaped for services vs. Z-shaped for durables

   Mechanism: **pent-up durables demand** boosts recovery
Is this mechanism empirically plausible & quantitatively relevant?
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2. Measurement

- Strong support for key testable implication: durables IRF > services IRF
  Main check: monetary policy shocks
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2. **Measurement**

- Strong support for key testable implication: durables IRF > services IRF
  
  *Main check: monetary policy shocks*

- **Quantification:** effect of pent-up demand on recovery dynamics

  (a) Semi-structural *shift-share*

  (b) Calibrated structural *model* 

  \[ \text{COVID-19 split} \approx 70\% \text{ costlier than usual} \]
What does this mean for macro stabilization policy?
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3. **Policy implications**

- CB objective: stabilize output given sectoral & aggregate shocks

- Exercise: characterize eq’m by **sectoral shock incidence** & **CB info set**
This Paper

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    ○ Measurement: output loss fully characterized by shift-share estimates
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a) Aggregate output
  ○ Continually under-stimulate in services-led recession
  ○ Measurement: output loss fully characterized by shift-share estimates

b) Sectoral output
  ○ Perfect output stabilization attainable with simple rule
  ○ Policy is easier for longer in services recession
Related Literature

• Sectoral heterogeneity & business cycle dynamics
  ◦ Supply-side mechanisms
  ◦ Durables spending
    Mankiw (1982), Barsky et al. (2007), Berger-Vavra (2015), McKay-Wieland (2020)

• Strength & shape of recoveries
  Hall (2016), Benigno-Fornaro (2018), Hall-Kudlyak (2020)

• COVID-19 recession
  ◦ Sectoral incidence
    Chetty et al. (2020), Cox et al. (2020), Guerrieri et al. (2020)
  ◦ Recovery shapes
    Reis (2020), Gregory-Menzio (2020)
The Pent-Up Demand Mechanism
Model Overview

- Environment: multiple goods + Keynesian block
  - Today only durables + services, in paper $N$ sectors $i$ with durability $\{\delta_i\}_{i=1}^N$
  - Rest of the economy: sticky prices, labor-only production
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• Agg. risk: shocks $\{b^c_t, b^d_t, b^s_t\}$ to (sectoral) demand = consumption utility
  ○ Solution method: first-order perturbation (= perfect foresight transition)
  ○ Notation: hats = log deviations from steady state
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• **Use boldface notation to refer to cumulative IRFs (CIR), e.g.**

\[
y^{d} = \mathbb{E} \left[ \sum_{h=0}^{\infty} \hat{y}_{t+h} \mid b_{0}^{d} \right]
\]
Model Details I

- Representative household with preferences

\[ \mathbb{E}_0 \left[ \sum_{t=0}^{\infty} \beta^t \left\{ e^{b^c_t} \left[ e^{b^s_t} \phi^\zeta s_t^{1-\zeta} + e^{b^d_t} (1 - \phi^\zeta) d_t^{1-\zeta} \right] \right] \frac{1-\gamma}{1-\zeta} - 1 - \nu(l_t) \right\} \]

  - \( b^c_t \): aggregate demand shifter (uncertainty, income risk, deleveraging, …)
  - \( \{ b^s_t, b^d_t \} \): sectoral demand shifters (preference changes, disease risk, …)

- Budget constraint:

\[ p^s_t s_t + p^d_t \underbrace{[d_t - (1 - \delta) d_{t-1}]}_{e_t} + \frac{\kappa}{2} \left( \frac{d_t}{d_{t-1}} - 1 \right)^2 d_t + a_t = w_t l_t + \frac{1 + r^n_{t-1}}{1 + \pi_t} a_{t-1} + q_t \]
• Representative household with preferences

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• Normalizations: \( \bar{s} = \phi, \delta \bar{d} = \bar{e} = 1 - \phi \), so \( \bar{y} = 1 \)
• Rest of the economy
  ○ **Production**: sticky prices, single common intermediate good
    Empirical relevance: small relative price movements/elastic durables supply
    \[
    \begin{align*}
    \hat{y}_t & = \phi \hat{s}_t + (1 - \phi) \hat{e}_t \\
    \hat{\pi}_t & = \zeta \hat{m}_t + \beta \mathbb{E}_t [\hat{\pi}_{t+1}]
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Model Details II

