

MITOCW | 3. Growth, TFP, and Inequality

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ROBERT In terms of where we are in the class, it seems like we just got started, but it's actually the third lecture. So after
TOWNSEND: the end of the day, we're almost 1/4 done with a class. It's scary. Yeah, it's bad news, not good news.

There's another way to think about that, which is there's no final exam. There are homeworks-- they're coming-- and TA sessions. But part of the course is for you to write a research proposal, not a paper exactly, but a research proposal.

So that kind of leads me into what we're up to today and some sort of encouragement and caution. We are trying to do several things at once. One, of course, is to look at particular papers in the literature as exemplary of what is out there. And actually, there, it matters to get into the details and really understand the mechanics and a few of the surprises. Some things are not straightforward. And even narrowly, it will raise questions about what if they had assumed this instead of that, or is there some extension to this model, or there's something I just really dislike about this model? You'll get inspired.

So we're doing that. But I'm also trying to provide overviews so you can actually see where these particular trees fall in the forest. And I'm not saying it's easy. It's not easy for me. And I, for example, spent the weekend just thinking about lecture one, lecture two, and lecture three, sort of writing up English paragraphs about what are these papers really telling us and so on.

So my point is be patient with yourself. Don't be surprised if occasionally it's a bit bewildering because we are covering a lot of material. But the reward will come when you're thinking. Go back over the lectures, think about the details of particular papers. Maybe think about it in the context of your potential research proposal, in terms of what you might like to do, and I think you'll see things start coming together. Yo.

AUDIENCE: Can you talk a little more about the logistics of the proposal? So one thing is I was supposed to talk to you before.

ROBERT That would be good, yeah. As I said, I'm usually around. I try to stay around after class. I'm happy to iterate. It's
TOWNSEND: like a research conversation. You're thinking about x. You can get my reaction to it, get Whit's reaction to it.

AUDIENCE: And how far can we go from this, from the macro development into something else? It has to be something that's--
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[INTERPOSING VOICES]

ROBERT We should talk. I'm not sure what you're asking me.

TOWNSEND:

AUDIENCE: If I am doing something that's more micro-related, would that be--

ROBERT Oh, there's a whole micro part of the class. We just haven't gotten there yet. There's, like, two lectures away, we
TOWNSEND: go through a whole measurement lecture. And then we spend almost the rest of the class talking about micro tests of this and that. And then we reintegrate it and get sort of moved back toward the macro.

Sometimes I teach the micro first, waiting forever to get to the macro part. This time we kind of reversed it the other way. So micro is fine.

AUDIENCE: And just in terms of timing, I forgot. When is the proposal due? Is it at the end of your part, or--

ROBERT TOWNSEND: The end of my part, yeah. And we reserve the last class, and I can make it longer. As many of you as possible should think about actually presenting and getting some practice at presenting your ideas.

OK. So today is mostly, almost all of it, about limited commitment in terms of obstacles to trade. And I'll try to highlight where that's coming up. The topic, is of course, macro-ish, growth, TFP, inequality. But it has these financial market imperfections. And of course, that's the bridge back to the micro. And the introductory part of this, where I'm doing the big picture, the forest, is broken down into three segments, one of which is highlighted, here but I should tell you about the other two.

First of all, we're going to start talking about transitions. I was doing that last time. Some of this literature is all about transitions and about financial reforms or real sector reforms. There is a second part of this introductory section which is entirely about cross-section. It's comparing one country to another, and most of that is in steady state.

And finally, there is the link between the two, which is how much of transitional dynamics is really going to solve the entire problem, and can you save your way out of constraints so that steady states look very different from the transitions, or is there something left over.

So you start off with what's in the news all the time, rightly so, which is China. And this paper is called *Growing Like China*. And the question starts with a puzzle. How can it be that a country with measured high rates of return is nevertheless kind sending its funds abroad for investing in low rate of return assets?

And China's in the news for many reasons, but among other things, it's just really almost the fastest growth rate in the world, and there's lots of structural shifts going on in terms of sectors and a lot of privatization. We have return investments above 20%. Savings rates have been even higher than that. And China's accumulating-- its savings well exceeds its demand for credit, and its foreign reserves have to go to trillions or something, from \$21 billion to \$2,130,000,000 and so on.

So here is another picture. This is those numbers. This is foreign reserves and the difference between deposits and loans. And not only is the difference between deposits and loans high, it keeps getting bigger and bigger, as do the foreign reserves as a percent of GDP.

