The Macro-Economics of Superstars

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Rosen (1981) first described the *Economics of Superstars*:

- [information] technology allows a small number of talented individuals to serve a large market and reap correspondingly large rewards
  - description pre-dated the Internet
  - Rosen’s first example: comedians and TV
- superstars were a curious phenomenon in a handful of sectors
- but outside of the domain of traditional macroeconomics
Introduction

Over the past three decades, advances in information technology, chiefly the Internet, have *supercharged the superstars phenomenon*

Superstars (broadly defined to capture both individuals and firms):

- have become macroeconomically relevant
- are important drivers of several recent aggregate trends:
  1. declining demand for labor (and traditional capital)
  2. declining labor share
  3. increasing rents
  4. rise in income inequality

_The Macro-Economics of Superstars_ analyzes

- the recent forces behind and
- the broader macro implications
Rising Superstar Profit Share

Figure: Estimate of superstar profit share in national income, 1984 - 2014 (Source: Authors’ calculations based on Barkai, 2017, Piketty and Saez, 2017)
Information and Superstars

- Critical factor behind proliferation of superstars: digital innovation
  = advances in collection, processing, and provision of information

- Information differs from traditional production factors:
  - information is non-rival → can be copied at negligible cost
  - information is excludable → may generate monopoly power

→ Information technology supercharges the superstar effect
  - Rosen’s examples: comedians, musicians, authors, sport stars, artists, etc.
  - more generally: Internet entrepreneurs, finance professionals, franchise owners, manufacturers who automate, etc.
Summary of Contribution

- Our model of *digital innovation* leading to superstars
  = an innovation that replaces a fraction of production tasks by a digital process that can be scaled at negligible cost
  → superstars technology features increasing returns
  → superstars capture large market share, earn rents
  (in contrast to models of “factor-biased” technological change)

- We derive implications for:
  - factor prices and shares
  - market concentration
  - income distribution
  - public policy
Evolution of Aggregate Factor Shares

  - US decline 64% to 58% from mid-1980s to mid-2010s
  - similar in other developed countries
  - at firm level, correlated with:
    - patents (Barrufaldi and Paunov, 2016)
    - information technology (Brynjolfsson et al, 2010)
    - rising market concentration (Autor et al, 2017)

- Traditional capital share has declined (e.g. Barkai, 2017)
- Profit share of income has increased

→ our explanation: *rising superstar profits* as main driver
Overview of Model

Model structure:

- Representative consumer
- Two traditional factors: capital and labor
- Intermediate goods combined into final good *a la* Dixit-Stiglitz

Technologies for intermediate goods production:

- Traditional CRS technology: Cobb-Douglas
- Superstar technology: digital innovation automates a fraction of tasks involved in production
Baseline Model

Consumers:

- Inelastic labor supply \( L = 1 \)
- Final good obtained from differentiated intermediate goods with \( \epsilon > 1 \)
  \[
  Y = \left( \int Y_i^{1-\frac{1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}
  \]
  with price of final good \( P = \left( \int P_i^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}} = 1 \) as numeraire
- Demand for each intermediate good is
  \[
  Y_i = (P_i)^{-\epsilon} Y
  \]
  → inverse demand curve \( P_i(Y_i; \cdot) \)
Traditional Technology

- Traditional technology for intermediate goods:
  \[ Y_i = F_i(K_i, L_i) = A_i K_i^\alpha L_i^{1-\alpha} \]

  open access → perfect competition

- Factors are hired at market prices \( R \) and \( W \)

- Total cost function with traditional technology
  \[ TC^T(Y_i) = \left( \frac{R}{\alpha} \right)^\alpha \left( \frac{W}{1-\alpha} \right)^{1-\alpha} \frac{Y_i}{A_i} \]

- Constant unit cost
  \[ UC^T(Y_i) = \left( \frac{R}{\alpha} \right)^\alpha \left( \frac{W}{1-\alpha} \right)^{1-\alpha} / A_i \]
Consider an entrepreneur in sector $i$ who develops a digital innovation
- that imposes a fixed cost $\xi_i \geq 0$ but
- that automates a fraction $\gamma_i \in (0, 1)$ of production tasks at negligible marginal cost
- in baseline model: entrepreneur has *exclusive* right to the innovation (e.g. patent)