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  ○ **Policy**: neutral monetary policy = fix expected real rate
    Later: numerical solution with other kinds of rules
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• **Equilibrium selection**: \( \lim_{t \to \infty} \hat{y}_t^b = 0 \)
  = continuity at indeterminacy boundary, see Lubik & Schorfheide (2003, 2004)
The Pent-Up Demand Mechanism

Intuition in a Special Case
• **Experiment**: $\zeta = \gamma$, $\kappa = 0$, iid shocks. Normalize trough to -1%.
Demand Composition & Recovery Dynamics

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1. Pure durables demand shock \( b^d_t \): recovery led by pent-up demand

\[
y^d = -1 + (1 - \delta) = -\delta
\]
Demand Composition & Recovery Dynamics

- **Experiment**: $\zeta = \gamma, \kappa = 0$, iid shocks. Normalize trough to -1%.

2. Pure service demand shock $b_t^s$: lost output is never recovered

$$y^s = -1$$
Demand Composition & Recovery Dynamics

- **Experiment**: $\zeta = \gamma$, $\kappa = 0$, iid shocks. Normalize trough to -1%.

3. Ordinary recession $b^c_t$: dominated by pent-up demand effects

$$\lim_{\beta \to 1} y^c = -1 + \frac{(1 - \phi)}{\phi \delta^2 + (1 - \phi)(1 - \delta)} (1 - \delta) \gg -1 + \frac{\bar{e}}{\bar{y}} (1 - \delta)$$
Demand Composition & Recovery Dynamics

- **Experiment**: $\zeta = \gamma$, $\kappa = 0$, iid shocks. Normalize trough to -1%.

4. COVID-19 mix of $b^c_t$ and $b^s_t$: weak pent-up demand
The Pent-Up Demand Mechanism

A General Forecasting Result
The Full Model

• Return to full model, AR(1) shocks, but keeping $\zeta = \gamma$. 

Details

1. Incomplete markets: fraction $\mu$ of hand-to-mouth households
2. Many sectors: $N$ sectors heterogeneous in durability and adjustment costs
3. Supply shocks: shocks to relative productivity of different sectors

Proposition

 Normalize the shocks $\{b_{d,t}, b_{s,t}\}$ to move output on impact by -1%. Then where $\theta_d \in [0,1)$. If $\theta_d < 1 - \delta$, then $b_{y,d,t} > b_{y,s,t}, \forall t > 0$. 

Empirical Relevance
The Full Model

- Return to full model, AR(1) shocks, but keeping $\zeta = \gamma$. Similar for:
  
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### Proposition

Normalize the shocks $\{b_{t}^d, b_{t}^s\}$ to move output on impact by -1%. Then

$$y^d = -\frac{1}{1 - \rho_b} \frac{\delta}{1 - \theta_d}, \quad y^s = -\frac{1}{1 - \rho_b}$$

where $\theta_d \in [0, 1)$. 
The Full Model

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$$\hat{y}^d_t > \hat{y}^s_t, \quad \forall t > 0$$
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Forecasting Recoveries

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• Need to map IRFs to forecasts:

\[
E \left[ \hat{y}_{t+h} \mid \{\hat{s}_{t-\ell}, \hat{e}_{t-\ell}\}_{\ell=0}^{\infty} \right]
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Forecasting Recoveries

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\[ \mathbb{E} [ \hat{y}_{t+h} \mid \{ \hat{s}_{t-l}, \hat{e}_{t-l} \}_{l=0}^{\infty} ] \]

**Proposition**

Let \((\sigma_c, \sigma_d, \sigma_s) > 0\) and let \(u_t = (u_t^s, u_t^d)')\) denote the forecast residuals of a reduced-form \(VAR(\infty)\) in \((\phi\hat{s}_t, (1 - \phi)\hat{e}_t)')\).
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\mathbb{E} [\hat{y}_{t+h} | \{u_t^s = -\omega_s, u_t^d = -\omega_d\}] = -[\omega_s \cdot \hat{y}_t^s + \omega_d \cdot \hat{y}_t^d]
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\]

and so in particular

\[
\mathbb{E} [y^\omega | \{u^s_t = -\omega_s, u^d_t = -\omega_d\}] = -\left[\omega_s \cdot \frac{1}{1 - \rho_b} + \omega_d \cdot \frac{1}{1 - \rho_b} \frac{\delta}{1 - \theta_d}\right]
\]
Supporting Empirical Evidence
Empirical Evidence

