The Economic Ripple Effects of COVID-19

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Motivation

• COVID+non-pharmaceutical interventions (NPIs):
  ▶ largest (transitory ?) aggregate shock since...
  ▶ more permanent reshuffling of what/how we consume

• This paper:
  ▶ Ripple effects of a LARGE transitory shock, e.g., Lockdown?
  ▶ Ripple effects of a pure reallocation shock?
  ▶ How effects depend on policies/institutions?
Motivation: How Bad, For How Long?
Motivation: How Bad, For How Long?
Motivation: Neoclassical Dynamics of Lockdown
Related Literature

- See NBER Working Papers 26867-27281
This Paper

- **Heterogeneous Agents model**
  - occupational choices
  - stochastic ability
  
  \[
  z_t = \begin{cases} 
  z_{t-1} & \text{with prob. } \psi_t \\
  z \sim 1 - z^{-\eta} & \text{otherwise}
  \end{cases}
  \]

  - credit friction: collateral constraints, \( k_t \leq \lambda a_t \)
  - labor friction: matching friction w/ rest unemployment

- **Deterministic dynamics following unanticipated shocks:**
  - Lock-down: fraction \( \phi \) of all firms becomes **Non-Essential** (shut-down).
  - Reallocation shock: 10% of individuals redraw their productivity, \( 0.87 = \psi_1 < \psi = 0.97 \)

• Analyze macro and micro implications of:

1. one-period lockdown shock, three cases:
   1.1 non-essential firms have no income, liable for rental/debt payments (baseline)
   1.2 also liable for wage payments, i.e., no wage subsidies/furloughs
   1.3 small open economy with tighter credit constraints...

2. Pure reallocation shock...
Agent’s Optimization Problem: Essential

\[ v_t (z, a) = \max_{a', o_c} \left\{ \frac{[c_t]^{1-\sigma}}{1-\sigma} + \beta E v_{t+1} [z', a'] \right\} \]

\[ c_t + a_{t+1} = \max \{ w_t, \pi_t (z, a_t; r_t, w_t) \} + (1 + r_t) a_t - T_t \]

where

\[ \pi_t (z, a; r, w) = \max_{k,l} z k^\alpha l^\theta - (r_t + \delta) k - w_t l \]

subject to \( k \leq \lambda a \)

- Full replacement unemployment insurance: \( w_t \)
- Lump-sum taxes with budget balance, \( T_t = w_t U_t \)
Agent’s Optimization Problems: Non-Essential

- Businesses
  \[ v_{1}^{NE}(z,a) = \max_{a'} \left\{ \frac{[c_t]^{1-\sigma}}{1-\sigma} + \beta Ev_2 [z', a'] \right\} \]
  \[ c_1 + a_2 = -(r + \delta) k_1 - (1 + r_1) a_1 - T_1 \]

- Workers
  \[ v_{1}^{W}(z,a) = \max_{a'} \left\{ \frac{[c_t]^{1-\sigma}}{1-\sigma} + \beta Ev_2 [z', a'] \right\} \]
  \[ c_1 + a_2 = w_1 + (1 + r_1) a_1 - T_1 \]

- Non-essential entrepreneurs only pay rental cost, \( -(r + \delta) k_1 \).
  \( \triangleright \) employment at will (US) or generous government wage subsidies (Europe)

- non-essential become essential for \( t \geq 2 \)
Labor Market Friction

- $M_t$ unemployed workers matched to the hiring market

\[ M_t = \gamma \left( U_t + JD_t \right) \]

- Evolution of Unemployment

\[ U_{t+1} = U_t + JD_t - M_t \]

- Job Destruction

\[ JD_t = \int \left[ \max \{ l_{t-1} - l_t(a,z), 0 \} \right] \left[ dG_t^E + dG_t^{NE} \right] + \text{exiting entrep.} \]

- Walrasian Hiring Market Clearing

\[ \int_{l_t(a,z) > 0} \left[ 1 + l_t(a,z) \right] \left[ dG_t^E + dG_t^{NE} \right] = 1 - U_{t+1} \]

- Labor demand

- Labor supply
Labor Market Friction with Rest Unemployment

- non-essential workers are not reallocated in the first period
- but can be rehired frictionlessly by their previous employers in the second period
  - only by surviving firms
  - if their net-worth constraint does not bind
Labor Market Friction with Rest Unemployment

- $M_t$ unemployed workers matched to the hiring market
  
  \[ M_1 = \gamma (U_1 + JD_1 - R_1) \]
  
  \[ M_2 = \gamma (U_2 + JD_2 - RH_2) \]

  where

  \[ R_1 = \text{job destruction by surviving non-essential firms in } t = 1 \]

  and

  \[ RH_2 = \psi \int_{l_0 > 0} \max \{ \min \{ l_2 (a, z), l_0 \} - l_1, 0 \} \, dG_{NE}^2 \]

