

**STEG Virtual Course on
"Key Concepts in Macro Development"**

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Supplemental lecture: Technology diffusion and adoption

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Q: In the Neo Classical Solow Swan Model with technological progress convergence occurs through change in K/L or growth in k or y takes place. so here the difference is in terms of technology diffusion leading to Increasing returns to scale?

A: Probably the way I would explain this is in relation to Richard Rogerson's first presentation. This is looking at exactly how countries catch up to the global technological frontier. Richard simply alluded to the gap between a country's A_i and the global $A_{\bar{}}$. Chris is focusing on the way that technology diffuses from the frontier to the countries that are behind the frontier. No increasing returns needed, necessarily.

A: These models (can) lead to convergence in TFP over time rather than all through capital. Often non-rival ideas lead to increasing returns to scale (ala Romer), but the diffusion itself is more about the dynamics of TFP rather than returns to scale.

Q: What about countries proven to leapfrog?

A: The idea here is that countries might be able to leapfrog a lot of technologies in the middle, but still difficult to innovate at the global frontier. So that's consistent with the way I hear people using the term 'leapfrogging' in popular discourse... A country might skip grid electricity and jump to off-grid renewables... Or skip landline phones and jump straight to smartphones. But those conversations are seldom about countries jumping from far behind the frontier to actually innovating at the frontier.

A: My comment comes from context of manufacturing vs technological innovation and whether leapfrogging in one is more possible than the other

Q: You have been discussing cross-country differences. With firm heterogeneity and the evidence of large productivity differences across firms, can this diffusion model be mapped into a within-country setting?

A: Yes, very much so... And that's coming next, I think.

Q: the models you're speaking about look at the desire for continued growth and continued search of betterment, perfection, or new skills. are there models which look at decision making and "satisfaction" or where a farmer is "comfortable" with one method and needn't new methods. It also has to do with changing consumer behaviors and the decisions being made in the future of work sphere by both firms and consumers. I advocate for cross disciplinary economics

A: This is an interesting question. There is an old literature on 'satisficing' relative to 'optimizing', but this literature is very much focused on optimizing choices. We recognize that the optimization decision doesn't necessarily imply maximizing output... And in many contexts, an agricultural household facing market failures might not even maximize profits as such. (See the literature beginning with Singh, Squire, and Strauss 1986 on the agricultural household. In that framework, households facing market failures could optimize without maximizing profits... For instance, leisure and other arguments of the utility function might enter the production decision.

A: This question actually involves a deeper philosophical question and a potential critique of economics more broadly. As a practical answer, however, our methods of optimization require something to be maximized to give predictions for human behavior and the central economic question of scarcity presumes some unsatiation on the margins.

Q: Continuous time setup is easier because of closed form solution? Or something else? I mean compared to discrete time setup.

A: I am not sure about the particulars of this situation, but sometimes there are simply a broader set of mathematical results for differential equations, and thresholds can be easier because they meet with equality rather than checking inequalities. Feel free to ask Chris afterward, if he doesn't address it.

Q: On the point that larger population would allow more draws from the idea distribution: This does not seem to match with high population growth in poor countries and persistently low agricultural productivity in these countries. So how applicable is this model to poor countries?

A: In terms of mechanisms, Kremer's famous paper linked population levels to technology levels using the end of the ice age as a "natural experiment". However, diffusion itself may be slow, so perhaps the benefits of population are not realized because of low diffusion. Similarly, high population growth may limit the accumulation of complementary inputs (e.g., physical or, perhaps more relevant, human capital). A small educated population may produce more ideas than a large uneducated population, for example.

Q: If a firm decides to search, they have to use the new technology that they draw, or they can keep producing with their old technology?

A: They use the max, i.e., the better of the technologies.

Q: Chris might get to it, but how does this ensure a non-degenerate equilibrium distribution of productivity?

A: The distribution shifts rightward over time and is unbounded... actually, he is answering it right now. Once you normalize by the growth, things are stable (and nondegenerate).

Q: Do these models include risk aversion perhaps? A model where some technologies like flood-resistant seeds are adopted but others that are perceived high-risk are not adopted despite higher returns?

A: I have not seen that introduced in these models. There is certainly work on risk and technology adoption, work by Donovan on the macro side, Udry, Foster, Rosenzweig, Emmerick, and others on the microside come to mind.

Q: Clarification q (sorry if I missed it) In the model just discussed does the distribution of firm productivity settle down to a stationary distribution or if not why is it that the distribution can keep shifting indefinitely? (is the idea distribution firms draw from is shifting over time?).

A: The one he just went over leads to a productivity distribution that keeps its shape but shifts to the right over time. However, properly normalized it is stationary. So, akin to a BGP vs. a normalized steady state, if you think back to first year macro.

Q: What is the advantage of thinking of this model in an open economy setting? What would we not get if we shut down the international trade side?

A: They use an open economy because they want to be able to use the model to address questions on openness.

Q: More of a conceptual question - how well do firms know the distribution of and law of motion of productivity? Like, how public is that knowledge?

A: This is a bigger question about rational expectations assumption and how well-informed people are in general. Lucas had key contributions applying RE to macro monetary policy, and yet at the same time he had a monetary model, where people weren't fully informed about the state (only the distribution).

A: I could imagine that higher productivity firms get more media coverage, making the perceived distribution higher than the actual distribution.

Q: What's the intuition for the "smooth pasting condition"?

A: This has to do with Brownian motion and the option value that would be available to wait near a kink. If there were a kink, one could always do better by waiting an instant, and so things need to be smooth.

Q: Is it possible to study discrete number of firms in economy in this setup? I am thinking about something like “oligopoly model”, so firms have market power...

A: I will ask Chris this question at the end.

Q: Can you explain conceptually “technology diffusion” vs “business stealing”? Both are firms increase productivity based on other firms; what is difference in terms of modelling, etc? For business stealing I am thinking about Schumpeterian growth model

A: Business stealing has to do with profits. Diffusion is about “nonrival” ideas. These models are typically competitive producing a single homogenous good, so not profits to steal. If we have time, I will let Chris answer.

Q: Would you say China is a good example of the success of technology adoption?

A: Certainly. It has played an important role in all of the East Asian growth miracles. The technologies that were originally adopted were all from abroad. Places like Korea are now innovating at high levels as well.