• Testable implication: PUD effects $\Leftrightarrow$ durables IRF above services IRF

$$\hat{e}_t^c \gg \hat{s}_t^c, \quad \forall t$$
Empirical Evidence

• Testable implication: PUD effects ⇔ durables IRF above services IRF

\[ \hat{e}^c_t \gg \hat{s}^c_t, \quad \forall t \]

• **Ideal laboratory**: monetary policy transmission
  
  1. IRF ranking applies without change to monetary policy shocks
  2. Relatively standard approach to time series identification is available
     

     
     **Today**: simple recursive VAR
Empirical Evidence

• Testable implication: PUD effects ⇔ durables IRF above services IRF

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     [Proposition]
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Today: simple recursive VAR

• **In paper**: uncertainty & oil shocks, Wold error transmission
  [Details]
Results

Figure: Quarterly IRFs, with trough response normalized to -1% for all.

- **Main result**: Z-cycle for Durables, V-cycle for Services
Results

Figure: Quarterly IRFs, with trough response normalized to -1% for all.

- **Main result**: Z-cycle for Durables, V-cycle for Services
  - Test: Bayesian posterior credible sets for CIR ratios \( \{s^m/e^m, nd^m/e^m\} \)
  - Consistent with previous work documenting overshoot in durables
    Erceg-Levin (2006), McKay-Wieland (2020)
Quantification
Objective: Quantify the effect of pent-up demand on recoveries

\[ \frac{\partial \mathbb{E}(\text{recovery strength})}{\partial \text{spending composition}} \]

Recall mini model: these effects may be sizable

Now:

1. Semi-structural shift-share: re-weight VAR IRFs
2. Full structural model: explore large parameter space & model extensions
Recession Composition & Recovery Strength

**Objective:** Quantify the effect of pent-up demand on recoveries

\[
\frac{\partial \mathbb{E} \text{(recovery strength)}}{\partial \text{spending composition}} \equiv \frac{\partial y^\omega}{\partial \omega}
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where \( y^\omega \) is the CIR for a recession with sectoral split \( \{\omega_i\} \):

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y^\omega = \mathbb{E}_0 \left[ \sum_{t=0}^{\infty} \hat{y}_t \mid \{ u_{0,i} = -\omega_i \} \right]
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\[ \frac{y^{\text{covid}}}{y^{\text{normal}}} > 2 \]
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- Now: quantitative measurement
  1. **Semi-structural shift-share**: re-weight VAR IRFs
  2. **Full structural model**: explore large parameter space & model extensions
Quantification

Semi-Structural Shift-Share
Proposition

Extend the model to feature monetary shocks of persistence $\rho_m$. Let

$$\hat{y}_t^\omega = \omega_s \hat{s}_t^m + \omega_d \hat{e}_t^m$$

where $m$ superscripts denote impulse responses to monetary policy shocks.

Then $\hat{y}_t^\omega$ is equal to the IRF of output to a pair of sectoral demand shocks $(b^s_t, b^d_t)$ with $\rho_b = \rho_m$ and $\sigma_s = \frac{\sigma_m}{1-\rho_m} \omega_s \bar{y}_s$, $\sigma_d = \frac{\sigma_m}{1-\rho_m} \omega_d \bar{y}_d$. 
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**Take-away:** weighted averages of monetary policy IRFs give $y^\omega$, $\omega \in [0, 1]$
Semi-Structural Shift-Share

• Implementation
  ○ **Range**: lower bound is pure services, upper bound is pure durables
  ○ Shares for **avg. recession** and **COVID-19** match historical composition
Semi-Structural Shift-Share

