The Scars of Supply Shocks

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Motivation

Supply disruptions have plagued the global economy

1. Covid disrupted global supply chains and forced factories to shut down

2. Energy and food price shocks due to Russia’s invasion of Ukraine

Many observers expect deep scarring effects, by inducing persistent drops in potential output below its pre-crisis trend (IMF, 2022)
effects from the conflict remain largely contained to the countries directly involved. More limited public investment responses and relatively bigger challenges to remedy learning losses mean that upward potential output revisions are not as large in emerging market and developing economies. Importantly, improvements in vaccination rates have also been associated with upward revisions to output projections across the forecast horizon (Figure 1.19). This pattern reinforces the importance of continuing pandemic mitigation policies.

Trade Growth to Moderate, External Imbalances to Narrow over Medium Term

Global trade:
Reflecting the significant slowdown in overall activity, global trade growth is expected to decline notably in 2022. Global goods demand is expected to moderate because of the war as extraordinary policy support is withdrawn and as demand rebalances back toward services. Cross-border services trade—especially tourism—is however expected to remain subdued because of the war and lingering effects of the pandemic. Overall, global trade growth is projected to slow from an estimated 10.1 percent in 2021 to 5 percent in 2022 and further to 4.4 percent in 2023 (1 and 0.5 percentage points lower than in the January forecast). Over the medium term, trade growth is expected to decline to about 3.5 percent.
This paper

Revisit the economics of supply disruptions through Keynesian growth model with *scarring effects*

- Nominal wage rigidity
- Firms invest in innovation to appropriate future monopoly rents

Main results

1. Scarring leads to negative wealth effect, depressing aggregate demand
2. Scarring implies additional inflation which pops up with a delay

Implications for monetary policy
Structure of the talk

1. Introduction
2. Model
3. Scarring and aggregate demand
4. Implications for inflation
5. Conclusion
2. Model.
Households

Representative household with utility

$$\sum_{t=0}^{\infty} \beta^t \log(C_t).$$

Households have access to a bond paying interest rate $i_t$, implies Euler equation

$$\frac{1}{P_t C_t} = \beta(1 + i_t) \frac{1}{P_{t+1} C_{t+1}}.$$

Desired labor supply is $\bar{L}$. $L_t < \bar{L}$ possible due to wage rigidities, described below.
Firms

Final output is produced from labor $L_t$ and intermediate goods $x_{j,t}$ with quality $A_{j,t}$

$$Y_t = (Z_t L_t)^{1-\alpha} \int_0^1 A_{j,t}^{1-\alpha} x_{j,t}^\alpha dj,$$

where the supply shock is denoted $Z_t$

Monopolistic competition in production of inputs $j$ implies equilibrium profits

$$(P_{j,t} - P_t)x_{j,t} = P_t \omega A_{j,t} Z_t L_t,$$

where $\omega > 0$ is a parameter

- Profits increase in quality $A_{j,t}$
- Profits increase in market size $Z_t L_t$
Innovation

A firm $j$ investing one unit of the final good sees its productivity evolve as (vertical innovation)

$$A_{j,t+1} = A_{j,t} + \chi l_{j,t}.$$ 

Maximize NPV of monopoly rents implies

$$\frac{1}{\chi} = \frac{\beta C_t}{C_{t+1}} \left( \omega Z_{t+1} L_{t+1} + \frac{\eta}{\chi} \right),$$

where $\eta$ is probability of losing monopoly rent in the future.
Monetary policy and nominal rigidity

As in Werning (2015) and Mian et al. (2021), treat monetary policy as choosing the real interest rate directly, $r_t = (1 + i_t)(P_t / P_{t+1}) - 1$

- Implies we can study real side of the economy without making nominal rigidity explicit (see Section 3)
- Nominal rigidity merely pins down inflation dynamics, discussed in Section 4
Summary of equilibrium in 3 equations

Denote $c_t \equiv C_t/A_t$ and $g_t \equiv A_t/A_{t-1}$. Aggregate demand is

$$c_t = \frac{g_{t+1}c_{t+1}}{\beta(1 + r_t)}.$$  \hspace{1cm} (AD)

The growth equation

$$g_{t+1} = \frac{\beta c_t}{c_{t+1}} (\chi \omega Z_{t+1} L_{t+1} + \eta).$$  \hspace{1cm} (GG)

The resource constraint

$$\Psi Z_t L_t = c_t + \frac{g_{t+1} - 1}{\chi},$$  \hspace{1cm} (RR)

where $\Psi > 0$ is a parameter.

