Romer and Ricardo
What is at Stake?

Andy Atkeson
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Current Paper

- Aims to measure fraction of products that are “Romer” or “Ricardo”
    - Some questions about the definitions used for “Romer” and “Ricardo”
    - Some concerns about the measurement procedure
        - What does it mean for two countries to have the blueprint for a “product”?
- Why would we care about the answer to the question of how many products are “Romer” or “Ricardo”?

Big Picture (my take)

- Should we have an Industrial Policy to stimulate innovation?
  - No reason to think that equilibrium innovation is optimal
- U.S. firms invest a lot in innovation
  - NIPA Intangibles Investment now > 5% GDP
  - Corrado et. al. broader measure > 15% GDP
- But U.S. aggregate productivity growth is modest
- Standard growth models imply simply doing more of the same investment will not yield big gains for growth
  - Romer and some Ricardo models
  - Atkeson and Burstein (2019)

Reallocating Innovation

- Potentially big gains from Industrial Policies if the equilibrium allocation of innovative investment across firms is not socially optimal
    - Mankiw and Whinston (Rand 1986)
    - Eaton and Grossman (QJE 1986)
- General models of imperfect competition and firms' innovative investments very hard to solve
    - Ericson and Pakes (ReStud 1995)
- Dynamics of innovation and competition make competition policy even harder
- What do we know about the interaction of imperfect competition and innovation and its implications for economic growth?
    - Not much. (Aghion et. al. 2005 and Peters 2020 notwithstanding)

Existing Growth Models

- Sidestep complications of dynamic imperfect competition
    - For tractability, not realism
    - Both Romer and Ricardo with large step size
- CES demand and constant markups across products and time
    - Conditional on aggregate innovative investment
        - Equilibrium allocation of investment across firms is optimal
        - No role for industrial policy to target the allocation of innovative investments across firms

Questions Raised by Data

- Measured innovative investment is highly concentrated
    - In 2014, top 10% of largest R&D investors worldwide accounted for 70% of R&D and 60% of patents (OECD 2017)
    - In US, 4 industry groups account for 70% of R&D
        - Chemicals, Computers, Transportation Equipment, and Information Technologies
- Is this concentration of R&D optimal?, or the result of skewed equilibrium incentives for investment?
- Universities wrestle with the same question in funding research
    - Chase NIH grants and student interest?
    - Or invest in a broader range of departments?

A Step Toward Expanding Our Set of Growth Models

- Nested CES (Atkeson and Burstein 2008)
- Categories of products $j = 1,2,\ldots,J_t$
- $$C_t = \left(\sum_{j=1}^{J_t} C_{jt}^{1-\frac{1}{\sigma}} \right)^{\sigma/(\sigma-1)}$$
- Consumption within a category products $i = 1,\ldots,K_{jt}$
- $$C_{jt} = \left(\sum_{i=1}^{K_{jt}} c_{jit}^{1-\frac{1}{\eta}} \right)^{\eta/(\eta-1)}$$
- Close and distant competitors $\eta > \sigma$
- Firm production $y_{jit} = z_{jit} l_{jit}$ innovate to raise z_{jit}

Implied Demand

- Within a category
- $\frac{c_{jit}}{C_{jt}} = \left(\frac{p_{jit}}{P_{jt}}\right)^{-1/\eta}$ with $P_{jt} = \left[\sum_{i=1}^{K_{jt}} p_{jit}^{1-\eta}\right]^{1/(1-\eta)}$
- Across categories
- $\frac{C_{jt}}{C_t} = \left(\frac{P_{jt}}{P_t}\right)^{-1/\sigma}$ with $P_t = \left[\sum_{j=1}^{J_t} P_{jt}^{1-\sigma}\right]^{1/(1-\sigma)}$
- With $\eta = \sigma$ nests Romer
- With $\eta \to \infty$ nests Ricardo
- With $\eta \in (\sigma, \infty)$ everything in between

Romer and Ricardo with large step size

- Romer ($\eta = \sigma$):
  - CES residual demand curves for all firms
  - all products sold at a constant markup over marginal cost
  - Equilibrium allocation of innovative investment across firms is optimal (holding aggregate investment fixed)
- Ricardo ($\eta \to \infty$):
  - With gap between productivity of leader and second firm in each category sufficiently large
  - Equilibrium outcome has same pricing as Romer
  - Competition with second firm in category does not constrain leader's price
  - Equilibrium allocation of innovative investment across firms is optimal (holding aggregate investment fixed)

Everything in between

- Bertrand or Cournot competition among products in a category
- Now markup of price over marginal cost for each firm depends on the firm's market share the category $\mu(s)$
- Markups increasing in category market share $\mu'(s) > 0$
- Effects of innovation on competition
  - A leading firm that innovates gains market share
  - It does not fully pass on the productivity improvement to a lower price for consumers
  - But it also reduces the markups of the follower firms
  - A follower firm that innovates (or a new entrant) forces the leading firm to lower its price
- Welfare impacted by changes in aggregate price index and the level of profits

Ricardo Example

- In Ricardo limit with big step size
  - Leader firm 1 prices at monopoly price
    - $p_1 = \frac{\sigma}{\sigma - 1}\frac{1}{z_1}$
  - Innovation by leader $z_1 \uparrow$ lowers leader price
  - Innovation by second firm $z_2 \uparrow$ has no impact on equilibrium
- In Ricardo limit with small step size
  - Leader firm 1 prices at marginal cost of follower
    - $\frac{\sigma}{\sigma - 1}\frac{1}{z_1} > p_1 = \frac{1}{z_2} > \frac{1}{z_2}$
  - Innovation by leader $z_1 \uparrow$ has no impact on leader price — only increases leader profits
  - Innovation by second firm $z_2 \uparrow$ reduces leader price and profits. No impact on production efficiency

Wrapping up

- How many products are “Romer” or “Ricardo”
  - My guess: none (in the demand sense)
  - Every firm has close and more distant competitors
  - No firm prices at unconstrained monopoly price for category
- This view implies equilibrium innovation and competition are tightly connected
- Policy and Research Challenge:
  - What, if anything, do we want to do about that?