MACROECONOMIC IMPLICATIONS OF COVID-19: CAN NEGATIVE SUPPLY SHOCKS CAUSE DEMAND SHORTAGES?

GUERRIERI + LORENZONI + STRAUB + WERNING

(BOOTH)  (NWU)  (HARVARD)  (MIT)
OUR QUESTION...
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- Say’s Law (misquoted!)
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“Supply creates its own Demand”
OUR QUESTION...

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- Today...
OUR QUESTION...

▸ Say’s Law (misquoted!)

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Can negative supply shock create a demand shortage?
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  Can negative supply shock create a demand shortage?

- Pandemic, debate over...
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- Pandemic, debate over...
  - Supply vs Demand shock?
  - Monetary Policy Easing + Fiscal Stimulus?
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  Can negative supply shock create a demand shortage?

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**Goal: simple theory for insights**
**+ policy implications**
## RESULTS: EXCESS DEMAND FROM SUPPLY SHOCK?

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# Results: Excess Demand from Supply Shock?

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INTUITIONS

- **Single Sector (Representative Agent)**
  - Negative supply shock = Positive news (relative to today!)

- **Single sector + Incomplete Markets**
  - Incomplete markets helps...
  - ... but in extreme case, workers that lose income stop consuming...
  - ... workers in unaffected sector consume same as before at same interest rate
INTUITIONS

- **Multisector...**
  - 50% drop for everyone ≠ 100% for half sectors (Nick Rowe)
  - Poor substitution across sectors (e.g. food at home and durables or entertainment)

- **Multisector + Incomplete Markets**
  - Incomplete markets further helps case
Fiscal Policy
- may be less effective per dollar spent
- but may still be optimal!

Going Deeper...
- mobility + supply chains
- business exit (restaurants $\rightarrow$ clothing stores)
- labor hoarding vs. job-match destruction perfect insurance
DEMAND VS SUPPLY

- Demand vs. Supply terminology...
  - not always clear, meanings differ...
  - ...supply shock lowers demand, but... 
    ...more than supply? excess demand?
- Taste shock = Supply shock 
  both give drop buyer/seller gains from trade...
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Taste shock = Supply shock
both give drop buyer/seller gains from trade...

Today: Demand deficiency...
- natural (flex price) interest rate (full employment) falls
- holding fixed interest rate: recession
SINGLE SECTOR

TAKE #1

COMPLETE MARKETS
**SINGLE SECTOR**

**TAKE #1**

**COMPLETE MARKETS**

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Preferences

\[ \sum_{t=0}^{\infty} \beta^t U(c_t) \]

Fixed endowment of labor (supplied inelastically) \( \bar{n} \)

Technology

\[ Y_t = N_t \]
SUPPLY SHOCK

- MIT shock...
  - $t=0$ temporary reduction labor supply (e.g. shutdown)
    \[ \bar{n} \rightarrow (1 - \phi)\bar{n} \]
  - $t=1,2,3..$ back to normal, flexible price allocation

- Flexible price equilibrium (natural) interest rate...
  \[ 1 + r_0 = \frac{1}{\beta} \frac{U'((1 - \phi)\bar{n})}{U'(\bar{n})} > \frac{1}{\beta} \]

- ... equilibrium with fixed interest rate (e.g. ZLB)
  \[ U'(c_0) = \beta \frac{1}{\beta} U'(\bar{n}) \]
SUPPLY SHOCK

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- Flexible price equilibrium (natural) interest rate...
  \[ 1 + r_0 = \frac{1}{\beta} \frac{U'((1 - \phi)\bar{n})}{U'(\bar{n})} \geq \frac{1}{\beta} \quad \text{interest rate rises} \]
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  \[ U'(c_0) = \beta \frac{1}{\beta} U'(\bar{n}) \]
  excess demand
**Proposition.** Single-sector + Complete Markets

- Negative Supply Shock
- Rise natural rate
- Increase excess demand

- Intuition...
  - negative supply shock = good news shock
  - agents want to borrow, not save
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**Up Next: Can Incomplete Markets Save Us?**
SINGLE SECTOR