• Implementation
  ○ **Range**: lower bound is pure services, upper bound is pure durables
  ○ Shares for **avg. recession** and **COVID-19** match historical composition

• Find: service-led recession ≈ **70 per cent costlier** in output PV
Quantification

Structural Model
Structural Model

- **Environment**: baseline model + two further twists:
  1. **Many shocks**
     - Aggregate & sectoral supply & demand shocks
     - Allow for heterogeneous shock persistence \( \{\rho_b, \rho_z\} \)
  2. **Standard monetary policy rule**
     
     \[
     \hat{r}_t^n = \phi \hat{\pi}_t, \quad \phi > 1
     \]
Structural Model

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Challenge: 1. & 2. break diagonal structure, so IRFs \( \neq \) forecasts
Structural Model

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     \[
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     \]

     Challenge: 1. & 2. break diagonal structure, so IRFs \( \neq \) forecasts

• **Experiment**

  - Compute conditional expectation
    \[
    y^\omega = \mathbb{E}_0 \left[ \sum_{t=0}^{\infty} \hat{y}_t \mid \left\{ u_0^s = -\omega, u_0^d = -(1 - \omega) \right\} \right]
    \]

    for ordinary composition vs. COVID-19 composition
### Parameterization

- **Background**: mostly calibrate to standard business-cycle targets

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
<th>Source/Target</th>
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<td>$\sigma_b^z/\sigma_z^z$</td>
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<td>Lubik &amp; Schorfheide (2004)</td>
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<td>$\sigma_i^i/\sigma_i^i$</td>
<td>Relative Sectoral Volatility</td>
<td>1</td>
<td>Foerster et al. (2011)</td>
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<td>$\beta$</td>
<td>Discount Rate</td>
<td>0.99</td>
<td>Annual Real FFR</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>Inverse EIS</td>
<td>1</td>
<td>Literature</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>Elasticity of Substitution</td>
<td>1</td>
<td>$=$ EIS</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Durables Consumption Share</td>
<td>0.1</td>
<td>NIPA</td>
</tr>
<tr>
<td>Technology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\delta$</td>
<td>Depreciation Rate</td>
<td>0.068</td>
<td>BEA Fixed Asset</td>
</tr>
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<td>Policy</td>
<td></td>
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<tr>
<td>$\phi_\pi$</td>
<td>Inflation Response</td>
<td>1.5</td>
<td>Literature</td>
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<td>Shocks</td>
<td></td>
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<tr>
<td>$\rho_b$</td>
<td>Demand Shock Persistence</td>
<td>0.83</td>
<td>Lubik &amp; Schorfheide (2004)</td>
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<tr>
<td>$\rho_z$</td>
<td>Supply Shock Persistence</td>
<td>0.85</td>
<td>Lubik &amp; Schorfheide (2004)</td>
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<td>$\sigma_b^i/\sigma_z^i$</td>
<td>Relative Demand Volatility</td>
<td>0.28</td>
<td>Lubik &amp; Schorfheide (2004)</td>
</tr>
<tr>
<td>$\sigma_i^s/\sigma_i^c$</td>
<td>Relative Sectoral Volatility</td>
<td>1</td>
<td>Foerster et al. (2011)</td>
</tr>
</tbody>
</table>

- **Then**: vary adjustment costs & slope of NKPC
Results

How many % costlier is the COVID-style recession in CIR terms?
Policy Implications
Policy Implications

• **Practice**: policymakers focussed on aggregate employment shortfalls
Policy Implications

- **Practice**: policymakers focussed on aggregate employment shortfalls

- **Our setting**
  - As before: sectoral + aggregate demand shocks \( \{b_t^C, b_t^S, b_t^d\} \)
  - Policy: set \( r_t^H \) before time-\( t \) shocks are realized, fixed prices

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Policy Implications

• **Practice**: policymakers focussed on aggregate employment shortfalls

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• **Experiment**
  (a) **Incidence**: at \( t = 0 \) arbitrary sectoral demand shock mix s.t. \( \hat{y}_0 = -1 \)
  (b) **Information**: given information set \( \mathcal{F}_t \), central bank sets real rates so that

\[
\mathbb{E} [ \hat{y}_{t+h} | \mathcal{F}_t ] = 0 \quad \forall h > 0
\]
Policy Implications

• **Practice**: policymakers focussed on aggregate employment shortfalls

• **Our setting**
  
  ◦ As before: sectoral + aggregate demand shocks \( \{b^c_t, b^s_t, b^d_t\} \)
  
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  \]

How do outcomes vary with (a) and (b)?
Aggregated Output Gap

For $F_t = H_t(\hat{y})$: perfect stabilization in ordinary recessions ...