Equ: path for $\{c_t, g_{t+1} > 1, L_t \leq \bar{L}\}$ s.t. (AD), (GG) and (RR) hold, given supply shock $\{Z_t\}$ and monetary policy $\{r_t\}$.
3. Scarring and aggregate demand.
In this section we establish that scarring effects depress aggregate (consumption) demand

- Scarring means future potential output is lost
- By a negative wealth effect, consumption demand falls

Study supply disruptions of the form

\[ \log(Z_t) = \rho \log(Z_{t-1}), \]

with initial condition \( Z_0 < 1 \)
The natural interest rate

Summary statistic of the balance aggregate supply/demand

Assume investment-in-innovation share of GDP is small, $\Psi Z_t L_t \approx c_t$. From (AD), the natural rate is given by

$$1 + \bar{r}_t = \frac{\bar{g}_{t+1} \bar{c}_{t+1}}{\beta \bar{c}_t} = \frac{\bar{g}_{t+1} \Psi Z_{t+1} \bar{L}}{\beta \Psi Z_t \bar{L}} = \frac{\bar{g}_{t+1} Z_0^{\rho t}(\rho - 1)}{\beta}.$$ 

- $Z_0 \downarrow$ implies $\bar{r}_t \uparrow$, i.e. supply falls by more than demand
- Endogenous response of $\bar{g}_{t+1} \downarrow$ (scarring) implies $\bar{r}_t \downarrow$

$\implies$ Scarring depresses aggregate demand, implying $\bar{r}_t$ rises by less or may even decline
The scars of supply shocks

Supply shock $Z_t$

Productivity growth $\bar{g}_t$

Potential GDP $\Psi \bar{A}_t Z_t \bar{L}$

Natural rate $\bar{r}_t$
The supply-demand doom loop

Weak aggregate demand can reinforce scarring effects, triggering a supply-demand doom loop

To see this, assume that

1. Central bank follows the rule $1 + r_t = (1 + \bar{r})(L_t / \bar{L})^{\phi}$, $\bar{\phi} < \phi < \infty$
2. Supply shock is permanent, $Z_t = Z$ for all $t$

Then (AD) and (GG) become two equations in $g$ and $L$

$$g = \beta(1 + \bar{r}) \left( \frac{L}{\bar{L}} \right)^\phi$$ \hspace{1cm} (AD)
$$g = \beta(\chi \omega ZL + \eta)$$ \hspace{1cm} (GG)
Effect of supply disruption in $L - g$ diagram

- Low growth implies negative output gap driven by weak demand
- Output gap implies low growth driven by weak incentives to invest
Lessons for monetary policy

⇒ Scarring effects call for *less tight* monetary policy response if goal is to stabilize the output gap

⇒ Tightening too much not only triggers a negative output gap, but implies additional scarring (consistent with evidence by Moran and Queralto, 2018; Garga and Singh, 2020; Jorda et al., 2020)
4. Implications for inflation.
In this section we establish that scarring effects imply additional inflation which pops up with a delay

May help explain why supply shocks can trigger inflation spells which are highly persistent
Determinants of inflation

Consider firms’ first order condition for labor

$$P_t = \frac{1}{1 - \alpha} \left( \frac{1}{\alpha} \right)^{\frac{2\alpha}{1-\alpha}} \frac{W_t}{A_t Z_t}. \quad (2)$$

The impact of the shock on inflation is mediated by two forces

1. The impact of the shock on wages $W_t$
2. The impact of the shock on productivity, $Z_t$ and $A_t$

Assume now wages follows the law of motion

$$\frac{W_t}{W_{t-1}} = \bar{g}^{1-\omega} \left( \frac{g_t}{Z_{t}} \right)^{\omega} \left( \frac{L_t}{\bar{L}} \right)^{\check{\zeta}}, \quad (3)$$

with $\omega$ indexation to productivity, $\check{\zeta}$ sensitivity w.r.t. unemployment (Phillips curve)
Scarring effects and inflation

Assume again central bank closes the output gap ($r_t = \bar{r}_t \Rightarrow L_t = \bar{L}$). Combining (2)-(3) and denoting $\pi_t \equiv P_t / P_{t-1}$,

$$\pi_t = \bar{g}^{1-\omega} \left( \frac{\bar{g}_t}{Z_t} \right)^{\omega-1}.$$  (4)

Scarring implies additional inflation

- Decline in growth means firms’ marginal cost is higher
- Assumes that nominal wages not perfectly indexed to productivity (i.e. wages do not fall)

Additional inflation pops up with a delay ($\pi_{t+1} \uparrow$ as $\bar{g}_{t+1} \downarrow$)

- Declines in investment take time to translate into productivity losses
- Inflation may remain high, even after the shock has ended
As supply shock fades (*disinflationary* phase), inflation can remain stubbornly high.
Lessons for monetary policy

Assume central bank has incentives to dampen inflation (add inflation costs to the model)

⇒ A policy of tight money can backfire, due to the supply-demand doom loop

Combine again (2)-(3), this time for an arbitrary output gap

\[ \pi_t = \bar{g}^{1-\omega} \left( g_t \frac{Z_t}{Z_{t-1}} \right)^{\omega-1} \left( \frac{L_t}{\bar{L}} \right)^{\xi}. \] (5)

▶ Tight money implies \( L_t \downarrow \) hence \( \pi_t \downarrow \), but due to \( g_{t+1} \downarrow \) also \( \pi_{t+1} \uparrow \) ⇒ shifts inflation from the present into the future

▶ Especially acute when indexation of wages to productivity is weak and the Phillips curve is flat
Scarring effects and inflation

By destroying productive capacity, a tight monetary stance pushes inflation into the future

Implies additional trade-offs for monetary policy
5. Conclusion.
We have revisited the economics of supply disruptions through the lens of a Keynesian growth model with scarring effects.

Main results

1. Scarring reduces aggregate demand by a negative wealth effect.
2. Scarring implies persistent high rates of inflation.

⇒ Important lessons for monetary policy.