TAKE #2

INCOMPLETE MARKETS
## Single Sector

### Take #2

### Incomplete Markets

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INCOMPLETE MARKETS

- **Budget constraints**
  \[ c_{it} + a_{it} \leq w_t n_{it} + (1 + r_{t-1}) a_{it-1} \]

- **Fraction \( \mu \) face borrowing constraint (results generalize)**
  \[ a_{it} \geq 0 \]

- **Euler for unaffected + unconstrained**
  \[ U' (c_{i0}) = \beta (1 + r_0) U' (c_{i1}) \]

- **Market clearing**
INCOMPLETE MARKETS

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- **Market clearing**
  \[ c_1 + \mu \phi \bar{n} = \bar{n} \]
  \[ c_0 = (1 - \phi) \bar{n} \]
INCOMPLETE MARKETS

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  $$c_{1} + \mu \phi \bar{n} = \bar{n}$$
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\[
1 + r_{0}^* = \frac{1}{\beta} \frac{U'((1 - \phi) \bar{n})}{U'((1 - \mu \phi) \bar{n})} \geq \frac{1}{\beta}
\]

Natural rate rises!
Proposition. Single-sector + Incomplete Markets

Negative Supply Shock → Rise natural rate + Increase excess demand
Again... why?...

- negative supply shock = good news shock
- agents want to borrow, not save
- at best if they can’t they consume zero...
- same as dropping out which is neutral
Incomplete Markets

Proposition. Single-sector + Incomplete Markets

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- Rise natural rate
- Increase excess demand

Again... why?...

- Negative supply shock = good news shock
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- At best if they can’t, they consume zero...
- Same as dropping out which is neutral

Lose a producer, lose a consumer... it’s a wash!  `(ツ)_/"
MULTIPLE SECTORS

TAKE #1

COMPLETE MARKETS
MULTIPLE SECTORS

TAKE #1

COMPLETE MARKETS

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Multiple Sectors

?
\[ \sum_{t=0}^{\infty} \beta^t U(c_{1t}, c_{2t}) \]

\[ U(c_{1t}, c_{2t}) = \frac{1}{1 - \sigma} \left( \phi^\rho c_{1t}^{1-\rho} + (1 - \phi)^\rho c_{2t}^{1-\rho} \right)^{\frac{1-\sigma}{1-\rho}} \]

\[ Y_{jt} = N_{jt} \]
\[
\sum_{t=0}^{\infty} \beta^t U \left( c_{1t}, c_{2t} \right) = \frac{1}{1 - \sigma} \left( \phi^\rho c_{1t}^{1-\rho} + (1 - \phi)^\rho c_{2t}^{1-\rho} \right)^{\frac{1-\sigma}{1-\rho}}
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\[Y_{jt} = N_{jt}\]

\[c_1^* = Y_1^* = \phi \bar{n}\]

\[c_2^* = Y_2^* = (1 - \phi) \bar{n}\]

\[p^* = 1\]

**Steady State**
$\sum_{t=0}^{\infty} \beta^t U(c_{1t}, c_{2t})$

$U(c_{1t}, c_{2t}) = \frac{1}{1 - \sigma} \left( \phi^\rho c_{1t}^{1-\rho} + (1 - \phi)^\rho c_{2t}^{1-\rho} \right)^{\frac{1-\sigma}{1-\rho}}$

$Y_{jt} = N_{jt}$

$c_1^* = Y_1^* = \phi \bar{n}$

$c_2^* = Y_2^* = (1 - \phi) \bar{n}$

$p^* = 1$

Steady State

Asymmetric MIT shock
MULTIPLE SECTORS

\[ 1 + r_t \equiv (1 + i_t) \frac{P_{2t}}{P_{2t+1}} \]

Real Interest Rate (for good 2)
MULTIPLE SECTORS

\[ 1 + r_t \equiv (1 + i_t) \frac{P_{2t}}{P_{2t+1}} \]

