Supply and Demand in Disaggregated Keynesian Economies with an Application to the Covid-19 Crisis

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Question

- Covid-19 unusual aggregate shock.
- Mix of heterogenous supply and demand shocks.
- Coexistence of tight and slack markets.
- Output, unemployment, inflation? Policy?

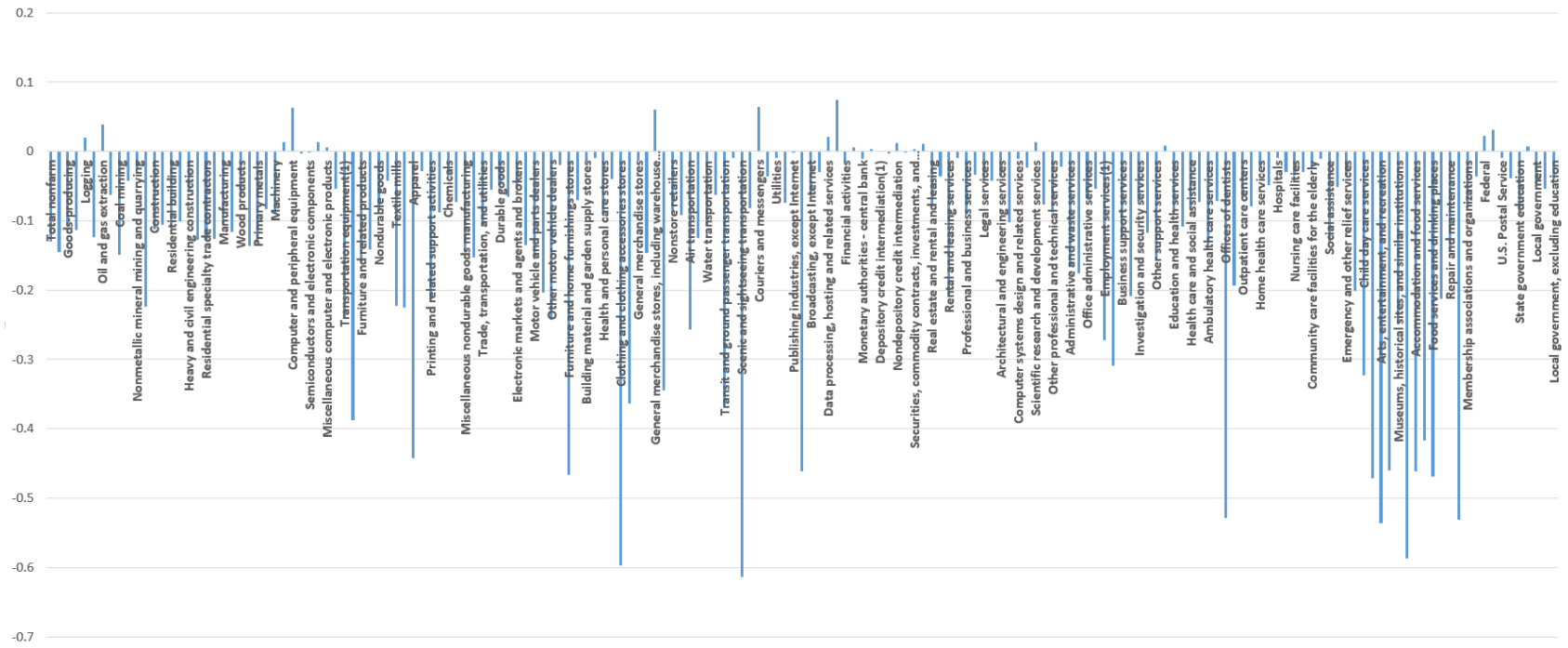
Paper

- Use general disaggregated model and aggregate up.
- Multiple sectors and factors, input-output linkages, elasticities.
- Nominal rigidities, ZLB, credit constraints, firm failures...
- Theoretical and quantitative results.