The total and unit cost functions of superstars are

$$
TC^S (Y_i) = \xi_i + (1 - \gamma_j) \, TC^T (Y_i)
$$

$$
MC^S (Y_i) = (1 - \gamma_j) \, UC^T (Y_i)
$$

→ fixed cost generates increasing return
→ exclusiveness generates market power
Superstar Strategy

- Adopting the superstar technology is profitable if fixed cost $\xi_i$ sufficiently low / cost-saving $\gamma_i$ sufficiently high.
- Superstars internalize demand curve $P_i(Y_i; Y)$ and maximize

$$\max_{P_i, Y_i} \Pi^S(Y_i) = P_i Y_i - TC^S(Y_i) \quad \text{s.t.} \quad P_i = P_i(Y_i; Y) \leq UC_i^T$$

(1)

- if cost savings small ($\gamma_i < 1/\epsilon$) then constrained by competition from traditional firms:

$$P_i = UC_i^T$$

- if cost savings large ($\gamma_i \geq 1/\epsilon$) then charge optimal monopoly price:

$$\underbrace{P_Y(Y_i; \cdot) Y_i + P_i(Y_i; \cdot)}_{\text{Marg Rev.}} = (1 - \gamma_i) \underbrace{UC_i^T}_{\text{Marg Cost}}$$

→ superstar price and markup

$$P^S_i = \mu_i \cdot UC_i^T \quad \text{where} \quad \mu_i = \min \left\{1, \frac{\epsilon}{\epsilon - 1} (1 - \gamma_i)\right\}$$
Digital Innovation and Superstars

Proposition (Digital innovation and superstar effect in sector $i$)

- **if digital innovation is small ($\gamma_i < \frac{1}{\epsilon}$), further innovation:**
  - leaves the price charged and the output level unchanged
  - linearly reduces demand for labor and capital
  - linearly increases superstar profits (rents & inequality)

  → labor-saving effect of innovation, divergence of output and employment

- **if digital innovation is large ($\gamma_i > \frac{1}{\epsilon}$), further innovation:**
  - reduces the price charged, with a constant markup $\frac{\epsilon}{\epsilon-1}$
  - increases factor demands, output and superstar profits in a convex fashion

  → output scale effect of innovation
Digital Innovation and Superstars

Figure: Effect of increasing digital innovation
Superstar Effect in General Equilibrium

Consider synchronized cost-savings $\gamma_i$ for all sectors $i \in [0, 1]$: 

Proposition (Superstars and Factor Shares in GE) 

Superstars earn a profit share of 

$$\sigma = \min\{\gamma_i, 1/\epsilon\}$$

as well as a capital share of $\alpha (1 - \sigma)$ and a labor share of $(1 - \alpha) (1 - \sigma)$.

Intuition:  

- before the optimal monopoly markup is reached, superstars absorb all cost-savings as profits  
- once cost savings are sufficiently high, they cut prices to increase quantities

But: this involves significant monopoly rents and inequality
Digital Innovation and Superstars

Figure: Digital innovation and factor shares
Welfare Analysis

Proposition (Monopoly Distortions from Digital Innovation)

The decentralized equilibrium exhibits
- insufficient digital innovation
- inefficiency low quantities

Intuition:
- markups distort both innovation decision and quantities after innovation implemented

Policy Remedies:
- use public investment to finance digital innovation
- offset monopoly markups via subsidy
- charge consumers fixed + variable cost
Extensions

Dynamic model:
- additional capital $K$ is only accumulated once $\gamma > 1/\epsilon$

More general market structure for superstars:
- overall rents lower the more competition
- but fixed cost creates a natural monopoly
  $\rightarrow$ trade-off btw duplicating innovation and markups

Digital innovation with endogenous choice of $\gamma$:
- superstars earn rents as long as decreasing returns to innovation
Conclusions

Digital Innovation and Superstar Technologies

- first lead to a reallocation from traditional factor income to superstar rents
  - but superstars keep prices low

- once superstars earn their optimal monopoly rents, further innovation expands income for all
  - but monopoly deadweight losses
    → role for policy intervention