You probably know this history. There was talks of reforms way back in 1978. A lot of people date the real turn in 1992, although additional things happened in 1997. Just to look ahead a bit, the next paper we're going to talk about is where Kaboski Shin, and they look at reforms across a bunch of countries. And they used this 1992 date. But I think for any particular country, it's kind of problematic to pick one year and say this is the year of the reform.

Very high investment rates. 39% of GDP. Rate of return on capital, at most, has fallen. To 21%. Rate of return on capital in manufacturing is close to 35%. Money should be flowing in there, not flowing out. This is DPTE, I think, is developing private enterprise as opposed to state-owned enterprise. And here you can see early on, in 1992, the private sector was employing relatively few workers. But this has been increasing so that-- I guess this graph's ending in 2006. Private sector is now like 50% of employment.

And here is the picture of the share of investment. And this is a big part of the story financed by bank loans, distinguishing state-owned enterprise from basically these developing private enterprise. So the point is, the money from the banks is going into these state-owned, state-operated manufacturing and other enterprises. They're getting something like 35%, if not 40% of their money not from internal finance, but externally through these banks. And the opposite is true. At best, this is now 10%. It used to be, like, 5%. So the private sector is financing itself with saving and internal investment.

So what's the story here? It's going to be a story of reforms, and then this shrinking, inefficient, state-operated sector releasing labor into the rest of the economy. And in fact, what's going on here is even though in principle, the production functions have diminishing returns, you don't suffer from diminishing returns for a long time because you can get all this quote, unquote labor that's being released by the other sector.

In some sense we saw this already with the Thai model last time, where we had labor and agriculture at subsistence wages being able to flow toward these entrepreneurs. That's kind of happening here. It's not out of agriculture, it's out of government, enterprise. And there are some very related seminal pieces. Arthur Lewis, one of the pioneers of development economics, and more recently, Jaume Ventura, have talked about how you can prevent diminishing returns from kicking in.

This is their view of the literature. I'm going to skip it. You can look at these slides later. Authors kind of have different views of what they do relative to the literature than the literature has about what these guys are doing. Yes.

AUDIENCE: In China is there evidence of in the time series of like convergence in [INAUDIBLE]

ROBERT TOWNSEND: I don't remember the panel aspect of that. I mean, there is kind of an average going on here between these inefficient state-owned enterprises and the private sector ones. And they go to an extreme that the return in the private sector is basically constant. If the aggregate's rising, it's because you're shifting more and more toward these-- yes.

AUDIENCE: I'm not sure that I understood exactly the argument they were [INAUDIBLE]. So was the idea that if I were a local investor in China, I want to invest in the private sector, but I wouldn't be able to because that money that goes into the financial sector China is funneled to state-owned enterprises?

ROBERT TOWNSEND: Yeah. It's not modeled deeply, but the idea is there's constraints on the borrowers. The private enterprise sector would like to borrow because the rate of return is really high, and they would make more money. But there is a simple, basically constraint on the amount they're able to borrow. So this is the limited commitment/collateral constraint. And that's the break. That's the key thing that's preventing the money from flowing, so they can't flow from one sector to the other. It flows out because the country overall is getting wealthier.

OK. But this is one of the papers where we're going to go and study the tree in some detail. And it's trickier than then this English might imply.

So this is the Buera Shin. Sorry, this one doesn't have Kaboski. As the co-author, unlike what I said. This is called *Financial Frictions and the Persistence of History, A Quantitative Explanation* so you know a lot of people beyond China have remarked on how successful Asian economies have been postwar for Japan and so on. And so they're going to study the so-called Asian miracle economies, and they're going to date the reforms.

And what their paper is about is basically if something had been kind of a roadblock, and you remove the roadblock, then these economies might look like solo economies. And we'd expect a very rapid convergence as capital increases. But in fact, when you calibrate these miracle economies the way you would a solo model at reasonable parameter values, although they're growing remarkably over 20-, 30-year periods, their growth rates are lower than you would predict and convergence is slower than what a simple solo model would predict.

So they're going to do this experiment. Now the thing, again, that's going to be the key element here is something like a collateral constraint. So you have all this churning and reallocation going on, but it can't happen right away. In fact, investment rates rise, total productivity rises. But it takes quite awhile. What countries are we talking about? Japan, Korea-- that's South Korea, by the way-- Malaysia, Singapore, Taiwan, Thailand. Apologies for listing Taiwan separately from China. I'm not going to get into big diplomatic issues here.

And this I already said. If you want to know something about the parameters they stick in, you can look at it. But here are some beautiful pictures. So we have, say, per worker, GDP relative to the US, this one is US worker productivity, and it's GDP divided by workers. And you can begin to see the labels of the countries here. This is the dating of the reform. Talk about 1992 for China. Each country, they-- heroically, I'm sorry, confess. I mean, if you read the history of Korea or Taiwan or whatever, it's really, really hard to come up with a date, but they did.

