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

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Macro Reading Group

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Plans

- Initial plan :
- Sectoral effects of social distancing
  Jean-Noël Barrot, Basile Grassi and Julien Sauvagnat
- Other more interesting paper with an empirical approach :
- Barrot, J.-N. and J. Sauvagnat (2016).
  Input Specificity and the Propagation of Idiosyncratic Shocks in Production Networks.
  The Quarterly Journal of Economics 131(3), 1543–1592.

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  - Changing shape of the AS curve : due to complementarity & binding rigidities constraints
- Plenty of results and extensions :
  - (i) Quantitative model : need both supply shocks and agg. demand, (ii) Demand spillovers, (iii) Policy responses

Model : two periods

- Consumers :

$$\max_{c_i} \quad (1-\beta)\frac{Y^{1-1/\rho}-1}{1-1/\rho} + \beta\frac{Y_*^{1-1/\rho}-1}{1-1/\rho} \qquad Y = \mathcal{D}\left(x_{01}, \ldots, x_{0N}; \omega_{0j}\right)$$

$$\sum_{i \in \mathcal{N}} p_i x_{0i} + \frac{\bar{p}_*^Y Y_*}{1+i} = \sum_{f \in \mathcal{G}} w_f L_f + \sum_{i \in \mathcal{N}} \pi_i + \frac{\bar{I}_*}{1+i'} \qquad E = p^Y Y$$

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- Production :

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

$$\frac{y_i}{\bar{y}_i} = \frac{A_i}{\bar{A}_i}\left(\sum_{j\in\mathcal{N}+\mathcal{G}} \bar{\omega}_{ij}\left(\frac{x_{ij}}{\bar{x}_{ij}}\right)^{\frac{\theta_i-1}{\theta_i}}\right)^{\frac{\theta_i}{\theta_i-1}}$$

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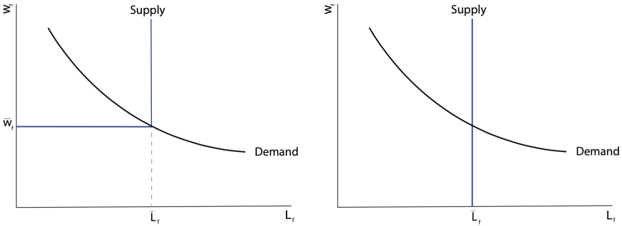
- Market clearing :

$$x_{0i} + \sum_{j\in\mathcal{N}} x_{ji} = y_i$$

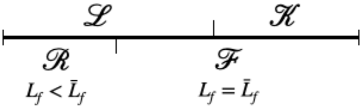
Model – Nominal rigidities for factors

- Slackness constraints :

$$\left(w_f - \bar{w}_f\right)\left(L_f - \bar{L}_f\right) = 0, \qquad \bar{w}_f \leq w_f, \qquad L_f \leq \bar{L}_f \qquad L_f = \sum_{i \in \mathcal{N}} L_{if}$$



(a) Factors in $\mathcal{L}$ (b) Factors in $\mathcal{K}$



Model – Shocks and Input Output definition

- Shocks :
  - Supply : Productivity A_i, Factor supply shocks : $\bar{L}_f$
  - Demand : Composition : ω_{0j} and aggregate shocks (i) Patience : $\frac{\beta}{1-\beta}$, (ii) Monetary shocks : i, $\bar{p}_*^Y$ and $\bar{Y}_*$

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- Network definitions :
  - Input-Output matrix : $\Omega_{ij} = \frac{p_j x_{ij}}{p_i y_i} = \frac{p_j x_{ij}}{\sum_{j \in \mathcal{N}+\mathcal{G}} p_k x_{ik}}$
  - Leontieff Inverse Matrix : $\Psi = (I - \Omega)^{-1} = I + \Omega + \Omega^2 + \dots$
  - Domar weights : goods : $\lambda_i = \frac{p_i y_i}{E} = \frac{p_i y_i}{\sum_{i \in \mathcal{N}} p_i x_{0i}}$ $\qquad \lambda_f = \frac{w_f L_f}{\sum_{f \in \mathcal{G}} w_f L_f}$

Result – Local comparative statics :

- Euler equation for output :

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

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

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  - Stagflationary effect of negative supply shocks,