Real Interest Rate (for good 2)

\[ U_{c_2}(c_{1t}, c_{2t}) = \beta(1 + r_t)U_{c_2}(c_{1t+1}, c_{2t+1}) \]
MULTIPLE SECTORS

\[ 1 + r_t \equiv (1 + i_t) \frac{P_{2t}}{P_{2t+1}} \quad \text{Real Interest Rate (for good 2)} \]

\[ U_{c_2}(c_{1t}, c_{2t}) = \beta (1 + r_t) U_{c_2}(c_{1t+1}, c_{2t+1}) \]

\[ 1 + r_0 = \frac{1}{\beta} \frac{U_{c_2}(0, c^*_2)}{U_{c_2}(c^*_1, c^*_2)} \quad \text{Natural rate after shock} \]
1 + r_t \equiv (1 + i_t) \frac{P_{2t}}{P_{2t+1}}

U_{c_2}(c_{1t}, c_{2t}) = \beta (1 + r_t) U_{c_2}(c_{1t+1}, c_{2t+1})

1 + r_0 = \frac{1}{\beta} \frac{U_{c_2}(0, c^*_2)}{U_{c_2}(c^*_1, c^*_2)}

(1 - \phi)^{\frac{\rho - \sigma}{1 - \rho}} < 1
Proposition.  Multiple Sectors + Complete Markets

Negative Supply Shock

Lower natural rate
+ deficient excess demand

\[
\frac{1}{\sigma} > \frac{1}{\rho}
\]

Keynesian supply shocks

Standard supply shocks
MULTIPLE SECTORS

TAKE #2

INCOMPLETE MARKETS
## Multiple Sectors

### Take #2

### Incomplete Markets

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MULTIPLE SECTORS + INCOMPLETE MARKETS

\[ 1 + r_0 = \frac{1}{\beta} \frac{U_{c_2}(0, c_{20})}{U_{c_2}(c_{11}, c_{21})} \]

\[ c_{20} = (1 - \phi)\bar{n} \]

\[ c_{11} = \phi (1 - \phi \mu) \bar{n}, \quad c_{21} = (1 - \phi) (1 - \phi \mu) \bar{n}. \]

Unconstrained agents

\[ 1 + r_0 = \frac{1}{\beta} (1 - \phi) \frac{p - \sigma}{1 - \rho} (1 - \phi \mu)^\sigma \]
MULTIPLE SECTORS + INCOMPLETE MARKETS

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\[ 1 + r_0 = \frac{1}{\beta} (1 - \phi)^{\frac{\rho - \sigma}{1 - \rho}} (1 - \phi \mu)^{\sigma} \]

Proposition. Multiple Sectors + Incomplete Markets

Negative Supply Shock

Lower natural rate +

deficient excess demand

\[ \sigma^{-1} > \frac{1 - \mu}{1 - \phi \mu} \cdot \rho^{-1} + \frac{\mu(1 - \phi)}{1 - \phi \mu} \]
MULTIPLE SECTORS + INCOMPLETE MARKETS

complete markets
MULTIPLE SECTORS + INCOMPLETE MARKETS

complete markets

Incomplete Markets
MULTIPLE SECTORS + INCOMPLETE MARKETS

**NOTE**: No “Paradox of Toil”
Output gap in non-shocked sector

\[ \phi = 0.75 \]

\[ \phi = 0.6 \]

\[ \phi = 0.4 \]

\[ \phi = 0.2 \]

**bust** with incomplete markets

worse with larger \( \phi \)

**boom** if \( 1/\rho > 1/\sigma \)

stronger with larger \( \phi \)

Market incompleteness \( \mu \)
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\[ G_t + T_{1t} + T_{2t} = 0 \]
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- Government spending $G$
- UI Transfers: from 1 to 2
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- Government spending \( G \)
- UI Transfers: from 1 to 2

**Proposition.** Multiple Sectors + Incomplete Markets

\[
\frac{n_{20}}{n} = \frac{G_0}{n} + \mu \frac{T_1}{n} + (1 - \phi \mu) (1 - \phi) \frac{1}{\sigma} \frac{\rho - \sigma}{1 - \rho}
\]
FISCAL POLICY

\[ G_t + T_{1t} + T_{2t} = 0 \]

- Government spending \( G \)
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**Proposition.** Multiple Sectors + Incomplete Markets

\[ \frac{n_{20}}{n} = \frac{G_0}{n} + \mu \frac{T_1}{n} + (1 - \phi \mu) (1 - \phi) \frac{1}{\sigma} \frac{\rho - \sigma}{1 - \rho} \]

