Demand Composition and the Strength of Recoveries

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Consumer theory: pent-up demand is stronger for durables.
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**Q**: What does this imply for how spending composition affects recoveries?

variation across recessions: (i) long-run shares, (ii) sectoral shock incidence
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- Multi-sector model with demand-determined output + demand shocks
- Derive *testable condition* for pent-up demand effects to be strong enough
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  a) Test condition using aggregate time series evidence
  b) Quantify effect of composition on recovery strength
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2. **Measurement & quantification**

   a) Test condition using aggregate time series evidence

   b) Quantify effect of composition on recovery strength

3. Discuss implications for **optimal monetary policy**
Theory
Model Overview

• Environment: textbook NK model + multiple sectors

  1. Representative household: consume **durables** and **services**

  2. Rest of the economy

    a) Labor-only production of intermediates, fixed rel. price of durables & services

    b) Nominal rigidities in price- & wage-setting

    c) Nominal rate set by monetary authority
Model Overview

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1. **Representative household**: consume **durables** and **services**

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• **Agg. risk**: shocks to agg. demand $b_t^c$ and sectoral demand $\{b_t^d, b_t^s\}$
Household

- Preferences

$$\mathbb{E}_0 \left[ \sum_{t=0}^{\infty} \beta^t \{ u(s_t, d_t; b_t) - v(\ell_t; b_t) \} \right]$$

where

$$u(s, d; b) = \frac{\left[ e^{b^c + b^s \tilde{\phi} s^{1-\zeta}} + e^{\alpha(b^c + b^d)} (1 - \tilde{\phi}) \zeta d^{1-\zeta} \right]^{\frac{1-\gamma}{1-\zeta}} - 1}{1 - \gamma},$$

$$v(\ell; b) = e^{\zeta_c b^c + \zeta_s b^s + \zeta_d b^d} \frac{\ell^{1+\frac{1}{\phi}}}{1 + \frac{1}{\phi}}$$

- $b^c_t$: aggregate demand shifter (uncertainty, income risk, deleveraging, ...)
  Note: $b^c_t$ has no real effects in flex-price eq’m = multi-sector notion of “agg. demand”

- $\{b^s_t, b^d_t\}$: sectoral demand shifters (preference changes, disease risk, ...)
  Note: $b^s_t = b^d_t$ acts like the common agg. demand shock $b^c_t$
Household

- **Preferences**

\[
\mathbb{E}_0 \left[ \sum_{t=0}^{\infty} \beta^t \{ u(s_t, d_t; b_t) - v(l_t; b_t) \} \right]
\]

where

\[
u(s, d; b) = \frac{e^{b_c + b_s \phi s^{1-\zeta}} + e^{\alpha(b_c + b_d)}(1 - \phi)^\zeta d^{1-\zeta}}{1 - \gamma} - 1
\]

\[
u(l; b) = e^{s_c b_c + s_s b_s + s_d b_d} \frac{l^{1+\frac{1}{\phi}}}{1 + \frac{1}{\phi}}
\]

- \( b_c \): aggregate demand shifter (uncertainty, income risk, deleveraging, …)
  
  Note: \( b_c \) has no real effects in flex-price eq’m = multi-sector notion of “agg. demand”

- \( \{ b_s, b_d \} \): sectoral demand shifters (preference changes, disease risk, …)
  
  Note: \( b_s = b_d \) acts like the common agg. demand shock \( b_c \)

- **Budget constraint**

\[
s_t + \underbrace{d_t - (1 - \delta)d_{t-1}}_{e_t} + \frac{\kappa}{2} \left( \frac{d_t}{d_{t-1}} - 1 \right)^2 d_t + a_t = w_t l_t + \frac{1 + r_{t-1}^n}{1 + \pi_t} a_{t-1} + q_t
\]
Theory

Intuition in a Special Case
• **Special case**: $\zeta = \gamma$, no adj. costs, iid shocks, fixed prices
  \[ \text{demand-determined output } \hat{y}_t = \phi \hat{s}_t + (1 - \phi) \hat{e}_t \text{ with eq’im selection } \lim_{t \to \infty} \hat{y}_t = 0 \]

  - Look at impulse responses to shocks \( \{ b_0^c, b_0^s, b_0^d \} \)
  - Focus on recovery dynamics (shape), fixing severity of recession (scale)
The Pent-Up Demand Mechanism

- **Special case**: $\zeta = \gamma$, no adj. costs, iid shocks, fixed prices

1. Durables demand shock $b_t^d$: recovery boosted by pent-up demand
The Pent-Up Demand Mechanism

• **Special case:** $\zeta = \gamma$, no adj. costs, iid shocks, fixed prices

1. Durables demand shock $b_t^d$: recovery boosted by pent-up demand

$$\hat{y}^d = \sum_{t=0}^{\infty} \frac{\hat{y}_t^d}{\hat{y}_0^d}$$

Measures weakness of the reversal of output. Stronger recovery = smaller normalized CIR
The Pent-Up Demand Mechanism