- Prop. 1 :

$$d\log Y = \sum_{i \in \mathcal{N}} \lambda_i d\log A_i + \sum_{f \in \mathcal{G}} \lambda_f d\log L_f$$

$$= \underbrace{\sum_{i \in \mathcal{N}} \lambda_i d\log A_i + \sum_{f \in \mathcal{G}} \lambda_f d\log \bar{L}_f}_{\text{neoclassical effect}} + \underbrace{\sum_{f \in \mathcal{L}} \lambda_f \min \left\{ d\log \lambda_f + d\log E - d\log \bar{L}_f, 0 \right\}}_{\text{Keynesian effect}}$$

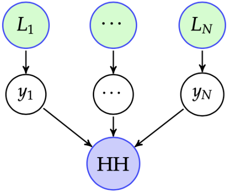
Result – Local comparative statics : factor share and price

- Prop 2 : Forward propagation vs. Backward propagation :

$$d\log p_k = -\sum_{i\in\mathcal{N}} \Psi_{ki} d\log A_i + \sum_{f\in\mathcal{G}} \Psi_{kf} \underbrace{\left(d\log\lambda_f + d\log E - d\log L_f\right)}_{=d\log w_f}$$

$$d\log\lambda_k = \theta_0 \mathbb{C}\mathrm{ov}_{\Omega^{(0)}}\left(d\log\omega_0, \frac{\Psi_{(k)}}{\lambda_k}\right) + \sum_{j\in 1+\mathcal{N}} \lambda_j\left(\theta_j - 1\right)\mathbb{C}\mathrm{ov}_{\Omega^{(j)}}\left(-d\log p, \frac{\Psi_{(k)}}{\lambda_k}\right)$$

A simpler example : Horizontal economy



$$
\begin{aligned}
Y/\bar{Y} &= \left(\sum_i \bar{\lambda}_i (y_i/\bar{y}_i)^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} \\
y_i/\bar{y}_i &= L_i/\bar{L}_i, \\
L_i &= \min\{\bar{L}_i, \lambda_i E/\bar{w}_i\} \\
w_i &= \max\{\lambda_i E/\bar{L}_i, \bar{w}_i\}.
\end{aligned}
$$

- Change in labor in flexible and rigid sectors :

$$
d\log L_{\mathcal{F}} = d\log \bar{L}_{\mathcal{F}} := \sum_{f\in\mathcal{F}} \frac{\lambda_f}{\lambda_{\mathcal{F}}} d\log \bar{L}_f \qquad d\log L_{\mathcal{R}} < d\log \bar{L}_{\mathcal{R}}
$$

- By Proposition 2 , the change in the share of a factor f is given by

$$
\lambda_{\mathcal{F}} d\log \lambda_{\mathcal{F}} = -\frac{(1-\theta)(1-\lambda_{\mathcal{F}})}{1-(1-\theta)(1-\lambda_{\mathcal{F}})} \lambda_{\mathcal{F}} d\log \bar{L}_{\mathcal{F}}
$$

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- Use the above relation : reallocation from rigid to flexible sectors :

$$\lambda_{\mathcal{R}} d\log L_{\mathcal{R}} = \sum_{f\in\mathcal{R}} \lambda_f d\log\lambda_f = -\sum_{f\in\mathcal{F}} \lambda_f d\log\lambda_f = -\lambda_{\mathcal{F}} d\log\lambda_{\mathcal{F}}$$

- Aggregate output change : Amplification through Keynesian channels :

$$\begin{aligned} d\log Y &= \lambda_{\mathcal{F}} d\log \bar{L}_{\mathcal{F}} + \lambda_{\mathcal{R}} d\log L_{\mathcal{R}} = \frac{\lambda_{\mathcal{F}} d\log \bar{L}_{\mathcal{F}}}{1-(1-\theta)(1-\lambda_{\mathcal{F}})} \\ &= \underbrace{\lambda_{\mathcal{F}} d\log \bar{L}_{\mathcal{F}} + \lambda_{\mathcal{R}} d\log \bar{L}_{\mathcal{R}}}_{\text{neoclassical effect}} + \underbrace{\sum_{f\in\mathcal{R}} \lambda_f \left(\frac{(1-\theta)\lambda_{\mathcal{F}} d\log \bar{L}_{\mathcal{F}}}{1-(1-\theta)(1-\lambda_{\mathcal{F}})} - d\log \bar{L}_f \right)}_{\text{Keynesian effect}} \end{aligned}$$

A simpler example : Horizontal economy

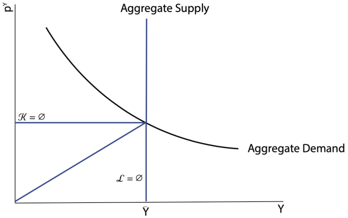
- Prop 3 : (Global Sufficient Statistics).

