Hysteresis, the Big Push, and Technological Adoption

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Introduction

This paper studies the circumstances under which temporary shocks may leave long-lasting effects on the economy; a phenomenon known as hysteresis. Understanding hysteresis is a first order concern in macroeconomic research. In particular, the slow recovery observed in many countries after the Global Financial Crisis suggests negative shocks often leave long-run scars on economic activity. Similarly, the COVID-19 pandemic, and geopolitical disruptions of energy markets have exacerbated these concerns. However, little is know about the determinants of hysteresis and the conditions under which it may emerge. This knowledge is critical for the design of policies seeking to counteract any negative long-run scarring, and alters cost-benefit analyses in favor of resilience building macro-prudential measures. Additionally, it is important to understand how temporary events may affect important long-run developments, such as the energy transition to low-carbon technologies.

Structure of the Model

- Agents:
  1. Representative consumer inelastically supplying one unit of labor (no savings).
  2. Unit mass of firms producing differentiated intermediate inputs.
  3. Final good firm aggregating intermediate inputs à la Dixit–Stiglitz.
- Intermediate firms choose to operate traditional ($\mathscr{T}$) or more productive modern ($\mathscr{M}$) technology.
- Firms in $\mathscr{M}$ pay heterogeneous adoption cost j^c, and continuation cost k^c (after 1^{st} period in).
- Two adoption thresholds (firms' indices):
  - Entry into $\mathscr{M}$: threshold j (where the value function of staying out is equal to the one of entry).
  - Exit from $\mathscr{M}$: threshold k (where the value function of staying in is equal to the one of exit).
- **Proposition 1:** *Prices and quantities will be symmetric across all firms in each type $i \in \{\mathscr{T}, \mathscr{M}\}$.*
  - Firms in $\mathscr{M}$ will have lower marginal cost → High output, low price.
  - Firms in $\mathscr{T}$ will have higher marginal cost → Low output, high price.
- **Proposition 2:** *Let the final good, Y_t, be the numéraire ($P_t = 1\ \forall t$). Given a share of firms in the modern sector, m_t, and the optimal choices of prices and quantities for firms in each sector, it is possible to derive functions for aggregate quantities*
- **Definition 1:** *An equilibrium is household policies; policies for firms, $i \in \{\mathscr{M}, \mathscr{T}\}$; prices and a measure $\{m_t\}_{t=0}^{\infty}$ of intermediate firms operating in the $\mathscr{M}$-sector, such that the household maximizes utility, all intermediate producers maximize their profits net of the costs of using the $\mathscr{M}$-sector technology, the final good producer solves its problem, prices clear all markets, and m_t satisfies:*

$$m_t = \int_{j \geq k} \int \delta(j,k) \gamma_{j,k,t} \, dj dk \qquad (1)$$

where $\delta(j,k)$ is the joint density of j and k, and;

$$\gamma_{j,k,t} = \begin{cases} 1 & \text{if } u_{j,k,t} = \mathscr{A} \\ 0 & \text{if } u_{j,k,t} = 1 \end{cases}$$

- **Definition 2:** *An steady state equilibrium is an equilibrium as in Definition 1, for which $m_t = m_{t+j}$, $\forall t, j$.*

How are the optimal thresholds obtained?

- By simulation is possible to obtain optimal thresholds (j,k) given costs (j^c, k^c), and a shock.

What if $j = k$?