Agenda

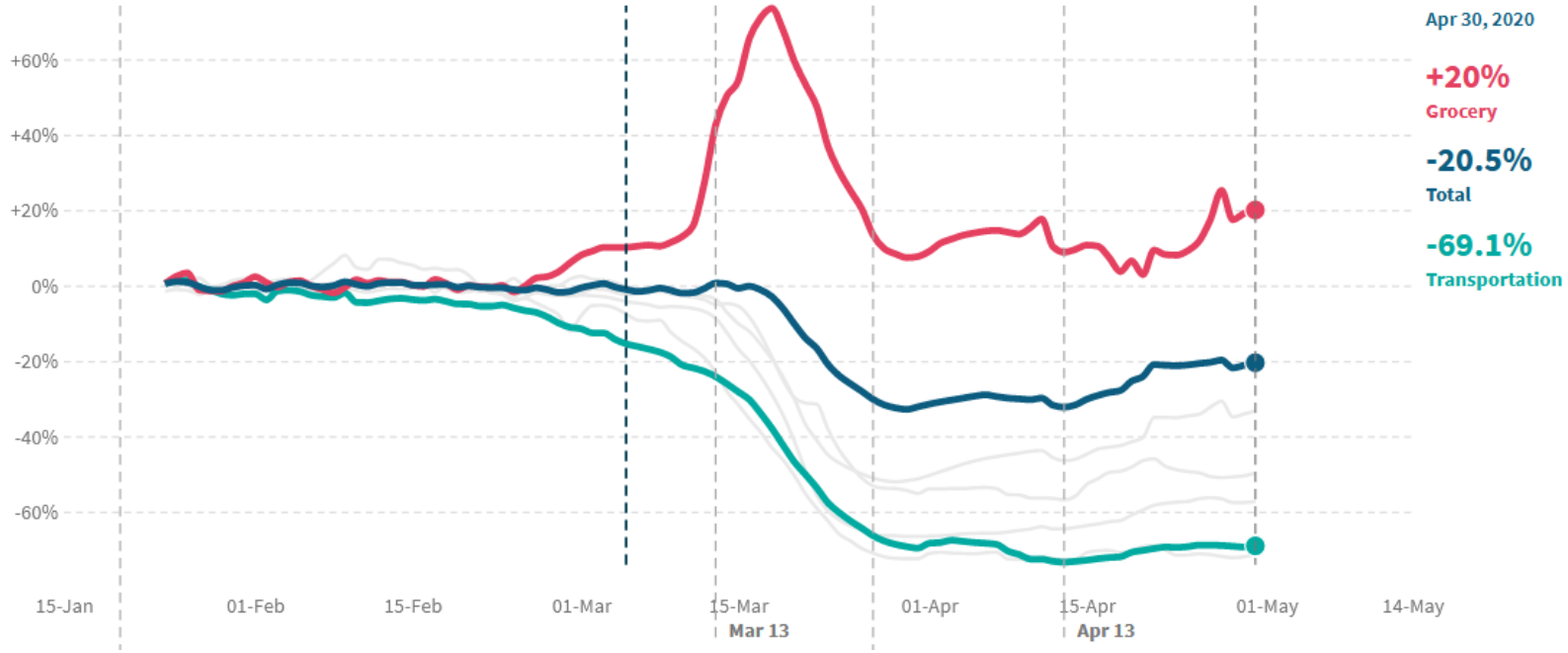
- Some Data Facts
- Model Setup
- Local Comparative Statics
- Global Comparative Statics
- Quantitative Illustration
- Additional Results
- Conclusion