- **Special case**: $\zeta = \gamma$, no adj. costs, iid shocks, fixed prices

1. Durables demand shock $b^d_t$: recovery boosted by pent-up demand

$$\hat{y}^d = \frac{-1 + (1 - \delta)}{-1} = \delta$$
• **Special case**: $\zeta = \gamma$, no adj. costs, iid shocks, fixed prices

2. Services demand shock $b_t^s$: no pent-up demand, lost output is foregone

$$\hat{y}^s = \frac{-1 + 0}{-1} = 1$$
The Pent-Up Demand Mechanism

- **Special case:** $\zeta = \gamma$, no adj. costs, iid shocks, fixed prices

3. Aggregate demand shock $b_t^C$: hybrid case

$$\hat{y}^C = 1 - \frac{1 - \phi}{\phi(1 - \beta(1 - \delta))\delta + 1 - \phi} (1 - \delta)$$
The Pent-Up Demand Mechanism

- **Special case**: $\zeta = \gamma$, no adj. costs, iid shocks, fixed prices

4. For any $\{b^c_t, b^s_t, b^d_t\}$, let impact services share be $\omega \equiv \frac{\phi \hat{s}_0}{\phi \hat{s}_0 + (1-\phi) \hat{e}_0}$. Then:

$$\hat{y} = 1 - (1 - \omega)(1 - \delta)$$

$\implies$ the larger the services share $\omega$, the weaker the recovery
Theory

Back to the Full Model
Does this result survive in the full model?

- Setting: full model + two simplifications
  
  (i) Separable preferences over durables & services ($\gamma = \zeta$)
  
  (ii) Passive monetary policy, fixes (expected) real rate

  Equivalent to fixed prices + fixed nominal rate

Details

- Why is this useful?
  
- Result extends to HtM households, N sectors, general adj. costs, …
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- Find: not necessarily, since pent-up demand can be offset by adj. costs

**Proposition**

Let $s^c$ and $e^c$ denote the services and durables nCIRs to the aggregate demand shock $b^c_0$. Then, given $\{b^c_0, b^s_0, b^d_0\}$, $\hat{y}$ is increasing in $\omega$ if and only if

\[ s^c > e^c \]
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### Proposition

Let $s^c$ and $e^c$ denote the services and durables nCIRs to the aggregate demand shock $b_0^c$. Then, given $\{b_0^c, b_0^s, b_0^d\}$, $\hat{y}$ is increasing in $\omega$ if and only if

\[
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- Why is this useful? $s^c$ & $e^c$ are measurable objects
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- Why is this useful? $s^c$ & $e^c$ are measurable objects
- Result extends to HtM households, $N$ sectors, general adj. costs, ...
- Later: allow for $\gamma \neq \zeta$, consider other monetary rules
Measurement
Hypothesis: If spending cuts in a demand-driven recession are concentrated in services, then the recovery is hampered by weak pent-up demand.
Empirical Evidence

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- **Test**: true if and only if sectoral nCIRs satisfy

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• Ideal laboratory: monetary policy shocks

1. Equivalent to aggregate demand shocks in our model

2. Relatively standard approach to time series identification is available


Today: simple recursive VAR
Hypothesis: If spending cuts in a demand-driven recession are concentrated in services, then the recovery is hampered by weak pent-up demand.

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- **Ideal laboratory**: monetary policy shocks
  1. Equivalent to aggregate demand shocks in our model ▶️ Proposition
  2. Relatively standard approach to time series identification is available

**Today**: simple recursive VAR

- **In paper**: uncertainty & oil shocks, reduced-form shocks ▶️ Details
services nCIR is 88% larger than durables nCIR (22% for non-durables)

- Note: consistent with previous work documenting overshoot in durables
  Erceg-Levin (2006), McKay-Wieland (2020)
Quantification
Quantification

• Two main reasons to expect variation in demand composition

  1. Fixed agg. demand shock $b_t^c$, but changing long-run shares $\phi$ [in paper]

  2. Fixed shares $\phi$, but changing shock combinations $\{b_t^c, b_t^s, b_t^d\}$ [today]
Quantification

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![Graph showing contributions to Real PCE change (%) for different categories and recessions]
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**Chart:**
- 1973 (Oil crisis) U.S. recession
- Average of past U.S. recessions
- COVID-19 U.S. recession