Thailand is in here. That's cool because we can compare it to other papers and so on. Japan. Singapore. That's per worker GDP. This is the investment out. Oh, this black line is kind of the unweighted average over all these countries. TFP. And private credit relative, again, to the US. By the way, this is that Thai credit boom we talked about last time. Yes.

AUDIENCE: How important is the assignment of the zero date here?

ROBERT TOWNSEND: They do not report. Presumably they played around. I hope they didn't cook it. I doubt they did. I know them quite well.

AUDIENCE: [INAUDIBLE] And it's just like in the series here. It looks like if you do the plus or minus two or three years, you still get similar breaks. Maybe not plus two.

ROBERT TOWNSEND: Well, you kind of hope that-- I mean, that kind of comes with the fact that things are slow. Even if you believe that it's a radical reform, the way they construct their model economy, it will happen slowly. So if you're off by a couple of years in your dating, I don't know. There's hardly anything here that really jumps. That's what you're saying. If you look at that line. For none of the countries is there, like, something popping up.

There's a slide with interest rates. I didn't quite understand those. But that could just be the reforms because interest rates are-- however, that said, ironically, their focus is on subsidies and taxes distorting the economy. And then the reform is elimination of those wedges, but they leave the financial sector intact. So forget what I said about the interest rate picture.

So here are these same, or related variables, GDP, TFP, investment rates, and so on. Now keep an eye. The black lines are-- the light gray line is the actual data. So this is what we're trying to get at. I think that's an average over the countries. And here's this interest rate one that I don't understand.

But anyway-- oh, and then there's two other lines here. The dotted one is where you basically eliminate the financing constraint in their model. And the lambda they use, largely, this 1.35, is the black line. So what they're claiming, and you can decide whether you believe it or not, is that largely the data are close to the black line and pretty far away from the dotted line so that the financial frictions really help in the explanation.

So I'm frowning when I'm looking at this. And then you should be inspired because this is a famous paper, I think rightly so. And they're candid. Look at the data. It's like I showed you my Thai data. I mean, it's not like they're hitting a home run on all these variables. Some of them look pretty far away from either prediction.

But again, I think they want you to see the other end of it, that the transitions at the dotted line are just much faster than sometimes even in their model, but certainly, then, in the data. That's the point of the paper is how to slow down the growth.

AUDIENCE: [INAUDIBLE] So what you're saying is that the lambda, 1.35, is what they use? So they basically say that the reforms don't eliminate everything. So there's still a lot of--

ROBERT
TOWNSEND: Yeah. So the idea is you've got these lazy, untalented, rich firms that are overfunded because they're getting a subsidy. And you've got these lean, high productivity, private sector firms-- not state versus private, but in this case, private with talent and private without talent. And then you kind of eliminate the subsidies end and the taxes. And resources would like to flow to the high productivity firms, but it doesn't happen right away because you jam into these financing constraints. So it takes a long time.

Now their model is going to have forward-looking entrepreneurs. So these guys who are talented but constrained, now not suffering from taxes or something, they're going to be saving at high rates to try to overcome the financing constraints. And eventually that kicks in, but it takes time to accumulate capital sufficiently high value to be able to collateralized it to borrow some multiple and so on.

AUDIENCE: How do they [INAUDIBLE]?

ROBERT
TOWNSEND: They're using something like the initial external finance ratio credit to GDP, which varies across country. Yeah, so it's not-- I don't know which land. Maybe that was a particular country, and I didn't pay enough attention when I grabbed their slide. But it's different, certainly, for different countries.

And then they make a point about these companies hiring more and more workers and getting bigger and bigger. And there's something about factory employment you might want to take a look at. I'm not sure which data set I grabbed that from.

So the model we've kind of talked about how they pick parameters. Last lecture I was kind of making a big deal about estimating parameters from micro data. This is more in the macro tradition, where they're calibrating parameters or initial conditions the way we were just discussing. So we've said all this.

There is one exercise they do at the end, where they basically liberalize the financial sector, not just get rid of all the taxes and subsidies. Their language is a bit tricky. I read it three or four times until I finally understood what they were saying. They actually said that helps slow things down. Now what they really meant is the target is better than it was before, and it's going to take a little longer to get there because the steady state is quote, better. But in any event, I'm not going to focus.