Hours Worked



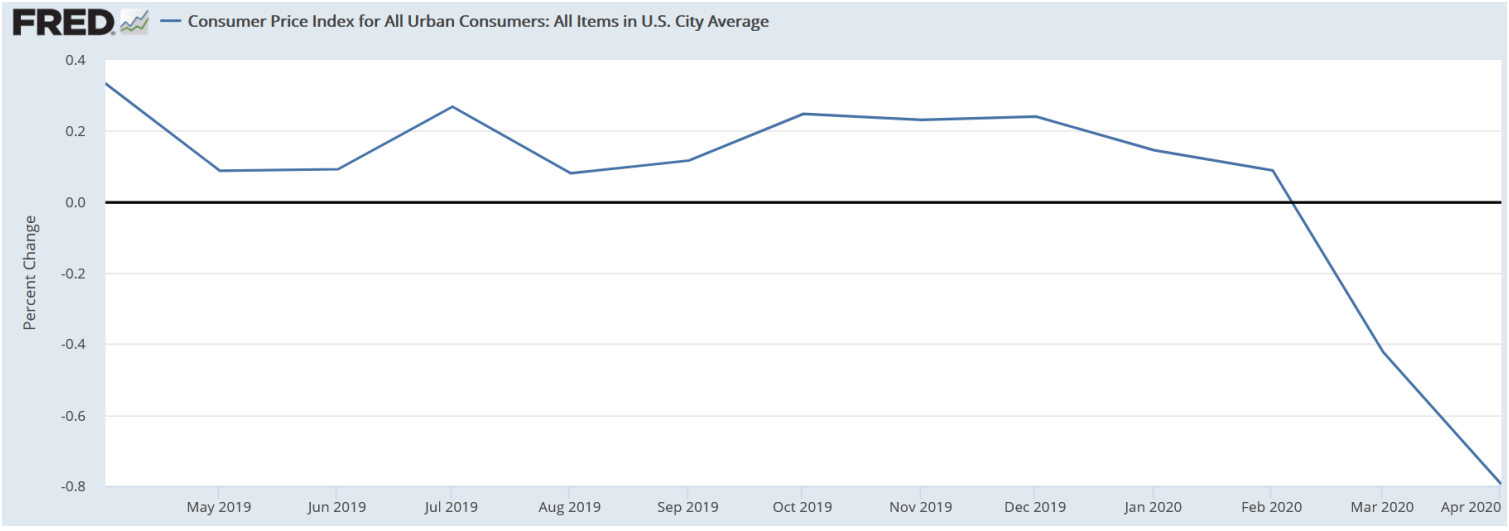
Hours worked by sector

Nominal Spending

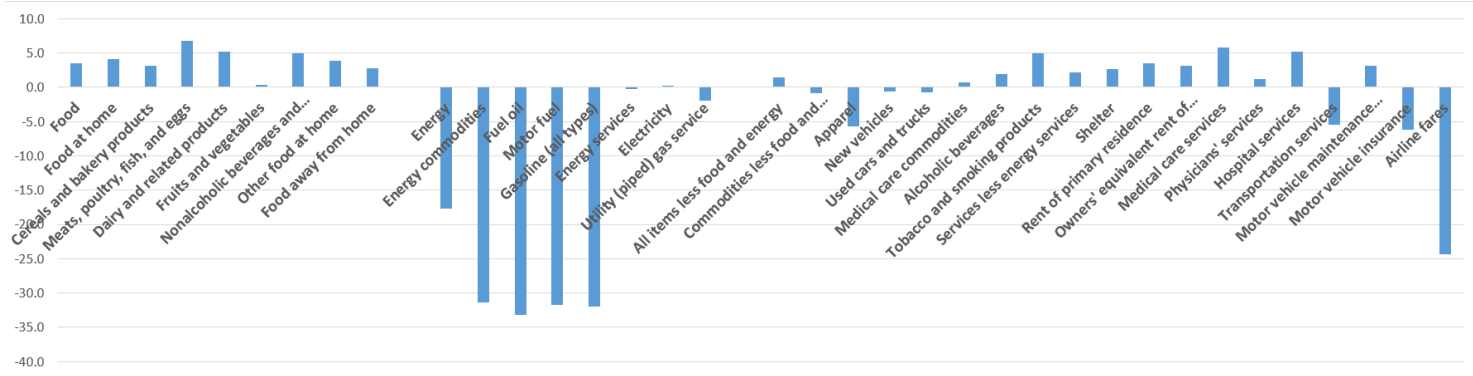


Aggregate and sectoral nominal spending

Inflation



(a) CPI inflation



(b) Prices by sector

Agenda

Proceed in Two Steps

- Start with neoclassical model.
- Then introduce Keynesian features: nominal rigidities and ZLB.

Neoclassical Model Structure

- $\mathscr{N}$ produced goods.
- $\mathscr{G}$ factors in inelastic supply.
- Homothetic final demand.
- Goods produced using other goods and factors.

Final Demand

- Final demand maximizes homothetic aggregator:

$$\mathscr{D}\left(c_1,\ldots,c_{\mathscr{N}};\omega_{\mathscr{D}}\right).$$

- Budget constraint:

$$\sum_{i\in\mathscr{N}} p_i c_i = \sum_{f\in\mathscr{G}} w_f \bar{L}_f + \sum_{i\in\mathscr{N}} \pi_i.$$

- Inelastic factor supplies $\bar{L}_f$.

Production

- Good i produced under constant returns:

$$y_i = A_i F_i \left(x_{i1}, \ldots, x_{i\mathcal{N}}, L_{i1}, \ldots, L_{i\mathcal{G}} \right).$$

- Producer i maximizes profits:

$$\pi_i = \max_{\{y_i\},\{x_{ij}\},\{L_{if}\}} p_i y_i - \sum_{j \in \mathcal{N}} p_j x_{ij} - \sum_{f \in \mathcal{G}} w_f L_{if}.$$

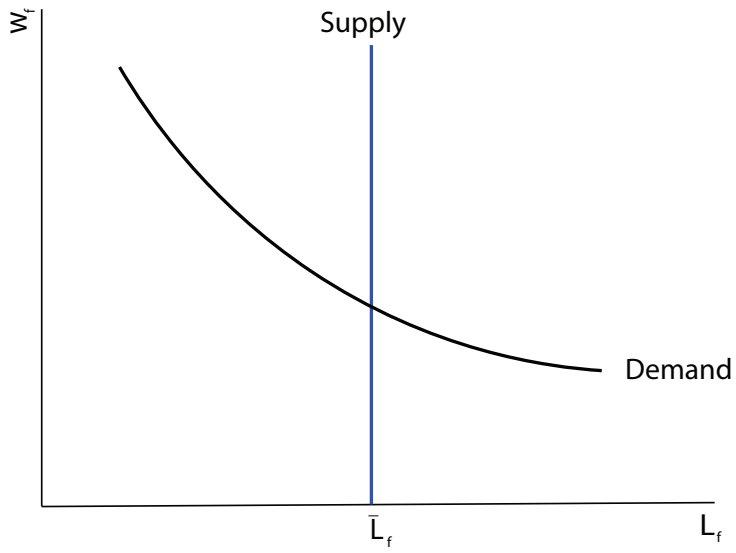
Neoclassical Equilibrium

- Agents optimize.
- Markets clear.

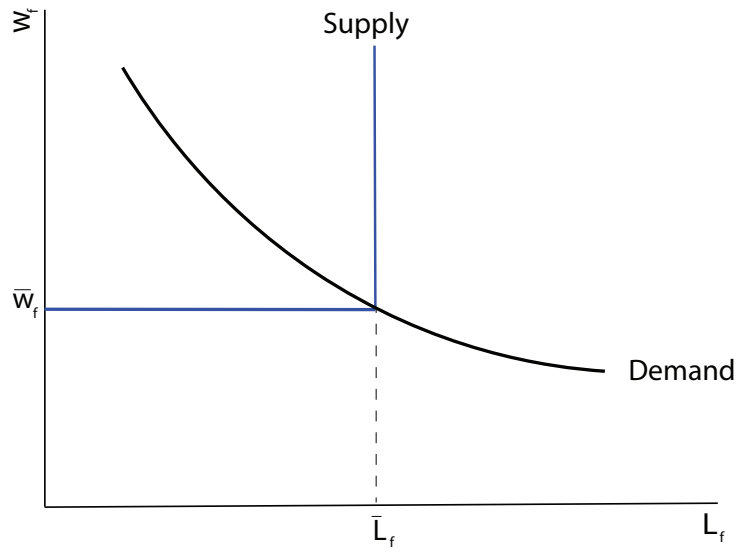
Keynesian Model

- Two periods: present and future.
- Utility maximization s.t. intertemporal budget constraint.
- Present: same as before $+$ downward nominal wage rigidity.
- Future: full employment $+$ fixed nominal expenditure.
- Monetary policy: full employment s.t. ZLB.

