Evaluating Endogenous Growth Models

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Introduction to Economic Growth

How they are the same

The Romer and Schumpeter models share a lot of features:

- The long-run growth rate is $g_A = g_L \lambda / (1 - \phi)$
- The allocation s_R does not influence the long-run growth rate
- Capital accumulation operates just like the Solow model
- The motive for innovation is capturing profits via monopolies

How they are different

The Romer and Schumpeter models have distinctions:

- The notion of technology is different: new products (Romer) versus better products (Schumpeter)
- Firms persist in Romer, they are replaced in Schumpeterian model
- Additional factor in s_R for Schumpeter, the probability of replacement
- If $g_A < r - g_L$, then s_R is higher in Schumpeter: discount rate on future is "big"
- If $g_A > r - g_L$, then s_R is higher in Romer: discount rate on future is "small"

What kind of innovation occurs?

Both kinds of innovation obviously happen:

- Klenow and Li (2020) estimate the importance of both
- 27% of growth via new varieties (Romer)
- 13% of growth via replacement by better versions (Schumpeter)
- The other 60% is via "own innovation": existing firms improving own products
- Our models don't allow for this. Why?

Own innovation

Why didn't we have "own innovation" in our models?

- Arrow replacement effect (Arrow, 1962). Existing firms destroy own profits by replacing varieties.
- Assumption of "drastic" innovation: older varieties assumed to be unprofitable

Can we think harder about this?

- The Arrow effect is present no matter what.
- But innovation isn't always drastic,
- Which means firms may persist and want to innovate to "take the lead" again
- Which leads to complicated strategic considerations as they compete

Strategic considerations

More nuance about how firms make choices. Will compare fixed cost of innovation to the *change* in firm value from innovation,

$$F = V_{new} - V_{old}. \tag{1}$$

Our basic Schumpeterian and Romer models assumed V_{old} was zero. The comparison of V_{new} and V_{old} depends on the

level of competition between firms

Competitive market

Assume firms are "close" in product quality, and they are in a competitive market. Their products are close substitutes (e.g. gas) or easy to make close copies of (e.g. clothes).

- The value $V_{old} \approx 0$ because of the competition
- If they do innovation, V_{new} would be very big, they "escape competition"
- The gap is big and the incentive to innovate is high for *both* firms

Competitive market

Assume firms are “far” in product quality, and there is a clear leader and follower. But this is still acompetitive market.

- The leader already has profits, so $V_{new} - V_{old} \approx 0$ (the Arrow effect)
- The follower can catch up, but that just makes them competitive, so $V_{new} - V_{old} \approx 0$.
- Neither has a big incentive to innovate

Competitive market

In competitive markets:

- Lots of innovation when neck-and-neck
- Which means there is quickly a leader and a follower
- At which point innovation slows down
- So the industry tends to end up with a leader and follower
- And little innovation overall
- And *more* competition would *not* make this better

Non-competitive markets

Assume firms are “close” in product quality, but they are in a non-competitive market. Think of firms that collude or have distinct segmented markets (e.g. hospitals or airlines)

- They already earn profits, so V_{old} is big.
- The gain from innovation, $V_{new} - V_{old} \approx 0$
- Neither firm has an incentive to innovate. They can just keep their existing profits.

Non-competitive markets

Assume there is a clear leader and follower, but they are still in a non-competitive market.

- The leader already has V_{old} that is big. There is little gain to innovation
- The follower can innovate and split profits with the leader, $V_{new} - V_{old}$ is big
- Followers have a lot of incentive to innovate

Non-competitive market

In non-competitive markets:

- Lots of innovation when there is a leader and follower
- Which means they are quickly even or equal
- At which point innovation slows down
- So the industry tends to end up with equal firms close in quality
- And little innovation overall
- And *more* competition *would* make this better

More competition and innovation

Comparing these situations gives us no clear answer on competition and innovation

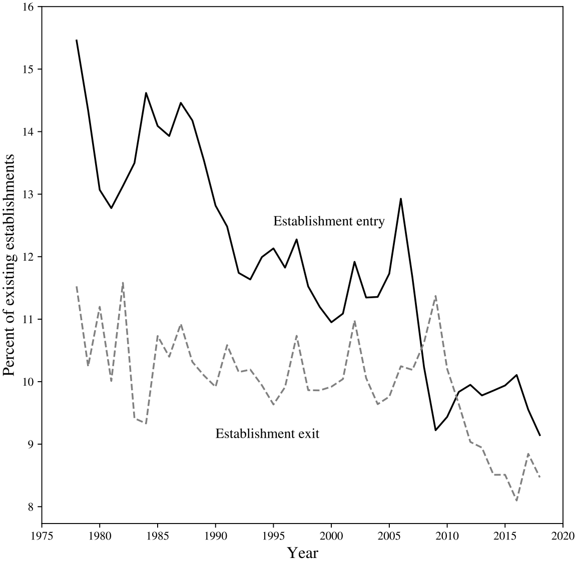
- When markets are competitive, more competition can lower innovation
- When markets are very uncompetitive, more competitive can raise innovation
- There is some middle ground of competition which maximizes innovation
- Firms need to fear being replaced
- But need to know they can hang onto some profits
- Perfect competition doesn't maximize growth