  – With log util $\rho = 1$, uniform elasticities of substitution $\theta_j = \theta, \forall_{j \in 1+\mathcal{N}}$, and if shocks affect only factor supply shocks $\Delta \log \bar{L}$ and agg. demand $\Delta \log \zeta$ (not productivity A or demand composition ω), Then :

$$\Delta \log Y(\Delta \log \bar{L}, \Delta \log \zeta, \bar{\Omega}) = \Delta \log Y \left(\Delta \log \bar{L}, \Delta \log \zeta, \bar{\Omega}'\right)$$

$\forall \bar{\Omega}$ and $\bar{\Omega}'$ such that $\bar{\lambda}_f = \bar{\Psi}_{0f} = \bar{\Psi}'_{0f} = \bar{\lambda}'_f$ for every $f \in \mathcal{G}$

AS-AD representation :



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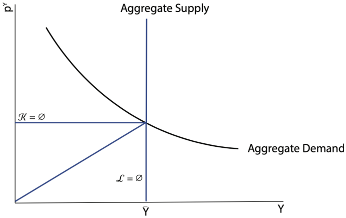
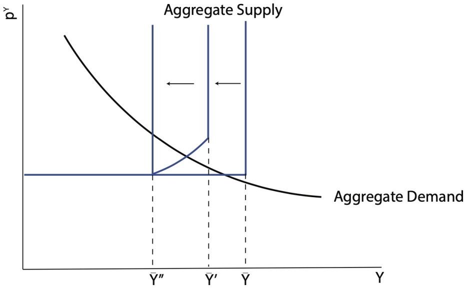
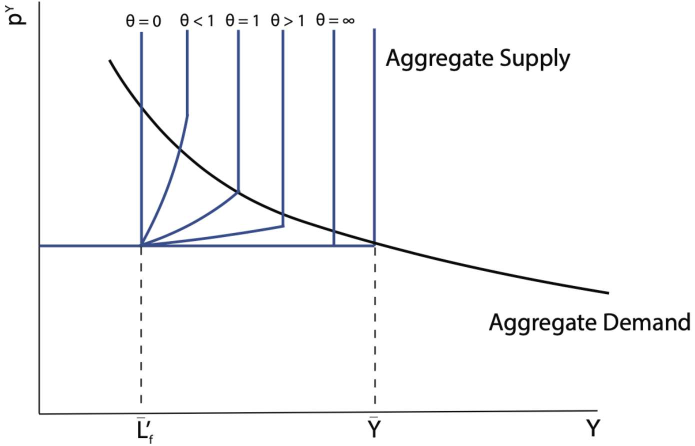




- Shock to one sector with Keynesian spillovers on aggregate supply

AS-AD representation : shocks



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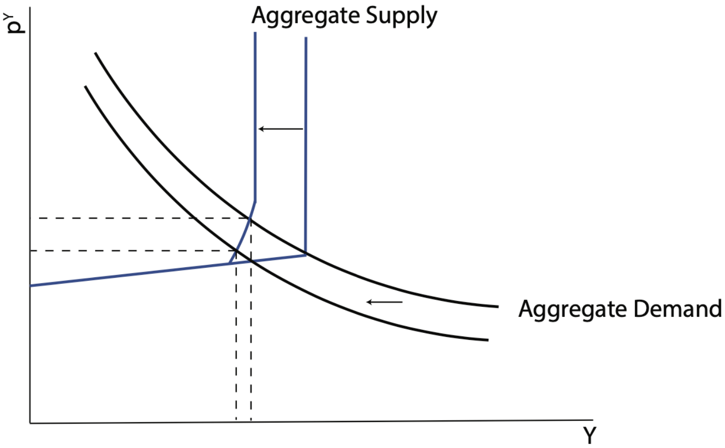

Extensions :

- Quantitative model :
  - Between 4 and 12 % Keynesian unemployment
  - Around 10% drop in real GDP (50%-100% more than in neoclassical model alone)
- Extensions : endogenous demand spillovers and policy
  - Constrained costumers
  - Firm failures
  - Policy responses : (less effective with complementarities)
    - Monetary policy
    - Payroll tax cut
    - Targeted fiscal policy