This is practically the last slide from them, but you do need to face choices about what reforms you're looking at in a given economy. And what I didn't say last time, and this could have been in the other lecture, is that if you look at, in this case, Thailand, and you look at measures of total factor productivity, you get the usual sort of factor shares. Capital has the highest share. Land, someone asked me about, is relatively low. Factor growth, well, this is the increasing capitalization of the economy. And then share times growth rate kind of makes a contribution. That factors contribution to GDP. And you can see a capital share is almost equal to the total. So again, this is capitalization going on.

And as you get these shifts out of sectors, and this is a quick review, we have the ratio of credit to GDP on one scale and financial access on the other. And you can see this turning point in 1986. That's the credit expansion measured at both the micro and at the macro level. And the point here about TFP is if you feed that in through the model we talked about last time, not only do you get TFP, can actually decompose actual TFP in Thailand into the contribution that's coming from this financial deepening effect. And this is the fit of the model predicted TFP to the measured Thai version of TFP that's coming from financial deepening.

So roughly, that financial liberalization in Thailand-- not other reforms, in this case, just looking at financial reforms-- actually explains something like 78% of Thai TFP growth. And that kind of thing now, for us, in Thailand, it's all on the extensive margin. But for them, all of their reallocation stuff is going on the intensive margin. There is no sector in their model that could not get credit at least up to capital, whereas in Thailand, they just didn't have bank branches in many parts of the country. So it's a different interpretation.

Now you know not everyone agrees with what's going on in China. This paper is about lifecycle savings. And they claim that the other guys are missing the point. And in particular, savings rates between the US and China varied a lot. And they used to be more similar than they are now. In 1988, savings rate across the household sector was roughly 5%. And basically, 20 years later, savings rate in China is up to 30% and the US declined to 2.5%. And all the while, the interest rates are coming down. So this is a puzzle for them. You know, what's going on?

Well, they construct a life cycle model, basically. They construct a life cycle model, and they're going to say, basically, in the US, young people are saving less and less. Guess I should do a poll. Do graduate students save or borrow up to your constraints? But in the US-- sorry, I'm making light of it-- young people are saving less and less. Actually, they're borrowing more and more. So the decline in the world interest rates made credit cheaper for young households. And they're taking advantage of it.

In China, it's the the middle aged guys who are saving more and more. Now the interest rate could have gone the other way. But this is one of these cases where the income effect trumps the substitution effect. And eat now, eat later. There's two goods. What's the Engel curve, so to speak? Higher incomes have generated higher savings in China.

So time and time again, the moral is you have a model. You may see things that don't fit. We already have. Somebody else will come along and try to exploit more data, and either add to the puzzle or provide an explanation for things that weren't fitting so well.

Each model, by construction, is not trying to get at everything. Don't fall into that trap. It's easy to think, if only we get it right, we'll have a totally realistic. All these models are abstractions, to some degree, and they're kind of telling a story about the growth process that's informative. And if there are too many moving parts, not only could we not tell a consistent story, we're going have trouble computing it.

So what's very typical here is to try to explain why TFP varies across countries. There's a huge literature on this called growth accounting. And they're going to attempt to model. This is where the Hsieh Klenow stuff, in terms of measurement, comes in. But they're going to feature something not just in the aggregate. They're going to feature the fact that poor, low income countries not only have low TFP, they have big differences across sectors in terms of productivity and relative prices. In particular, the manufacturing sector is terribly inefficient in low income countries, and the price of capital is relatively high in low income countries.

And they'll construct a model to explain some of those TFP differences. So what's the driver here? And this is one of the trees we're going to study in detail, so I don't want to repeat myself too much. But the idea they had, just to think about how one model differs from another one, is to introduce not only two sectors, but to have varying fixed costs. So the idea is this manufacturing sector, as opposed to what they call services, is the one that has these very big fixed costs.

So you can imagine that with financing constraints, it's very hard for people to invest as they might want to do in something that requires a lot of credit because the fixed costs are so high. And they embed that in occupation choice, so people are choosing whether to be a worker or to operate a business in one of the other sectors.

So as I said, this is all about cross-country data, as if every country were in a steady state. So they're going to go across countries that kind vary in the rate of, say, external finance or private credit to GDP, and see what else happens in the data as you go across those countries.

Where do they get the parameters from? Well, day one I talked about Rajan and Zingales. The other paper does this as well. Basically, you act like the US has wonderfully efficient credit markets. A little harder to swallow these days. And so things like the firm size distribution in the US is as it ought to be, and everyone has the same technology, but they're credit constrained and the US is not. So you sort of calibrate the technology part of the model based on the US firm size distribution, or in this case, manufacturing versus services as well. And then you stick that into these models of the developing country.