Figure: Stabilization policy in an ordinary recession
Aggregate Output Gap

For $F_t = H_t(\hat{y})$: … but too little stimulus in services recessions …

Figure: Stabilization policy in a services recession
Aggregate Output Gap

For $F_t = H_t(\hat{y})$: ... and then only partially correct the shortfall over time

Figure: Stabilization policy in a services recession
Aggregate Output Gap

For $\mathcal{F}_t = \mathcal{H}_t(\hat{y})$: … and then only partially correct the shortfall over time

Figure: Stabilization policy in a services recession
Aggregate Output Gap

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Figure: Stabilization policy in a services recession.
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Result I: For $F_t = H_t(\hat{y})$, the eq’m output CIR scales with the (unknown) CIR of the sectoral demand shock mix. 

Full Result
Result I: For $\mathcal{F}_t = \mathcal{H}_t(\hat{y})$, the eq’m output CIR scales with the (unknown) CIR of the sectoral demand shock mix.

Proposition

Suppose that $\mathcal{F}_t = \mathcal{H}_t(y)$, and let

- $\hat{y}_t^b$: IRF to actual time-0 shock $\{b^c_0, b^s_0, b^d_0\}$
- $\hat{y}_t^u$: IRF to reduced-form forecast innovation $u_t \equiv \hat{y}_t - \mathbb{E}[\hat{y}_t | \mathcal{H}_t(y)]$

Then the actual equilibrium output path is given as

$$\mathbb{E}_0\left[ \sum_{t=1}^{\infty} \hat{y}_t \right] = \frac{\sum_{t=0}^{\infty} \hat{y}_t^b}{\sum_{t=0}^{\infty} \hat{y}_t^u} - 1$$
Aggregate Output Gap

**Result I:** For $F_t = \mathcal{H}_t(\hat{y})$, the eq’m output CIR scales with the (unknown) CIR of the sectoral demand shock mix. ▶ Full Result

**Proposition**

Suppose that $F_t = \mathcal{H}_t(y)$, and let

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**Measurement:** service-led recession adds extra 70% to expected CIR
Result II: For $\mathcal{F}_t = \mathcal{H}_t(\{\hat{y}_i\}_i)$, achieve perfect stabilization with simple VAR-based rule, independent of sectoral incidence.

Figure: Easier-for-longer stabilization policy in a services recession
Conclusions

Consumer theory + demand-determined output \(\Rightarrow\) composition of household spending matters for likely strength of recovery
Conclusions

Consumer theory + demand-determined output $\implies$ composition of household spending matters for likely strength of recovery

- **This paper**: formalize, test, quantify
  - PUD effects are present & big in standard models + time series data
  - Measurement: service-led recession $\approx 70\%$ costlier than otherwise identical, ordinary durables-led contraction
Conclusions

Consumer theory + demand-determined output $\implies$ composition of household spending matters for likely strength of recovery

- **This paper**: formalize, test, quantify
  - PUD effects are present & big in standard models + time series data
  - Measurement: service-led recession $\approx 70\%$ costlier than otherwise identical, ordinary durables-led contraction

- Implications for **policy design**
  1. No one-size-fits-all response to aggregate output gaps
  2. *Easier-for-longer* in services recession ensures 0 expected output gap
Thank you!
Extensions

- Incomplete markets
  - A fringe $\mu$ of households has the same preferences, but is hand-to-mouth
  - Assume their income follows
    $$\phi \tilde{s}_t^H + (1 - \phi) \tilde{e}_t^H = \eta \hat{y}_t$$
    \[\Rightarrow\] Irrelevance result: HtMs scale IRFs up or down, but leave shapes unchanged