Equilibrium in Factor Markets



(a) Factors in $\mathscr{K}$



(b) Factors in $\mathscr{L}$

- "Capitals" $f \in \mathscr{K}$: always flexible.
- "Labors" $f \in \mathscr{L}$: flexible ($f \in \mathscr{F}$) or rigid ($f \in \mathscr{R}$) in equilibrium.

Comparative Statics

- Perturb initial equilibrium with shocks:
  - supply shocks A_i and $\bar{L}_f$;
  - demand shocks $\omega_{\mathscr{D}}$ and ζ.
- Local and global comparative statics.

Agenda

Intertemporal Euler Equations

- Log-linearized Euler equation:

$$d\log Y = -\rho d\log p^Y + d\log \zeta.$$

- Aggregate demand (AD) shock:

$$d\log \zeta = -\rho\left(d\log(1+i) + d\log\beta - d\log \bar{p}_*^Y\right) + d\log \bar{Y}_*.$$

- Negative shocks to labor supplies and shocks to composition of demand reduce output and increase prices (stagflationary).

- Negative AD shock reduce output and prices (deflationary).

Intertemporal Euler Equations

- Euler equation for aggregate nominal expenditure $E = p^Y Y$:

$$d\log E = (1-\rho)d\log p^Y + d\log \zeta.$$

- Focus on $\rho = 1$ nominal expenditure exogenous:

$$d\log E = d\log \zeta.$$

Intratemporal Aggregation Equation

- Changes in output are given by

$$d\log Y = \underbrace{\sum_{i\in\mathcal{N}} \lambda_i d\log A_i + \sum_{f\in\mathcal{G}} \lambda_f d\log \bar{L}_f}_{\text{potential output}} + \underbrace{\sum_{f\in\mathcal{L}} \lambda_f \min\left\{d\log\lambda_f + d\log E - d\log\bar{L}_f, 0\right\}}_{\text{output gap}}.$$

- Changes in factor *supplied* are given by

$$d\log L_f = \begin{cases} d\log\bar{L}_f, & \text{for} \quad f\in\mathcal{K}, \\ \min\left\{d\log\lambda_f + d\log E, d\log\bar{L}_f\right\}, & \text{for} \quad f\in\mathcal{L}. \end{cases}$$

Intratemporal Propagation Equations

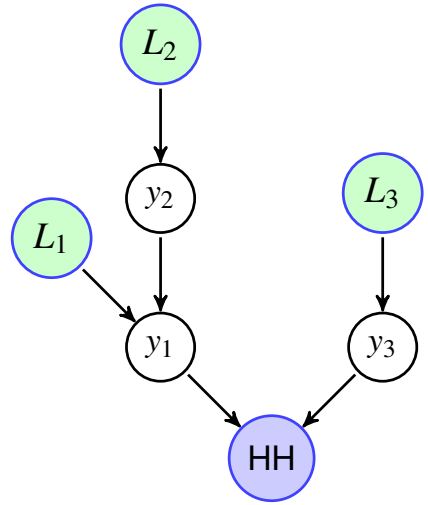
- Changes in sales and factor shares are given by

$$d\log\lambda_k = \theta_0 Cov_{\Omega^{(0)}}\left(d\log\omega_0, \frac{\Psi_{(k)}}{\lambda_k}\right) + \sum_{j\in 1+\mathcal{N}} \lambda_j(\theta_j - 1) Cov_{\Omega^{(j)}}\left(\sum_{i\in\mathcal{N}} \Psi_{(i)} d\log A_i - \sum_{f\in\mathcal{G}} \Psi_{(f)}\left(d\log\lambda_f - d\log L_f\right), \frac{\Psi_{(k)}}{\lambda_k}\right).$$

- Role of network (Ω,Ψ) and elasticities (θ_j).

Agenda

Benchmark with Simple Network Sufficient Statistics



- Assume uniform elasticities ($\theta_j = \theta$), unitary IES ($\rho = 1$).
- Assume only factor-supply shocks and AD shocks.
- Initial factor shares global sufficient statistics for network!
- Break (see paper): non-uniform elasticities or other shocks.