**Question:** Can these differences matter for recovery dynamics?
Approach 1: semi-structural shift-share

- Idea: **re-weight** sectoral IRFs to monetary shock to match desired sectoral spending composition

  Th’m: with $\gamma = \zeta$ and passive MP, get true counterfactuals for shocks w/ $\rho_b = \rho_m$
Approach 1: semi-structural shift-share

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  Th’m: with $\gamma = \zeta$ and passive MP, get true counterfactuals for shocks w/ $\rho_b = \rho_m$

- nCIR for **COVID-19 shares** $\approx 70\%$ larger than w/ **avg. shares**
**Approach 2**: counterfactuals in range of fully parameterized structural models

- **Setting**: full model, explore nCIRs across parameter space

  1. **Strength of adjustment costs**
  2. **Monetary policy rule & price stickiness**
  3. **Persistence** of the demand shocks \( \{b_t^C, b_t^S, b_t^d\} \)

⇒ Robustly find the expected large nCIR differences
Policy Implications
Policy Implications

Large effects of demand composition. Implications for *optimal policy*?
Policy Implications

Large effects of demand composition. Implications for optimal policy?

1. Aggregate demand shocks $b_t^c$ with changing long-run shares
   E.g.: How should central banks behave in more services-intensive economies?
   - Optimal monetary policy is independent of services share $\phi$ ▶ Proposition
   - Intuition: transmission of both $b_t^c$ and interest rates $r_t^n$ are equally affected
Policy Implications

Large effects of demand composition. Implications for **optimal policy**?

1. Aggregate demand shocks $b^c_t$ with changing long-run shares
   E.g.: How should central banks behave in more services-intensive economies?
   - Optimal monetary policy is **independent** of services share $\phi$
   - Intuition: transmission of both $b^c_t$ and interest rates $r^n_t$ are equally affected

2. Fixed long-run shares with changing shock incidence $\{b^c_t, b^s_t, b^d_t\}$
   E.g.: How should central banks respond to services-led recessions?
   - **Ease for longer** if recession is biased towards services
Conclusions

Basic consumer theory + Demand-determined output

Demand composition matters for strength of recoveries
Conclusions

Basic consumer theory + Demand-determined output

Demand composition matters for strength of recoveries

1. Key testable implication receives strong support in U.S. time series
2. Demand composition effects can be quantitatively meaningful
3. Implications for optimal stabilization policy
   a) No obvious intertemporal trade-off: pent-up demand for shocks & policy
   b) Hike rates too fast if services recession is treated like an avg. recession
Thank you!
Model details

1. Unions

- Standard wage-setting protocol gives

\[
\hat{\pi}_w^t = \frac{(1 - \beta \phi_w)(1 - \phi_w)}{\phi_w(\frac{\varepsilon_w}{\phi} + 1)} \left[ \frac{1}{\phi} \hat{\ell}_t - \left( \hat{w}_t + \hat{\lambda}_t - (\varsigma_c b^c_t + \varsigma_s b^s_t + \varsigma_d b^d_t) \right) \right] + \beta E_t [\hat{\pi}^w_{t+1}]
\]

where \( \lambda_t \) is the marginal utility of wealth

2. Producers

- Labor-only production and nominal rigidities give price-NKPC:

\[
\hat{\pi}_t = \zeta_p \left( \hat{w}_t - \frac{y''(\ell)}{y'(\ell)} \hat{\ell}_t \right) + \beta E_t [\hat{\pi}_{t+1}]
\]

3. Policy

- Consider baseline rule

\[
\hat{r}^n_t = \phi_\pi \hat{\pi}_t
\]

- For analytical results, consider limit case \( \phi_\pi \to 1^+ \)
Recession dynamics in the full model

- The sectoral spending impulse responses satisfy

\[
\hat{s}_t = \frac{1}{\gamma}(b^c_0 + b^s_0)\rho_t, \quad \hat{e}_t = \frac{1}{\gamma}(b^c_0 + b^d_0)\frac{\theta_b}{\delta} \left( \rho_b - (1 - \delta - \theta_d)\frac{\theta_d - \rho_b}{\theta_d - \rho_b} \right)
\]

- For aggregate output we thus get

\[
\hat{y}_t = \phi\hat{s}_0\rho_t^d + (1 - \phi)\hat{e}_0 \left( \rho_b^t - (1 - \delta - \theta_d)\frac{\theta_d^t - \rho_b^t}{\theta_d^t - \rho_b^t} \right)
\]

- The CIR to a generic shock mix \(\{b^c_t, b^s_t, b^d_t\}\) thus satisfies

\[
\hat{y} = \frac{1}{1 - \rho_b} \left[ 1 - (1 - \omega)(1 - \frac{\delta}{1 - \theta_d}) \right]
\]
Extensions