- \( G \) multiplier = 1
- \( T \) multiplier = Avg MPC
- No 2nd round Keynesian Cross operating!
Figure 1: How negative supply shocks can lead to demand shortages
— Case with equal inter- and intra-temporal elasticities —

(a) Before the shock

sector 1

sector 2

sector 1 workers

sector 2 workers

income

income
Figure 1: How negative supply shocks can lead to demand shortages
— Case with equal inter- and intra-temporal elasticities —

(a) Before the shock

(b) Representative agent

sector 1

sector 2

sector 1

sector 2

sector 1

sector 2

sector 1

sector 2

workers

workers

shocked

unaffected

income

income

income
Figure 1: How negative supply shocks can lead to demand shortages
— Case with equal inter- and intra-temporal elasticities —

(a) Before the shock

(b) Representative agent

(c) Incomplete markets

sector 1

sector 1
shocked

sector 2

sector 2
unaffected

sector 1

sector 1
shocked

sector 2

sector 2
bust

workers

workers

workers

workers
MOBILITY + DEMAND CHAINS
Suppose a fraction $\alpha$ of workers can move sectors.
Complete markets

\[
\bar{n} - (1 - \phi)\bar{n}
\]

Excess employment losses

Complete market equilibrium
Excess employment losses

\[ (1 - \phi)\bar{n} \]

\( \bar{n} \)

incomplete market equilibrium

1

\( \alpha \)
Excess employment losses rises or falls with $\alpha$?
ENDOGENOUS BUSINESS ACTIVITY

- From 2 sectors to continuum of varieties

\[ C_t = \left( \int c_{jt}^{1-\rho} \, dj \right)^{1/(1-\rho)} \]

- Monopolistic competition generates profits

\[ \Pi_{jt} = \rho N_{jt} \]

- Each variety produced by separate representative worker who also own that variety

- Key: businesses only active when

\[ \Pi_{jt} > v_{jt} \sim \Upsilon(v) \]

Random fixed cost
Chosen so that all firms are active in steady state
DEMAND AND BUSINESS EXIT

- Shock as before: Shut down mass $\phi$ of businesses
- Mass $\phi_0$ of inactive businesses = endogenous
- Two equilibrium conditions
  - Demand for labor in active sectors
    $\frac{N_0}{\bar{n}} = (1 - \phi_0) \frac{\rho}{\sigma} \frac{1 - \sigma}{1 - \rho}$
  - Assume incomplete markets
  - Keynesian supply shock regime
  - Supply of active sectors
    $1 - \phi_0 = (1 - \phi) \Upsilon(\rho N_0)$
DEMAND AND BUSINESS EXIT CASCADES
DEMAND AND BUSINESS EXIT CASCADES

The graph illustrates the relationship between demand and firm exit in a market. The x-axis represents $1 - \phi_0$, and the y-axis represents $N^e_{\mathbb{R}}$. The blue dashed line denotes the demand locus, the red line represents the equilibrium, and the blue dot line indicates the firm exit locus. The graph shows how demand and business exit interact in various market conditions.
BUSINESS EXIT MULTIPLIER

- Simple functional form

\[ \Upsilon(\nu) = \left( \frac{\nu}{\rho n} \right)^\eta \]

- \( \eta \) = elasticity of business exit to demand

\[ \log \frac{N_0}{\bar{n}} = \frac{1}{1 - \eta \frac{\sigma^{-1} - 1}{\rho^{-1} - 1}} \left( \frac{\sigma^{-1} - 1}{\rho^{-1} - 1} \right) \log(1 - \phi) \]

firm exit multiplier
**POLICY IMPLICATION: SUBSIDIZING LABOR**

- Imagine we subsidize wage bill with some $\tau > 0$
  - e.g. employer-side payroll tax cut

- Result:
  
  $\log \frac{N_0}{\bar{n}} = \frac{1}{1 - \eta \frac{\sigma^{-1} - 1}{\rho^{-1} - 1}} \frac{\sigma^{-1} - 1}{\rho^{-1} - 1} (\log(1 - \phi) + \eta \log(1 + \tau))$