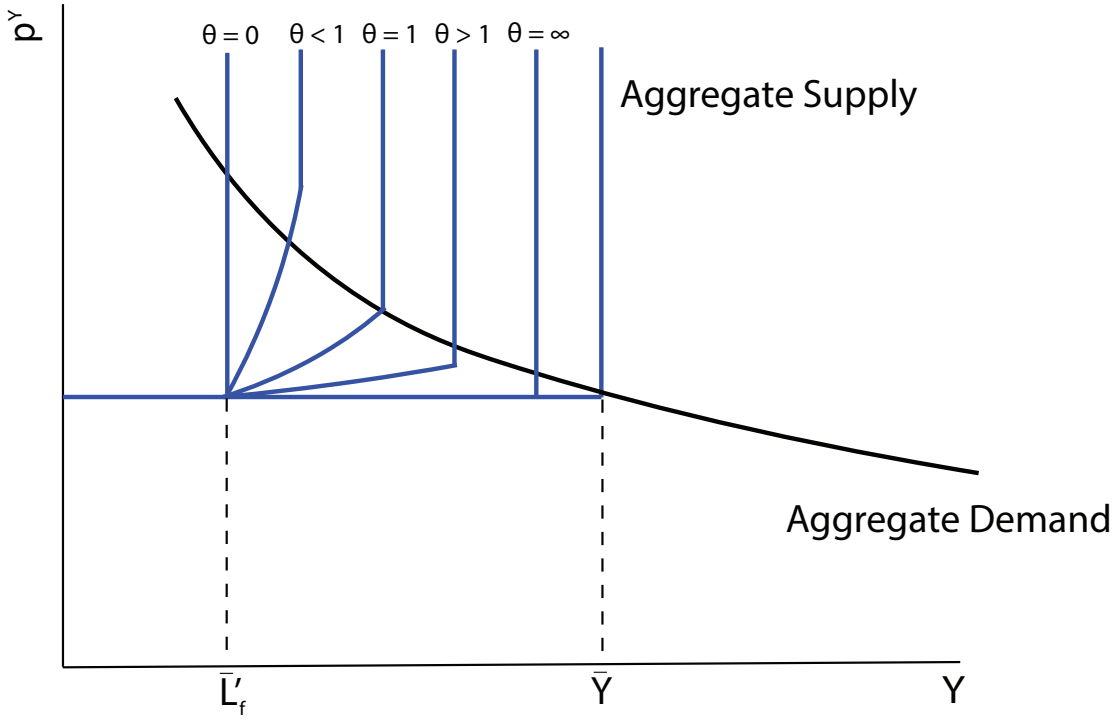
Complements vs. Substitutes

- Assume only factor-supply shocks (generalizes to AD shocks).
- With substitutes ($\theta > 1$):
  - reduction in labor supplied *increases* demand for other labors;
  - no Keynesian unemployment.
- With complements ($\theta < 1$):
  - reduction in labor supplied *reduces* demand for other labors;
  - Keynesian unemployment (factors with smallest supply shocks).

Global Comparative Statics with Complements ($\theta < 1$)

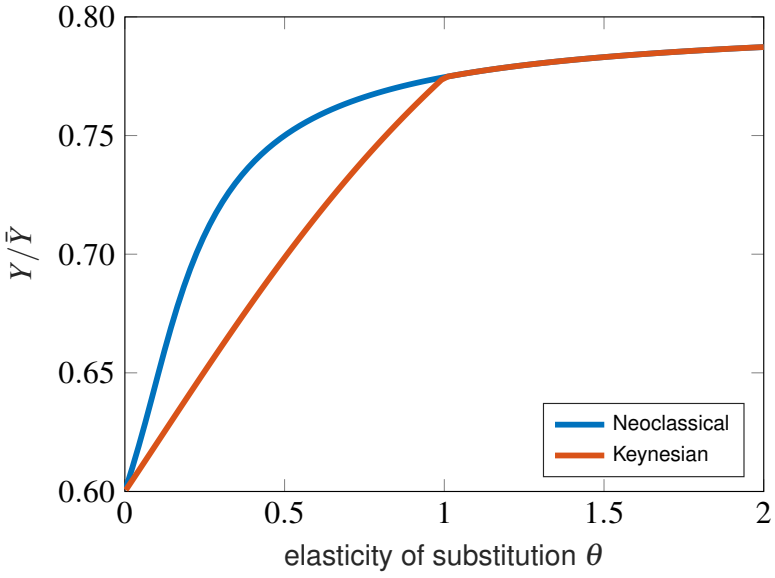
- Set of equilibrium vectors $\Delta \log L$ is *lattice* (with $\leq$).
- Unique best and worst equilibrium.
- $\Delta \log Y$ and $\Delta \log L$ increasing in $\Delta \log \bar{L}$ and $\Delta \log \zeta$.
- $\Delta \log p^Y$ decreasing in $\Delta \log \bar{L}$ and increasing in $\Delta \log \zeta$.

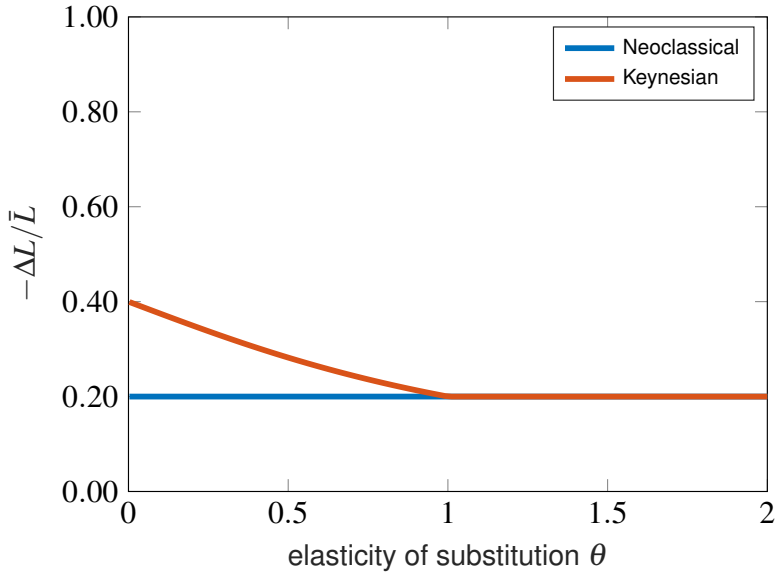
AS-AD Diagrams



- Two labor markets, supply reduction in one.
- AS *shifts*: recession and inflation (stagflation).
- AS *changes shape*: nonlinearities (amplification, interaction).