- Supply shocks
  - Intermediate good is turned into services at rate $z_t^s$ and durables at rate $z_t^d$
  - Then supply shocks show up in two places:
    1. Prices in the household budget constraint satisfy
      $$\hat{p}_t^s = -\hat{z}_t^s, \quad \hat{p}_t^d = -\hat{z}_t^d$$
    2. The output market-clearing condition becomes
      $$\hat{y}_t = \phi(-\hat{z}_t^s + \tilde{s}_t) + (1 - \phi)(-\hat{z}_t^d + \tilde{e}_t)$$
Monetary Policy Equivalence

Proposition

Consider the following two shocks:

(i) A common demand shock $b^c_t$ with persistence $\rho_b$ and volatility $\sigma^c_b$

(ii) An innovation $m_t$ to the rule

$$\hat{r}^n_t = \mathbb{E}_t [\hat{\pi}_{t+1}] + m_t$$

with persistence $\rho_m = \rho_b$ and volatility $\sigma_m = (1 - \rho_b)\sigma^c_b$

The impulse responses of all real aggregates $x \in \{s, e, d, y\}$ to the two shocks are identical:

$$\hat{x}^c_t = \hat{x}^m_t$$
Empirics: Uncertainty

• Second main experiment: uncertainty shocks
  Implementation as in Basu & Bundick (2017)

• Find: V- vs. Z-shape as for monetary policy
Empirics: Other Experiments

• Oil shocks
  ○ Project granular sectoral spending series on oil shock series
  ○ Find: PUD for durables/gas/transport, not for food/clothes

• Reduced-form dynamics
  ○ Estimate reduced-form VAR in all spending components
  ○ Find: services CIR 120% larger than for durables
Shift-Share: Uncertainty Shocks

The diagram illustrates the % Deviation over time (Horizon) for different scenarios:
- Range
- Avg. Recession
- COVID-19
Why will we invariably have $\theta_d \ll 1 - \delta$?
Forecasting by $\rho_b = \rho_z$ & $\phi_\pi$
How much less persistent would a services shock need to be to offset the pent-up demand effects?

• Straightforward calculation: services persistence $\rho_s$ must satisfy

$$\rho_s = 1 - \frac{1 - \theta_d}{\delta} + \frac{1 - \theta_d}{\delta} \rho_b$$

• Example calibration

  ○ Set $\rho_b = 0.83$, $\delta = 0.068$, $\beta = 0.99$, $\kappa = 0.15$, so get $\theta_d = 0.4966$

  ○ Then $\rho_s = -0.2586$
Proposition

Suppose that \( \mathcal{F}_t = \mathcal{H}_t(y) \), and let

- \( \hat{y}_t^b \): IRF to actual time-0 shock \( \{b_0^c, b_0^s, b_0^d\} \)
- \( \hat{y}_t^u \): IRF to reduced-form forecast innovation \( u_t \equiv \hat{y}_t - \mathbb{E}[\hat{y}_t | \mathcal{H}_t(y)] \)

Then:

\[
\mathbb{E}_0 [\hat{y}_t] = \hat{y}_t^b - \sum_{h=0}^{t-1} \hat{y}_{t-h}^u \mathbb{E}_0 [\hat{y}_h]
\]

and so

\[
\mathbb{E}_0 \left[ \sum_{t=1}^{\infty} \hat{y}_t \right] = \frac{\sum_{t=0}^{\infty} \hat{y}_t^b}{\sum_{t=0}^{\infty} \hat{y}_t^u} - 1
\]
Proposition

Suppose that $\mathcal{F}_t = \mathcal{H}_t(\{\hat{y}_i\}_i)$. Then

$$E_0[\hat{y}_t] = 0, \text{ for } t = 1, 2, \ldots$$

The real interest rate is set as

$$r_t - E[r_t | \mathcal{F}_{t-1}] = \sum_{i=1}^{N} \phi_{y_i} u_{it}$$

where the response coefficients $\{\phi_{y_i}\}_i$ depend on model parameters and the $\{u_{it}\}_i$ are reduced-form VAR forecast errors:

$$u_{it} = y_{it} - E[y_{it} | \mathcal{F}_{t-1}]$$