Econ 110A: Lecture 10

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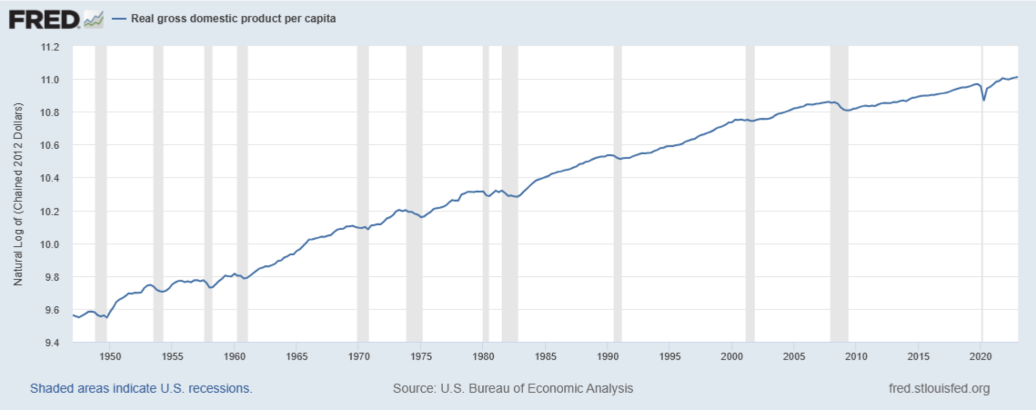
UCSD, Summer Session II

What is the ultimate cause of sustained economic growth?



The Romer Model

"Factor-based" representation of the production function

$$\underbrace{Y_t}_{\substack{\text{output} \\ \text{value added}}} = F(\underbrace{A_t}_{\text{ideas}}, \underbrace{K_t}_{\text{capital}}, \underbrace{L_{yt}}_{\text{labor}})$$

$F(A_t, K_t, L_t)$ is your production function. If $F(\cdot, \cdot, \cdot)$ is Cobb-Douglas, then:

$$Y_t = A_t \cdot K_t^{\alpha} L_{yt}^{1-\alpha}, \qquad 0 \leq \alpha \leq 1$$

The Romer Model

For now, to simplify things, assume $\alpha = 0$. Then:

$$Y_t = A_t L_{yt}$$

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What is A_t? Endogenous growth models:

- Process innovation: quality improvements to existing products, new techniques;
- Product innovation: new product varieties, new management practices.

Romer had in mind **product innovation**, even though it is not obvious in this simplified version of the model.

The Romer Model

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- So $L_{at} = \ell \bar{L}$.
- As a consequence, $L_{yt} = (1 - \ell)\bar{L}$.
- Finally, ideas are produced by allocating new researchers (labor) to it:

$$A_{t+1} = A_t + \bar{z} A_t L_{at} \iff A_{t+1} - A_t \equiv \Delta A_{t+1} = \bar{z} A_t L_{at}$$

The Romer Growth Model: Taking Stock

Normalizing the price of the output good $P_t = 1$ each period, for each period $t \in \{0, 1, 2, \cdots\}$, given parameters $\bar{z}, \bar{\ell}, \bar{L}$ and the initial value of the stock of ideas A_0 there are four unknowns $Y_t, A_{t+1}, L_{yt}, L_{at}$ and four equations:

$$
\begin{aligned}
Y_t &= A_t L_{yt} && (1)\\
\bar{L} &= L_{yt} + L_{at} && (2)\\
\Delta A_{t+1} &= \bar{z} A_t L_{at} && (3)\\
L_{at} &= \bar{\ell}\bar{L} && (4)
\end{aligned}
$$

that characterize the solution to this model.