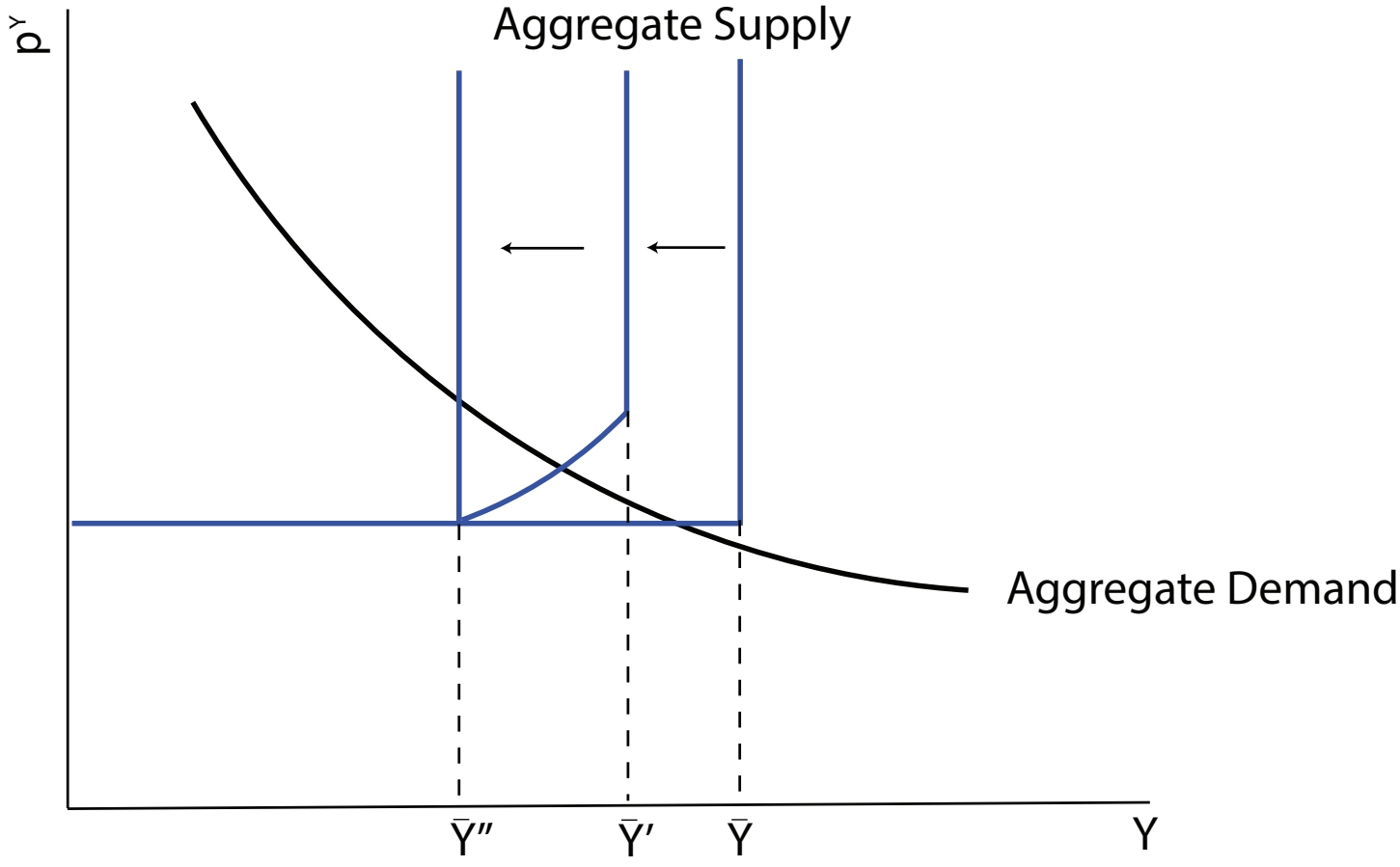
Amplification and Complementarities





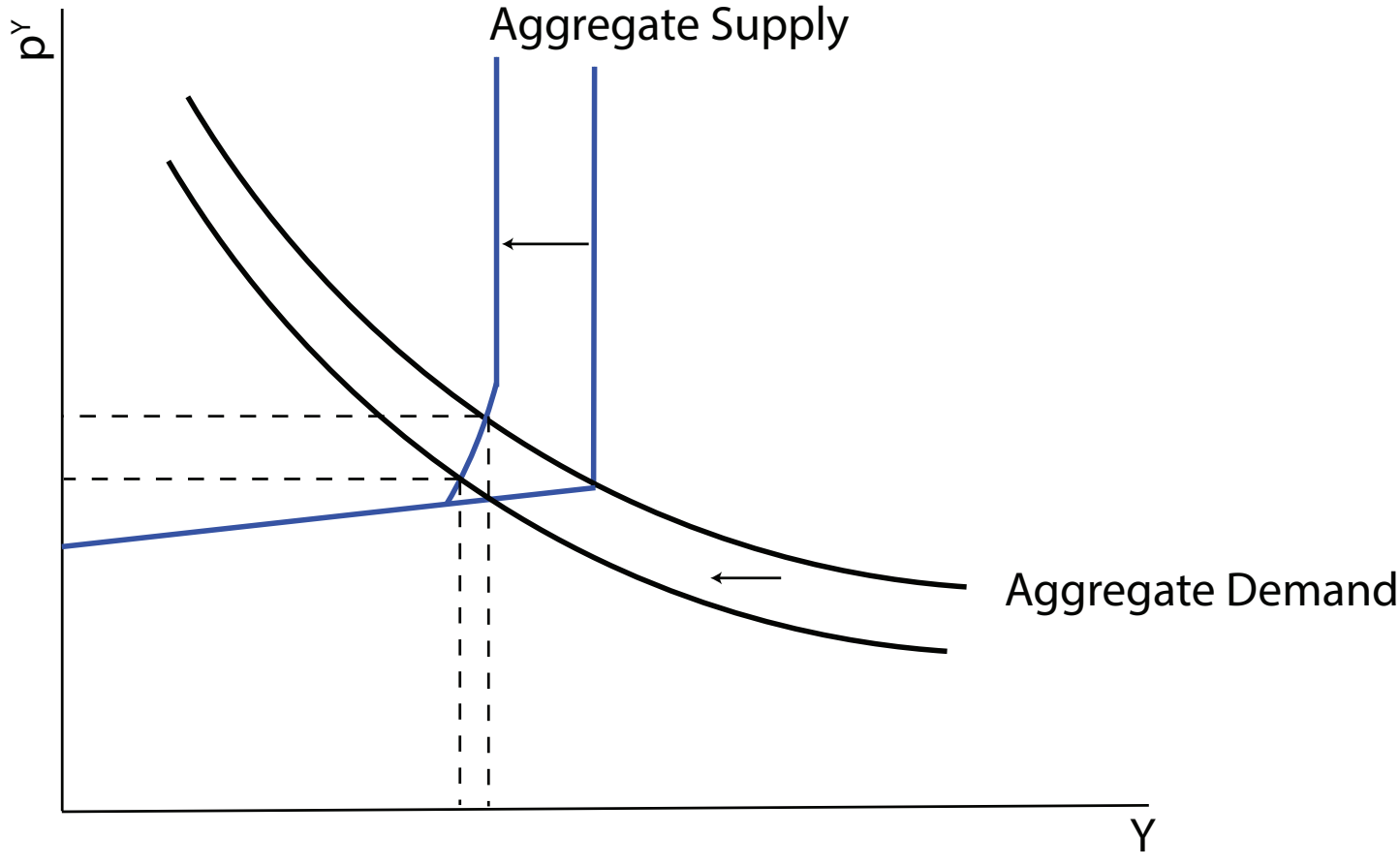
- Two equal-sized labor markets, 20% supply reduction in one.
- Unemployment increasing in complementarities.
- Output gap hump-shaped in complementarities.

Amplification and Supply Shock Heterogeneity



- Two equal-sized labor markets, supply reduction in one vs. both.
- Output gap increasing in supply shock heterogeneity.

Interaction of Supply and AD Shocks



- AD shock reduces output if large compared to supply shock.
- AD shock always reduces inflation (deflationary).
- Output gap from AD shock mitigated by complementarities.

Shocks to Composition of Final Demand

- See paper.
- Even with uniform elasticities, need new network sufficient statistics beyond initial factor income shares $\bar{\lambda}_f$:

$$\Delta \log \bar{\lambda}_f = \sum_{j \in \mathcal{N}} \bar{\Omega}_{0j} \exp(\Delta \log \omega_{0j}) \bar{\Psi}_{jf}.$$