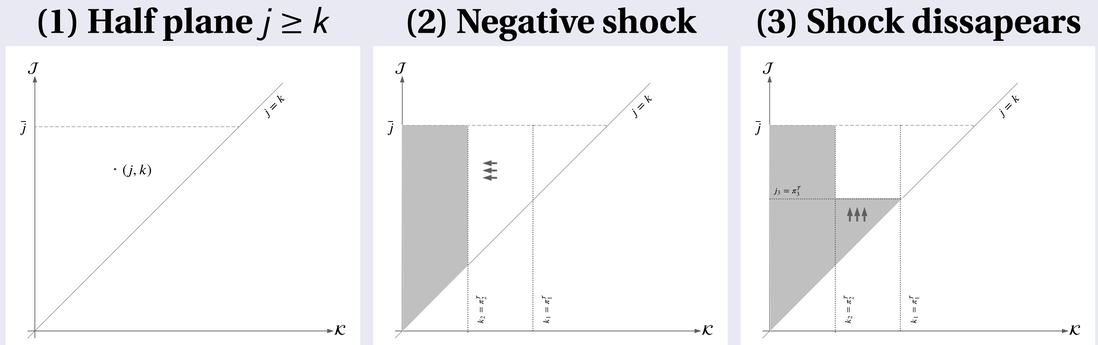
- Unique single steady state equilibrium (intersection of CDF of (j,k) and profits in the $\mathscr{T}$-sector).

What if $j \geq k$?

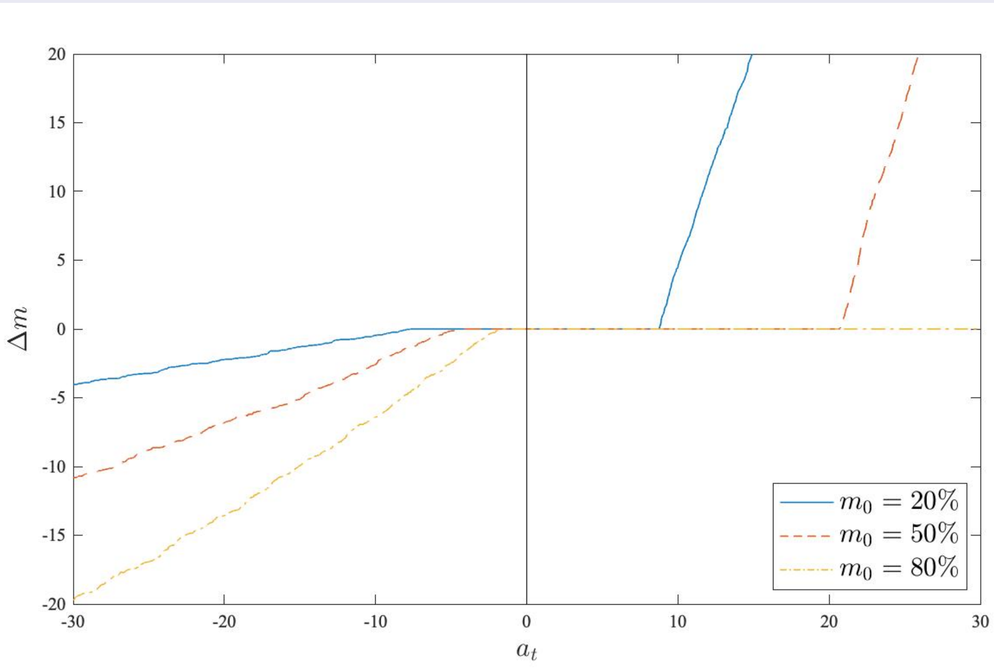
- Multiple steady state equilibria (intuition: two CDFs instead of one)
  - Path dependence and possibility of hysteresis.

Figure: **Graphical proof of possibility of hysteresis** ($j \geq k$)

(1) Half plane $j \geq k$ **(2) Negative shock** **(3) Shock dissapears**



Simulation results: Permanent impact on adoption share as a fuction of shock size for different initial values of the adoption share



Conclusion

- Theoretical supply-side framework for hysteresis.
- Relevant for drops in trend and for non-R&D intensive economies.
- Defines a set of conditions for the possibility of reverse hysteresis.
- Novel equilibrium selection criterion based on history of shocks, allowing for hysteresis.
- Key mechanism based on heterogeneous adoption and abandonment thresholds.
- Results:
  - Hysteresis depends non-linearly on the size of the shock, exhibiting significant asymmetry.
  - Hysteresis depends on the initial share of adoption:
    - Reverse hysteresis more likely in economies far away from the technological frontier.
  - Hysteresis depends on elasticity of substitution between intermediate inputs, the productivity of the new technology, and entry costs.
  - Friedman's plucking model more likely for economies on the technological frontier.

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