Solving the Romer Model

- Output per capita is:

$$\frac{Y_t}{\bar{L}} \equiv y_t = A_t L_{yt} = \frac{A_t(1-\bar{\ell})\bar{L}}{\bar{L}} = A_t(1-\bar{\ell})$$

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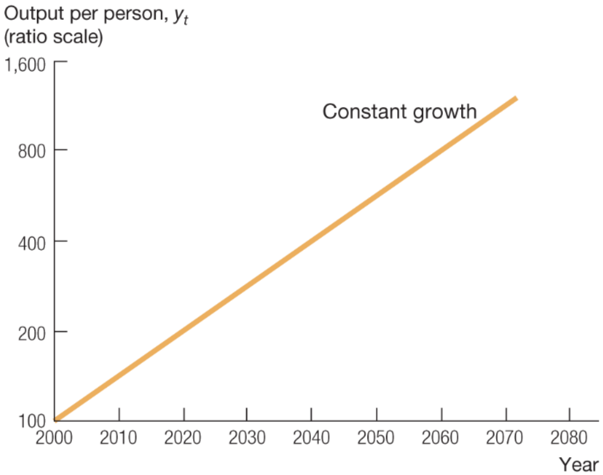
- Using the properties of **compound growth** (remember those) can then write A_t, y_t:

$$A_t = A_0(1+\bar{g})^t, \qquad y_t = A_0(1+\bar{g})^t(1-\bar{\ell})$$

The Balanced Growth Path



$$\ln y_t = \underbrace{\ln[A_0(1-\bar{\ell})]}_{\text{intercept}} + t \cdot \underbrace{\ln(1+\bar{g})}_{\text{slope}}$$

The economy is in a balanced growth path (BGP) when **all endogenous variables grow at the same constant rate.**

The Romer model has **no transition dynamics.** It jumps directly to the BGP.

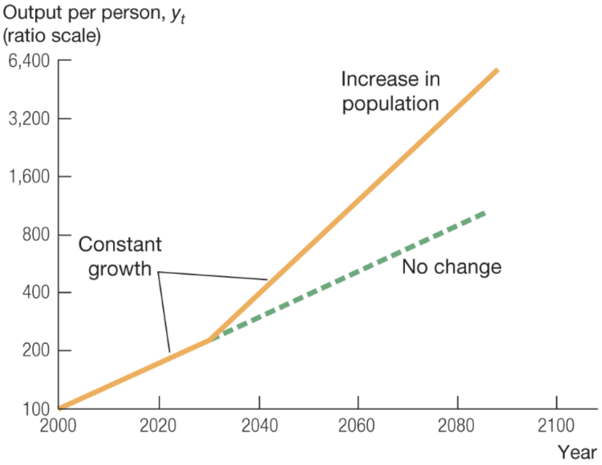
Experiments with the Romer Model

Experiment 1: Increase in Population

Suppose the economy is in the balanced growth path of the Romer model.

Unexpectedly, there is a permanent increase in Population, from $\bar{L}$ to $\bar{L}' > \bar{L}$ for all $t \geq t'$. What happens to output per person?

Experiment 1: Increase in Population



$$\underbrace{(1+\bar{z}\bar{\ell}\bar{L}')^{t-t'}}_{\text{new slope}} > \underbrace{(1+\bar{z}\bar{\ell}\bar{L})^{t-t'}}_{\text{old slope}} \text{ for all } t \geq t'$$

Experiment 1: Increase in Population

- Production Model: y falls when $\bar{L}$ is increased.
- Solow Model: y falls at first when $\bar{L}$ is increased, then returns to initial level.
- Romer Model: y does not fall when $\bar{L}$ is increased, it grows faster instead due to scale effects and nonrivalry of ideas.

Experiment 2: Increase in the share of researchers in the population

Suppose the economy is in the balanced growth path of the Romer model.

Unexpectedly, there is a permanent increase in the share of researchers in the population, from $\bar{\ell}$ to $\bar{\ell}' > \bar{\ell}$. for all $t \geq t'$. What happens to output per person?