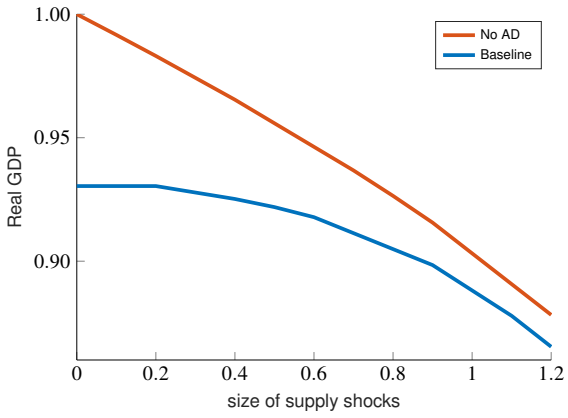
- Need network-adjusted factor intensities Ψ_{jf}.
- Shock to composition of final demand: stagflationary, resulting output gaps amplified by complementarities.

Agenda

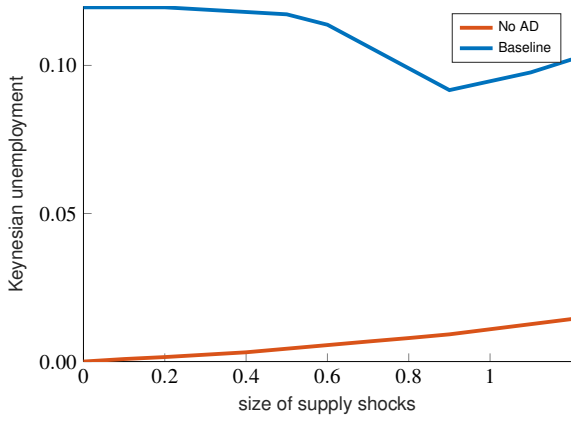
Quantitative Illustration

- Stylized version of U.S. economy: 66 sectors, sectoral production using capital, labor, and intermediates.
- Factors cannot be reallocated across sectors (short run).
- Elasticities $(\sigma, \theta, \varepsilon, \eta) = (0.8, 0.1, 0.5, 1)$.
- Pick shocks to match data: reduction in aggregate nominal expenditure ($\sim -15\%$), hours worked by sector ($\sim -15\%$ on average), and mild deflation (-0.8%).
- Two scenarios (identification problem):
  - negative AD shocks and negative labor-supply shocks;
  - negative AD shocks and composition-of-demand shocks.