Now quite relevant to what we're trying to do in terms of micro and macro all at the same time is they take that setup and do a microfinance revolution. So again, there's the usual collateral financing constraint. It varies across countries. And then-- maybe I can just jump here. Then what they do, so people come in and they have a certain amount of wealth or assets, and then decide whether to be a worker or an entrepreneur.

Normally, the entrepreneur faces some kind of financing constraint that depends on its wealth and maybe on its talent, and fee parameterizes how binding that constraint is. And here's the revolution, which is all of a sudden, you don't have to be constrained. You can get a loan which has nothing to do with your talent. And whatever your asset level is, you get to borrow a fixed size microfinance loan. So they embed that. The point is they're going to embed it in general equilibrium and then watch people choose, kind of do a controlled experiment.

Actually, what they do is a partial equilibrium versus general equilibrium version. So we can look at the partial equilibrium version first, which basically says that you start the economy off, and then you do this microfinance innovation. And most things are going up. Certainly output and capital are going up over time-- sorry, it's cross-section-- go up as the amount of loan from the microfinance sector increases.

All the economies are alike at the beginning, but the extent of the loan size varies in the cross section. And you can see, the larger the loan, the higher is output, the higher is capital in the economy, and not much is happening with TFP.

But it general equilibrium, and you'll see this more in a minute when we go through the predecessor model, both the wage and the interest rate are endogenous. So when you provide credit, you start shifting the occupation choice of people. You start shifting the amount of capital they want to set up and run firms. That is changing the demand for credit. It also, as scale varies, changes the demand for employment starts moving the wage around. And so the general equilibrium effects are quite different, namely output doesn't move, even across economies as credit is moving. Output, TFP, is slightly increasing. And the economies are getting less and less capital. Yes.

AUDIENCE: How do we read the [INAUDIBLE]? How do we read the [INAUDIBLE]?

ROBERT
TOWNSEND: Yeah. I guess we'd have to dig back into the paper to get at the units. Part of it is I think everything has been normalized to have the same unit. I think the answer is it's all relative to this initial-- because all three lines have the same intercept, and that's not likely in any given model. So this is meant to get at what happens in the cross-section as you increase the amount of credit. That's why they more or less all fit on the same diagram.

AUDIENCE: How do you read [INAUDIBLE]?

ROBERT
TOWNSEND: Yeah. This is, again, a microfinance loan. This is just the size of the loan relative, I think this is to initial wealth or something.

AUDIENCE: [INAUDIBLE] down because the guys are having more access to finance because [INAUDIBLE] we get more capital because there are less constrained or something.

ROBERT
TOWNSEND: I'm trying to remember. It all has to do with the interest rates and the wages. I think the interest rates are going down. Look at one more picture and see if that helps. Otherwise, we'll have to dig out the paper. This is for a given economy as you fix the level of the microfinance loan and then vary wealth. So it turns out that in partial equilibrium, more or less, the benefits are the same by wealth. But in general equilibrium, it's the relatively poor people who are able to take advantage.

Maybe the wage is going up. That's part of it. So those untalented people who are workers are benefiting. That has to be true. By talent, over here, by ability, it's not true that the low ability guys are the primary beneficiaries. Basically, the peak is here, both in general and partial equilibrium, although in general, you can see that the general equilibrium makes the peak less, and it drops further.

So the weak statement is the most able entrepreneurs in the country are not benefiting from microfinance, and they may actually be hurt from microfinance when you take into account the general equilibrium effect. I think that's also the wage going up. Yes.

AUDIENCE: So the wage is starting point 8 Is it the same all the way to zero? The x axis?

ROBERT
TOWNSEND: I don't recall enough about how they calibrated this. Yeah, it's either the same, or they've truncated the ability distribution so the units actually start up here at point 8 than at 0. But the point is yeah, the action is here. The same comment, your same question would apply here in terms of what is the scale of wealth.

AUDIENCE: It was the same all the way down to-- suppose that we thought, oh, this is not a rescaling, and it shoots all the way down to the 0. That would be remarkable if literally they were just the same from point 8 to 0. And it's like the only action occurs at the end.

ROBERT
TOWNSEND: Remember, you have this crucial cutoff about who wants to be running a firm. You can be a wage earner, and whatever the wages are, they're fixed in equilibrium. That's the best option for many, many, many people. You have to be sufficiently talented to climb over that threshold and want to run a firm. And when you're running a firm, you could be constrained. You could have-- like China, you could have very high marginal returns, but with that collateral constraint, you can't borrow very much. So even though you have this amazingly high return, you can't exploit it. So the levels of profit stay low.

OK. Well, it may be frustrating that we can't go into the details of this thing more. But in terms of quote, the big picture, you can see them making use of these kinds of models to examine a very relevant experience. Most evidence we have on microcredit is at the micro level, and it's almost, by construction, partial equilibrium.