Amplified effect due to business exit multiplier

- Can get similar result for monetary policy:
  - lower rates keep businesses in business
  - “business exit channel”

Helps businesses stay afloat!
LABOR HOARDING
VS
JOB WORKER
MATCH DESTRUCTION
$V_0 = \max\{-w + \frac{1}{R} V_1, 0\}$
LABOR HOARDING TO PRESERVE JOB MATCHES

\[ V_0 = \max\{ -w + \frac{1}{R} V_1, 0 \} \]

\[-w + \frac{1}{R} V_1 < 0\]
LABOR HOARDING TO PRESERVE JOB MATCHES

\[ V_0 = \max\{-w + \frac{1}{R} V_1, 0\} \]

\[-w + \frac{1}{R} V_1 < 0 \quad \text{Destroy Matches} \]
LABOR HOARDING TO PRESERVE JOB MATCHES

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\(-w + \frac{1}{R} V_1 < 0 \quad \text{Destroy Matches} \)

\(-w + \frac{1}{R} V_1 \geq 0 \)
LABOR HOARDING TO PRESERVE JOB MATCHES

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\(-w + \frac{1}{R} V_1 < 0\) \quad \text{Destroy Matches}

\(-w + \frac{1}{R} V_1 \geq 0\) \quad \text{Labor Hoarding}
\[ V_0 = \max\{-w + \frac{1}{R} V_1, 0\} \]

\(-w + \frac{1}{R} V_1 < 0 \quad \rightarrow \quad \text{Destroy Matches}\)

\(-w + \frac{1}{R} V_1 \geq 0 \quad \rightarrow \quad \text{Labor Hoarding}\)

\[ \text{Perfect Insurance!} \]
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\[ \frac{1}{\beta} \quad \text{Perfect Insurance!} \]
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OPTIMAL POLICY

HEALTH + MACRO
OPTIMAL POLICY

- Add public health dimension
  \[ \sum_{t=0}^{\infty} \beta^t \left( U(c_{1t}, c_{2t}) + h_t \right) \]

- Health depends on private behavior and on aggregates (externality)
  \[ h_t = H(c_{1t}, n_{1t}, Y_{1t}, \xi_t) \]

- Three sources of inefficiency...
  - health externality (as in Eichenbaum-Rebelo-Trabandt)
  - lack of insurance
  - involuntary unemployment
PUBLIC HEALTH AND MACRO POLICIES

- Start with no public health policy...
  - Private decisions to limit consumption in sector 1
  - consumption dominates labor: involuntary unemployment!

- **Remark 1**: Unemployment may not be socially inefficient! (reduce labor further)

- Keynesian Wedge vs. Pigouvian Externality $HY_1$

- **Remark 2 (complementarity)**: Shutdown of sector 1 optimal, but can cause KSS, so we need to lower $r_0$

- **Remark 3 (optimal policy)**: With incomplete markets targeted transfers hit three birds with one stone
  - Provides insurance
  - Raises natural rate (important if at ZLB): may not need to raise $r_0$
  - Makes public health policy more desirable
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THREE WAY COMPLEMENTARITY!
## CONCLUSIONS

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<th>Complete Markets</th>
<th>Incomplete Markets</th>
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<td><strong>Single Sector</strong></td>
<td><strong>NO (Standard)</strong></td>
<td><strong>NO! (New)</strong></td>
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<td><strong>Multiple Sectors</strong></td>
<td><strong>POSSIBLE</strong></td>
<td><strong>EVEN MORE POSSIBLE</strong></td>
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Thank You!
EXTRA SLIDES
ABSTRACT FROM UNCERTAINTY . . .

- Uncertainty: well understood, clear mechanism, potential relevant and complement to what we do...

- But, pandemic + lockdown...
  - relatively front-loaded shock
  - uncertainty endogenous?
  - uncertainty on duration: not deliver recessionary effects
  - some uncertainty increases demand: toilet paper

- If story is uncertainty or future dip, then after we bottom out: recovery should be swift
Demand vs. Supply termsology...

- not always clear, meanings differ...
- supply shock lowers demand, but...
  ...more than supply? excess demand?

Taste shock = Supply shock ≠ Demand shock both give drop buyer/seller gains from trade...

Today: Demand deficiency...

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