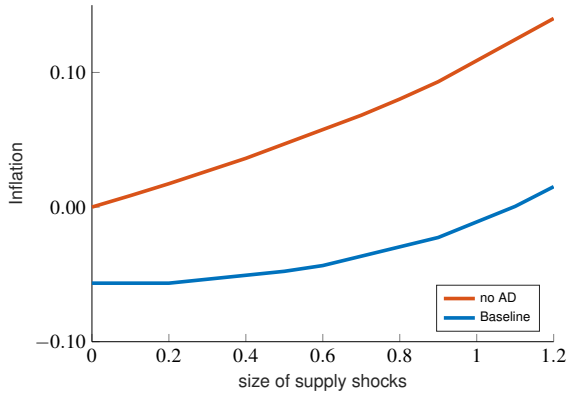
Negative Labor-Supply and AD Shocks



(a) Real GDP



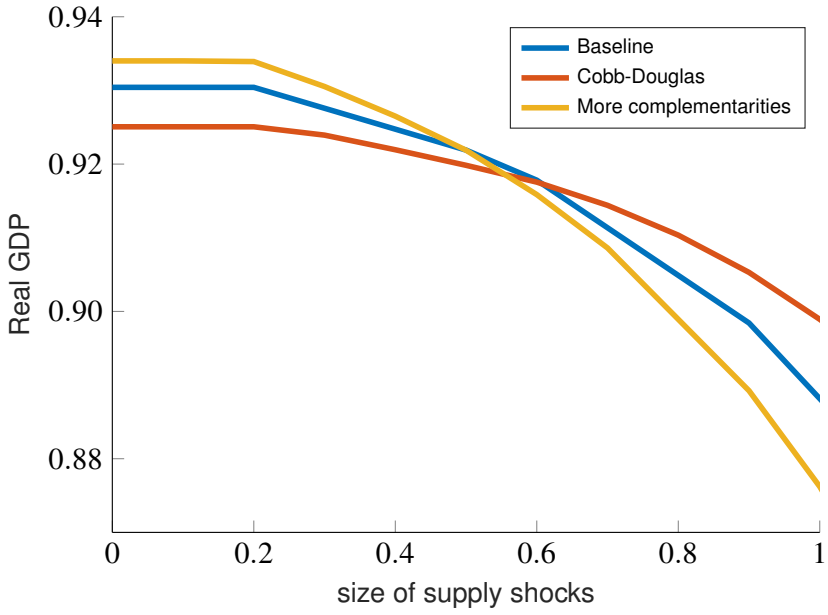
(b) Unemployment



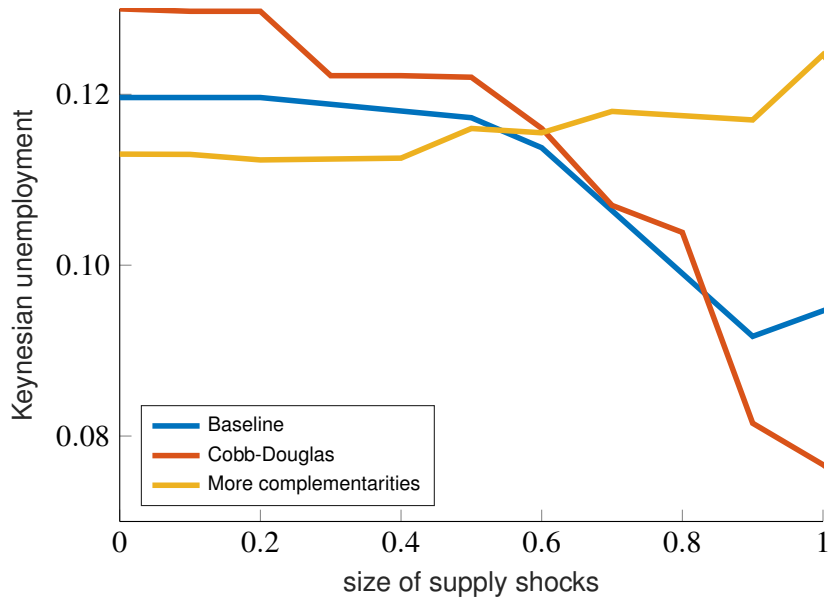
(c) Inflation

- Fix negative AD shock and scale negative labor-supply shocks.
- Supply shocks only: some unemployment and inflation.
- Supply and AD shocks: high unemployment and deflation.

Role of Complementarities



(a) Real GDP



(b) Unemployment

- Compare to more or less complementarities.
- Complementarities mitigate negative AD shock.
- Complementarities amplify negative supply shocks.

Composition-of-Demand and AD Shocks

	Real GDP	Inflation	Unemployment
Sticky Labor	-0.08	-0.04	0.15
Sticky Labor and Capital	-0.12	0.00	0.16

- Sticky labor: unemployment and deflation.
- Sticky labor and capital: more unemployment and less deflation.
- Sticky capital? Capital under-utilization and firm failures.

Agenda

More in Paper

- More examples of network effects with non-uniform elasticities.
- Endogenous demand shocks from credit constraints.
- Endogenous supply shocks from business failures.
- Policy: conventional and unconventional monetary policy, targeted fiscal stimulus, payroll tax cuts, transfers...

Agenda

Conclusion

- Covid-19 unusual aggregate shock: mix of heterogenous supply and demand shocks; coexistence of tight and slack markets.
- Must use disaggregated model to understand macro implications!
- Must use as much disaggregated data as available.
- Not a “big mess”: clear theoretical and quantitative lessons.
- Next steps: revisit numbers as disaggregated data becomes available, make progress on identification problem.