Joe and I tried to remedy that because Thailand put money in every village, and the villages vary in size. So we actually started to see the wage moving a little bit. But mostly, microcredit, as in RCTs, by construction, is going to have a partial equilibrium effect. But these, what's going on in Bangladesh? The whole country's got it. And we don't see the country without it. But that's why we need the model, to get to these counterfactuals.

And I'm going to skip Joaquin's dissertation. It's on inequality. It's quite interesting. And I'm going to skip this thing about alleviating constraints in the long run. But we'll come back to it in homework and so on with Abhijit and Ben Moll on the persistence of misallocation.

So let's get into the details of this China paper. I think you spent some time at the beginning of class. So maybe I can get by with not having to re-motivate it, and we'll start with the model.

So it is an overlapping generations. That's always a bit heroic. Of course, it makes the thing much more tractable because you've only got, essentially, two periods of life to worry about in the dynamic optimization. Everyone's got the same preferences, by the way, whether you're going to be a worker or running a private firm. And it's over consumption today and consumption tomorrow. θ is a power and β is the discount rate.

Workers. There's not much of an occupation choice thing here. Basically, it's almost as if exogenously, you've got workers versus entrepreneurs, so they downplay that choice, unlike the paper we just looked at. Workers earn some wage. And what do they do with the money? They can put it in the bank at some interest rate R_T . We'll come back to that momentarily.

Entrepreneurs are managers in entrepreneurial firms, and they earn something that makes them want to do that rather than be a wage earner. Now I just got done saying that there's not really any essential occupation choice, but that's because they parameterize this thing so that this return that an entrepreneur can get is always greater than the wage in equilibrium at the parameters they choose.

What can they do with their money? They could also put their money in the bank at the same rate of interest, or they could put it in their firm. But like we've been saying, the rate of return is going to be really high on internal self-financed savings. So that's what they're going to do with their money. They don't put it in the bank. So that's higher than the rate.

And some sort of things to keep an eye on. The population is growing at some rate. I don't know why they did that. I don't know whether they needed to get the model paths closer to the data. But anyway, that is in the model, and I'm not going to talk about it very much. Big story is productivity differences between state and private enterprise.

And here's the production function. So there's two types of technologies. There's kind of a centralized and a decentralized technology. The decentralized technology is going to require managers. In effect, the centralized one doesn't take advantage of having managers, and I'll tell you why. It's pretty artificial. But for now, just note some things here.

There is this exogenous technological progress, so that's kind of classic macro stuff. This A has a T on it. It's going to be growing over time. But it's labor augmenting. It's not sitting out here in front of the production function. It'll be there in a minute, but it's going to carry, inherit this $1 - \alpha$ when you pull it outside.

Here's the χ thing. So if you're in the decentralized private sector, then that technology is augmented by χ . χ is greater than 1. Now the idea is, why doesn't everyone do this? And even the state-financed firms, they kind of tell a story. And the story is basically-- let's look at the decentralized firm first. The decentralized firm has capital. Initially, it comes from somewhere. But during the production period, it's predetermined, and then they can hire labor, and they can hire managers. Managers need to be paid some compensation.

Why this thing? So the idea here is a manager can basically steal the output, walk off with it. And so that's the ψ , the pitchfork thing. So that's kind of like the financial distortion. That's going to drive this thing. The higher is ψ , the more the manager can steal. And in fact, here's the thing. They're saying monitoring somehow prevents these hired managers from walking off with anything, but everything. But only the decentralized firms have this monitoring technology. The state-operated enterprises are so darn inefficient that basically, ψ is equal to 1. So forget having managers. So that's the story.

But it's really rigged, meant to tell a little deeper story than just imposing a finance constraint. So this will be at equality. You're going to have to pay the managers that amount just so they don't steal. And then plug that in, and you get the sort of maximization problem, which is now just maximizing. And you can see, after you pull out the factor labor, factor productivity, that you get stealing is not good. That lowers it, that χ is greater than 1 raised to a power, that raises it. So this is kind of the productivity effect of running a private firm. Yes.

AUDIENCE: [INAUDIBLE]

ROBERT TOWNSEND: It's fixed so far. But it's actually going to be determined in this overlapping generations model. People who plan to be entrepreneurs in the second period will save.

AUDIENCE: This would have been identical [INAUDIBLE].

ROBERT TOWNSEND: Yeah, you could have done that.

TOWNSEND:

OK. I said this.