Schumpeterian dynamics

The Schumpeterian model explicitly links firm entry and exit and economic growth

- We know the long-run growth rate doesn't depend on how fast firms turn over
- ..but the *level* of productivity depends on $E[dN]$
- ..which influences how fast firms replace one another

Declining rates of entry and exit



Implications

If firm entry/exit is lower, this tracks to lower $E[dN]$ in the model:

- Which could be indicative of lower s_R
- ..but measured s_R appears higher (see Chapter 4)
- ..so either the measure of s_R is imperfect (possible)
- ..OR something else changed in the economy

Implications

Assume s_R did go up, but $E[dN]$ did fall, how might that work?

$$\frac{s_R}{1-s_R} = \frac{\alpha(1-\alpha)}{(1-\alpha)} \frac{E[dN]}{r - g_A - g_L + E[dN]}.$$

One possibility is that α changed

- If $\alpha(1-\alpha)$ goes up, the profit share goes up
- While $(1-\alpha 0$ goes down, and the labor share falls
- This would drive firms to raise s_R
- And could offset a drop in $E[dN]$

Indicative of rise in “winner-take-all” innovation?

Are we doing enough R&D?

There are several reasons s_R won't be the optimal value. A first is:

- Firms value profits of innovation, but do not take into account the effect of their innovation on others.
- If $\phi < 0$ raising A lowers the innovation rate. Firms could do too *much* innovation.
- Or if $\phi > 0$ raising A raises the innovation rate. Firms do too *little* innovation.

Are we doing enough R&D?

A second reason s_R isn't optimal:

- If $\lambda < 1$, then doing R&D crowds others, lowering the rate of innovation
- In this sense firms do too *much* innovation
- R&D would be improved if more coordinated

Are we doing enough R&D?

A third reason s_R isn't optimal:

- To ensure economic profits we need to make ideas excludable
- That happens via patents, copyrights, etc.
- These rights give firms monopolies, or market power, over that idea
- Monpolists tend to under-produce while maximizing profits
- Consumers would like it if innovators produced more at a lower price
- There is too *little* innovation because firms only account for their profits

The social return to R&D

Jones and Summers (2020) try to calculate the social value of R&D. The PDV of GDP per capita given growth of g_A is

$$\frac{y_0}{r - g_A} \tag{2}$$

givn initial value of y_0 and a discount rate of r. If there was *no* innovation, the PDV would be

$$\frac{y_0}{r} \tag{3}$$

so the benefit of R&D is

$$\text{Benefits} = y_0 \left(\frac{1}{r - g_A} - \frac{1}{r} \right). \tag{4}$$

The costs of R&D

The costs of R&D are the resources and workers we apply to R&D, who don't produce goods and services in the near term.

$$\text{Costs} = \frac{w_0 s_R}{r - g_A}.$$

where $w_0 s_R$ are the wages of the fraction s_R of all workers who do R&D.

Benefit/Cost ratio

Calculate the ratio of benefits to costs as:

$$\begin{aligned} \rho &= \frac{\text{Benefits}}{\text{Costs}} \\ &= \frac{y_0\left(\frac{1}{r-g_A} - \frac{1}{r}\right)}{\frac{w_0}{r-g_A}} \\ &= \frac{y_0}{w_0 s_R}\frac{g_A}{r} \\ &= \frac{g_A/r}{(1-\alpha)s_R} \end{aligned}$$

Benefits are high if g_A is high and/or s_R is low.

Quantifying the benefits

Let $g_A = 0.018$, $r = 0.05$, $(1-\alpha)s_R = 0.027$, meaning R&D costs 2.7% of GDP.

$$\rho \approx \frac{0.018/0.05}{0.027} = 13.3.$$

One dollar of R&D returns about 13 dollars of present value. A huge return! Implication is that we should do a *lot* more R&D. Jones/Summers calculate that if R&D cost around 50% of GDP, it would still be worth it!

Why is R&D so powerful?

What makes R&D and innovation so valuable?

- R&D uses rival inputs (workers, some capital) *today*
- But produces non-rival ideas that can be used by others
- And can be used *forever* (or at least a long time)