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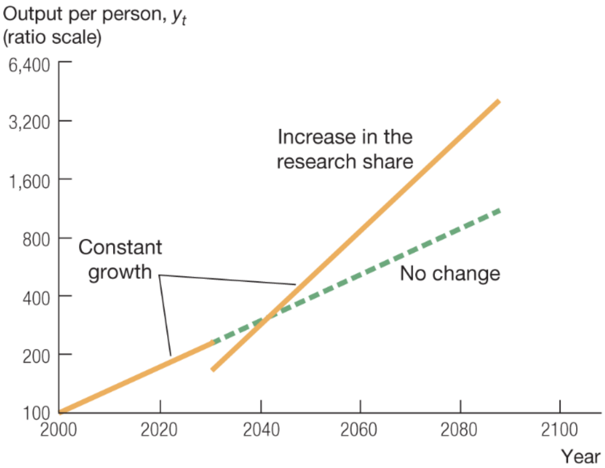
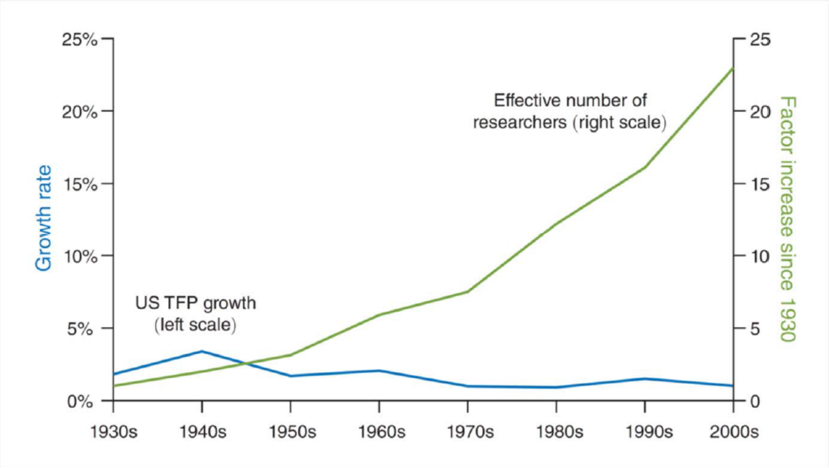


$$y_t = A_0 \underbrace{(1 - \bar{\ell})}_{\text{level effect} \downarrow} \underbrace{(1 + \bar{z}\bar{\ell}\bar{L}')^t}_{\text{growth effect} \uparrow}$$

Experiment 2: Increase in the share of researchers in the population

The Romer model predicts that more researchers (higher $\bar{\ell}\bar{L}$) imply a higher sustained TFP growth rate. Is there evidence of this in the data?



"**Are Ideas Getting Harder to Find?**" Bloom, Jones, Van Reenen, Webb (AER, 2020)

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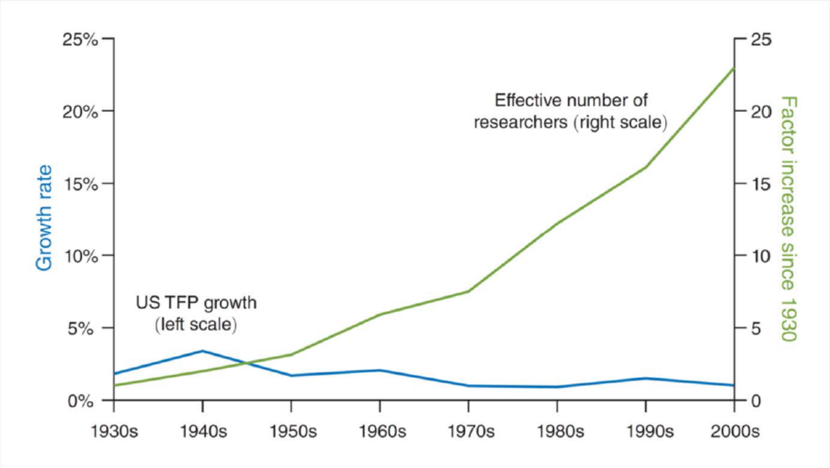

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Experiment 3: Increase in research productivity

Suppose the economy is in the balanced growth path of the Romer model.

Unexpectedly, there is a permanent increase in research productivity, from $\bar{z}$ to $\bar{z}' > \bar{z}$. for all $t \geq t'$. What happens to output per person?