So this is just that production function notation. It's the same production function for both except for the χ . And the notation substitutes in entrepreneurial firms versus financially integrated firms. F for financially integrated. But they're not efficient guys. They're inefficient guys. And here's that productivity marching along following this sort of exogenous mark-off process.

But the important friction is when I showed you that problem, or maybe it's not clear, not so clear yet that these private enterprise guys are limited in the amount that they can borrow. Yes.

AUDIENCE: So the z is just shock?

ROBERT TOWNSEND: It's boring. It's boring, but it's a big part of real business cycle analysis. The whole point of real business cycles is those aggregate shocks are driven by basically something like z or TFP. So they inherited that part of it.

I'll show you where it enters. It's going to generate some exogenous this growth rate. But it's not going to be enough to explain China. As we were saying earlier, you've got to put in some other financing restrictions to try to match up with the data.

OK. So the rate on deposits is going to be equal to the rate at which you can lend internationally. This is, like, US Treasuries, and that's where the money goes. Lending, there's a little bit of a markup, sort of not modeled. You have to charge more on your lending rate since some of it gets chewed up in the intermediation process. And this [INAUDIBLE] thing is basically that markup. So it subtracts off from the lending rate to be equal to the deposit rate.

OK. So we do a little algebra. And I'll try to let you know where the equations are coming from. So this κ , not k , is a ratio of capital to labor. But the labor is augmented by that augmenting technological progress. So as you may know, if you've worked through these things before, you have a Cobb Douglas production function. You want to look for wages and interest rates. Well, for example, the marginal product of capital will be set equal to quote, an interest rate, in this case the lending rate, because that's where you can borrow. And it ends up being-- it is this.

Over the weekend I reworked all these equations just to make sure I could do the algebra. This one's pretty standard. Some of them get a bit tricky, but it probably is going to take too much of our time to try to do it from scratch here. But I will try to give you some guidance about what substitutions are going on and why they're doing it this way.

The wage is the marginal product of labor, and this is an expression for the wage. Now that seems odd, except why not solve for labor? The point really is that this is fixed from abroad. That's going to fix κ . And once κ is fixed, then basically the wage is going to be constant if it were not for that technological progress. So the general equilibrium is made a lot easier here because they're able to get these closed form solutions for the wage and the interest rate.

So again, where we're going is resources are going to flow. Labor in particular is going to start flowing out of the state-owned enterprises, but it doesn't do anything to the wage. And the interest rates are pinned down internationally. So to the extent the economy's getting richer and richer and there's no place for that money to go, it's going to go abroad. Yes.

AUDIENCE: [INAUDIBLE] to provide entrepreneurs with the incentives to work as manager, and they have to be greater than this wage [INAUDIBLE]. How to guarantee [INAUDIBLE].

ROBERT TOWNSEND: Well, they set the parameters such that that's true. There's always this tension about where the parameters come from. So I'm drawn to micro data because then I can estimate something that I'm willing to believe. Other people like to calibrate them. Now, if you're telling a story, the story of China through the lens of this model is going to be consistent with big chunks of the data. So they're probably just happy to find a parameter that makes the story accurate. Different people have different tolerance levels.

OK. So here are these private sector firms. After you substitute in for m in a previous expression that we just talked about, it's just choosing employment. And you get the first order condition. Now this is a trick that turned out to be handy. Why isn't the wage? Well, they took the first order condition and they multiplied by n , and they put n on both sides of this thing. So there is a substitution in there. That's because this analytic expression-- the wage bill turns out to get used later and they wanted an expression for it.

What is n ? Basically, it's this thing. So the employment in these private sector firms is proportional to the capital. In fact, many, many things, almost everything in this model, is going to be proportional to capital. and the thing that does move, if anything, is basically this productivity. But a certain ratios are going to stay constant, even if some of the levels are moving.

So here is the wage. We substitute that wage back into 2, and we get this expression for the profits of the private sector. And the point is this thing on the right-hand side, it's just linear. So despite what you might thought would be the diminishing returns, the fact is they're able to hire enough labor on the extensive margin at a fixed wage so they don't get hit with those diminishing returns. And for the transition that they want to analyze, it's basically what they call a AK model, not to confuse the notation. It's linear, so basically, Rho is really high. I'm going to go bananas. Give me more k . k is good. I can make money. Rho is a lot higher than R .

No, no, no, no. There's going to be a constraint. That's the financing constraint. But it really helps the dynamics to figure it out. So again, what is that Rho ? It's this thing. And these are all basically parameters, interest rates fixed. α 's labor productivity, capital productivity. Pitchfork v was a distortion from stealing, that χ was this exogenous productivity in the state-owned sector. Everything on the right-hand side is just a number. And this thing is set, parameter choice set to be greater than 1. So that's going to be the driver of China.