• **Incomplete markets**
  
  - A fringe $\mu$ of households has the same preferences, but is hand-to-mouth
  
  - Assume their income follows
    
    $$\phi \hat{s}_t^H + (1 - \phi) \hat{e}_t^H = \eta \hat{y}_t$$
    
  $\Rightarrow$ 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
       
       $$\hat{y}_t = \phi (-\hat{z}_t^s + \hat{s}_t) + (1 - \phi) (-\hat{z}_t^d + \hat{e}_t)$$
Extensions

• N sectors
  - Household preferences over consumption bundles are now
    \[ u(d; b) = \left( \sum_{i=1}^{N} e^{\alpha_i (b^c + b^i)} \tilde{\phi}_i d_{it}^{1-\xi} \right)^{\frac{1-\gamma}{1-\xi}} - 1 \]
  - CIR satisfies
    \[ \hat{y} = \sum_{i=1}^{N} \omega_i \frac{\delta_i}{1 - \theta^i_d} = - \sum_{i=1}^{N} \omega_i e^c_i \]

• General adjustment costs
  - Consider a general specification:
    \[ \psi(\{d_{t-\ell}\}^{\infty}_{\ell=0}) \]
  - Key insight: does not affect separability of the system
Proposition

Consider the full model, extended to feature innovations $m_t$ to the central bank’s rule. The impulse responses of all real aggregates $x \in \{s, e, d, y\}$ to:

(i) a recessionary common demand shock $b_0^c < 0$ with persistence $\rho_b$

(ii) a contractionary monetary shock $m_0 = -(1 - \rho_b)\varsigma_c b_0^c$ with persistence $\rho_m = \rho_b$

are identical:

$$\hat{x}_t^c = \hat{x}_t^m$$
Other empirical tests: uncertainty

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

- Find: V- vs. Z-shape as for monetary policy
Other empirical tests

• **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
More sectoral impulse responses
Consider the baseline model with $\gamma = \zeta$ and a passive monetary rule. Let $\hat{s}_t^m$ and $\hat{e}_t^m$ denote impulse responses to a monetary shock. Then:

1. In an alternative economy with services share $\phi'$, the response of output to a common demand shock $b_0^c$ with persistence $\rho_b = \rho_m$ and $\hat{y}_0 = -1$ is

$$\hat{y}_t = - \left[ \frac{\phi'}{\phi' \hat{s}_0^m + (1 - \phi') \hat{e}_0^m} \hat{s}_t^m + \frac{1 - \phi'}{\phi' \hat{s}_0^m + (1 - \phi') \hat{e}_0^m} \hat{e}_t^m \right]$$

2. The response of output to a combination of shocks $\{b_0^c, b_0^s, b_0^d\}$ with persistence $\rho_m$ and s.t. $\{\hat{y}_0 = -1, \phi \hat{s}_0 = -\omega, (1 - \phi) \hat{e}_0 = -(1 - \omega)\}$ is

$$\hat{y}_t = - \left[ \omega \frac{\hat{s}_t^m}{\hat{s}_0^m} + (1 - \omega) \frac{\hat{e}_t^m}{\hat{e}_0^m} \right]$$
Details on structural counterfactuals

• Baseline calibration:

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• We then compare CIRs for $\{b_0^c, b_0^s, b_0^d\}$ with shares as in:

(i) COVID-19 recession

(ii) average post-war recession
Structural model results

- **COVID-19** vs. **avg. recession** nCIR ratio:
Structural model results

- Same counterfactual as a function of $\rho_b$ and $\phi_\pi$:
• The Wicksellian equilibrium rate of interest is

\[ \hat{r}_t = (1 - \rho_b) b^c_t \]

• Can be replicated by setting

\[ \hat{r}^n_t = (1 - \rho_b) b^c_t \]
Policy with sectoral shocks

• The Wicksellian eq’m rate for two sectoral shocks satisfies

\[ \hat{r}_t(b_0^s) = -\rho_b^t - \zeta_s \sum_{q=0}^{t-1} \rho_b^{t-q} \vartheta^q, \quad \hat{r}_t(b_0^d) = -\rho_b^t + \zeta_d \sum_{q=0}^{t-1} \rho_b^{t-q} \vartheta^q \]

where \( \{\zeta_s, \zeta_d, \varphi\} \) are all strictly positive

• Graphical illustration:
Discount factor shocks: Covid-19 v. Average CIR

Conventional discount factor shocks instead of our agg. demand shock:
Recovery strength across U.S. states

Normalized CIR 12 months following state-specific trough in terms of employment

Normalized CIR is measured as the cumulated percent change in employment from peak divided by the percent change in employment from peak to trough. Observations where the normalized CIR was below 20 were dropped.