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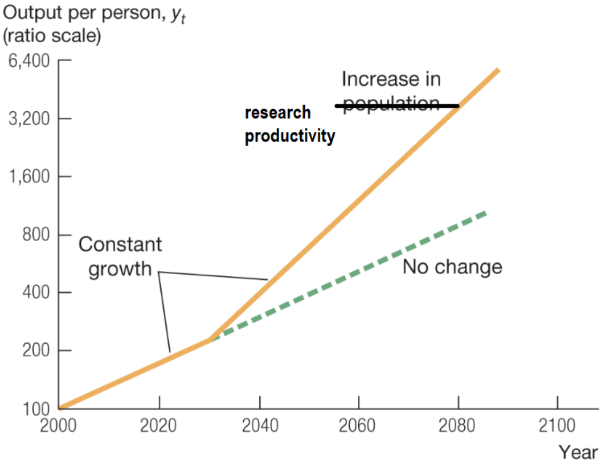


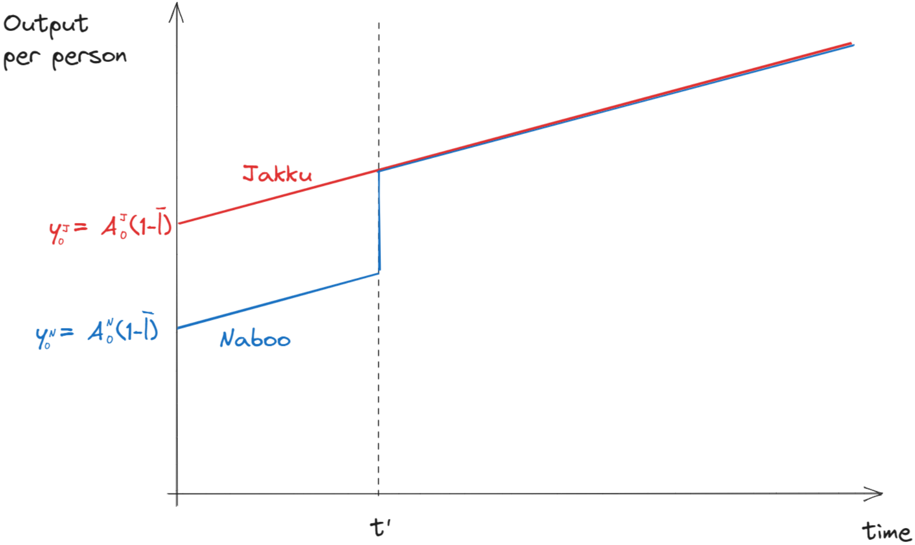
$$\underbrace{(1+\bar{z}'\bar{\ell}\bar{L})^{t-t'}}_{\text{new slope}} > \underbrace{(1+\bar{z}\bar{\ell}\bar{L})^{t-t'}}_{\text{old slope}} \text{ for all } t \geq t'$$

Experiment 4: Knowledge diffusion

Suppose there are two economies in isolated planets, Jakku and Naboo. Both economies are in the Balanced Growth Path of the Romer model, and are otherwise identical, except that Jakku has an initial stock of ideas larger than Naboo, namely $A_0^J > A_0^N$.

This means that every idea known in Naboo is already known in Jakku but the opposite is not true. Unexpectedly, the to planets discover each other and share their current stock of ideas. What happens to output per person in both economies?

Experiment 4: Knowledge diffusion



Takeaways

- While Solow divides the world between capital and labor, Romer divides the world into ideas and objects (labor in this simple version)
- Ideas are nonrival, which induces increasing returns to scale in ideas and objects taken together
- But growth also comes with some inefficiencies: increasing returns to scale (fixed costs) imply that $P > MC$ in some places, so there is some deadweight loss.
- Growth ceases in the Solow model because of diminishing returns —which also explains transition dynamics.
- Because of nonrivalry, ideas do not run into diminishing returns and this allows ideas to be sustained.