  ▶ i.e., job destruction by non-essential can be re-hired the following period

- Evolution of Unemployment

  \[ U_2 = U_1 + JD_1 - M_1 \]
  
  \[ U_3 = U_2 + JD_2 - M_2 - RH_2 \]
Calibration Strategy

- Parameter values set to match
  - distribution and dynamics of U.S. establishments
  - unemployment rate in U.S. ($\gamma$)
  - external finance to fixed capital in non-corporate sector in U.S. ($\lambda$)
    - also calibration to external finance in developing countries
Roadmap

• Analyze macro and micro implications of:

1. one-period lockdown shock, three cases:
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2. Pure reallocation shock...
The Lock-Down Shock

- Start from stationary allocation

- Unexpected shock: fraction $\phi$ of businesses considered Non-Essential
  - magnitude and persistence of $\phi$ still open question
  - assume $\phi = 0.3$, 1-period shock $\rightarrow$ emphasize model’s propagation
  - shock realized after occupation and factor demand decisions, but before production

- Two assumptions about labor costs in the first period:
  - are not paid by the firm, e.g., wage subsidies (Europe), furlough (US)
  - firm must paid wage bill
1. Burst of job destruction + matching friction $\rightarrow$ rise in Unemployment
2. Imperfect insurance $\rightarrow$ heterogeneous effect on net-worth
3. Financial Frictions $\rightarrow$ TFP, investment, rehiring dynamics
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  2. Pure reallocation shock...
Lockdown: Aggregate Variables II

- **Investment Rate**
- **Consumption**
- **Wage**
- **Interest Rate (bps)**

Graphs showing the behavior of economic variables over time.
Micro Implications I: Employment by Age

Young: less than 5 year old
Micro Implications II: Consumption

Graphs showing consumption patterns for different groups over time.
Roadmap

- Analyze macro and micro implications of:

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  2. Pure reallocation shock...
No Wage Subsidies: Aggregate Variables I

- **GDP**
  - Baseline (blue)
  - No Wage Subsidy (red)

- **TFP**
  - Baseline (blue)
  - No Wage Subsidy (red)

- **Capital Stock**
  - Baseline (blue)
  - No Wage Subsidy (red)

- **Unemployment Rate**
  - Baseline (blue)
  - No Wage Subsidy (red)
No Wage Subsidies: Aggregate Variables II
Micro Implications: Employment by Age

Young: less than 5 year old
Roadmap

• Analyze macro and micro implications of:

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2. Pure reallocation shock...
Small Open Economy: Aggregate Variables I

**GDP**

- Baseline, $\lambda = 7.5$
- SOE, $\lambda = 1.5$

**TFP**

**Capital Stock**

**Unemployment Rate**
Roadmap

- Analyze macro and micro implications of:

  1. one-period lockdown shock, three cases:
     
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     1.2 also liable for wage payments, i.e., no wage subsidies/furloughs
     
     1.3 small open economy with tighter credit constraints...

  2. Pure reallocation shock...
Pure Reallocation Shock

- Start from stationary allocation
- Unexpected shock: 10% of individuals redraw their productivity, \(0.87 = \psi_1 < \psi = 0.97\)
  - \(\sim 10\%\) of old businesses need to be replace by new ones
  - in a neoclassical world there are no aggregate consequences
  - process slow by financial and labor frictions
- It captures more permanent reshuffling of what/how we consume/produce
  - online person academic/business conference
  - changes in type of recreation and vacations
Pure Reallocation Shock: Aggregate Variables I
Pure Reallocation Shock: Aggregate Variables II

- **Investment Rate**
  - Baseline
  - Reallocation Shock

- **Consumption**

- **Wage**

- **Interest Rate (bps)**
Summary of Results

1. Fast aggregate recovery (with wage support/flexible employment & rest)
2. but large, persistence effects for young firms
3. fall of interest rate ($\Delta$ aggregate demand<$\Delta$ aggregate supply)
4. large ripple effect without wage support/inflexible employment
5. capital outflows from financially underdeveloped, small open economies
Work in Progress, Further Extensions

- **Distribution of welfare costs**
  - Who gain from wage subsidies, milder ripple effects?

- **Lockdown of different duration**
  - Are cost convex in the length?

- **Capital irreversibility,** $K_{t+1} \geq (1 - \delta) K_t$
  - Extension relevant for the case without wage subsidy, SOE with tighter credit constraint
  - Initial drop in the price of capital, further tighten constraints, e.g., Kiyotaki & Moore (1997)

- **Debt financed support policies**
  - Further depress investment
  - Ameliorate initial fall in consumption of constrained agents