And it would happen right away if it weren't for the borrowing constraint. So where do you get money from? OK, a little lesson on financing, which you already know. But in the notation, we asked about k . Where did k come from? K , at the beginning of the period, is predetermined, but it came from last period saving and from the amount that they borrowed. So that's the timing. And it's the saving of the entrepreneur who's going to be running that firm when they're older, and they save when they're young.

OK. So this L is kind of like L , liquidity, the amount you can borrow, could be 0. But basically you've got to pay back those loans because you borrow them at interest. And so the amount you've got to pay back is going to be bounded by your profit. And then they're kind of rewriting the expression for that.

So we imagine this is binding. This is where the credit constraint is. You're limited to pay back the loan out of, basically, next period's profits, or a proportion of it, I should say, with factor η . So the so-called leverage ratio, which is credit to the total amount of financing, both internal and external, is basically just this fixed number. A lot of this we've already talked about. We just threw in another parameter.

OK. So back to the entrepreneur maximizing utility with those preferences. When they're young, they're basically getting the managerial compensation less the savings. And when they're older, they get the return on the enterprise that they're quote, running, plus they get this extra kick because the more they can borrow at R_L , which is fixed, given that R_E is higher than that, they get a return on the resources that they got from externally. So they have money from their own internal rate, on their own savings, and then money from, quote, profits that they get being able to borrow at a lower rate than their rate of return.

And you can decompose this into the return, the premium, and the leverage ratio, all in a given period, multiplied by the savings rate. When we get to measurement, we're going to talk a lot about where does wealth come from. Wealth comes from saving. There's a savings rate, and then there's the rate of return you get on saving, which is like TFP, or basically factor productivity. This is effect, with some leverage, the productivity you get on given levels of saving.

The point is that this is all a constant, so the savings is just going to be proportional to m . Now again, I looked at this over the weekend. I'm like, huh? How is that coming from this? Well, no, no, you got to go back up here. And remember, you're going to get an Euler equation because you're going to be sacrificing consumption today as you say more, and you're going to get something out tomorrow with a fixed return. And given these preferences raised to a power θ , you get a nice expression for the savings rate. The rate is constant, and it's just proportional to their income.

So again, do you like it? I don't know. It's special. But it's part of the algebra. It's easy to tell the story in English. When you get to the equations, you realize assumptions are being made. Yes. Question?

AUDIENCE: [INAUDIBLE]

ROBERT Yeah. The way I'm giving this, probably not the most complimentary way. I'm basically saying they're making up
TOWNSEND: the parameters. If there's something disciplining the other parameters, then you need η to be less than 1 in order to be able to tell this. And the other papers in the literature are clearly doing that.

AUDIENCE: But my question is, why do you need an extra-- these firms have to pay their managers. So the χ has to be--

ROBERT Yeah, it's a very good question. And we'd have to go-- unless it pops up shortly in the next few equations, then I
TOWNSEND: would have to go back to the paper and tell you which particular piece of data are they trying to fit for which they need that η as opposed to the other things.

So then we get to the aggregate dynamics. Well, this is the return on Firm I. But it's linear, so basically you can you can aggregate up. So you're really going to use or abuse this algebra pretty heavily. The linearity makes it easy to get the total output in the entrepreneurial sector.

Now here are some other ingredients. We've already seen that wages and levels are proportional to output because of the stealing parameter. But output, we already just saw on the last slide, is proportional to capital. Also, managers save a constant rate out of their earnings. And we just saw that the leverage ratio is constant.

So lots of things are constants. Other things are proportional. Basically, the capital stock is the key driver. And it's moving with exogenous technological progress. So the ratio of output from one period to the next is the same as the ratio of the capital from one period to the next, and they're all equal to this common constant.

So the entrepreneurial sector, therefore, is growing. We've gone from levels to growth rates. That's the point. So now we can talk about how fast is the private sector in China growing.

Here's the financially integrated, inefficient government-financed firms. And this is another expression for output. This is the output of the private enterprise sector. Just to take you through the algebra so it's not too much of a mystery, they've deliberately gotten this term in the expression. That was the whole point of re-manipulating the output.

And this expression is something you can figure out from all the other things we did on the past four slides. So you get a simple expression in terms of κ and parameters for this adjusted ratio of total capital to total labor. You start substituting that in here. That's where it went. And you do a little more manipulation, and you can get output per worker in the whole economy. So this is a version of labor productivity for all of China.

And of course, output is the sum of the output in the two sectors. Total labor is still n here. But you can look at output as a function of labor employment from these tricks, controlling for κ and this productivity, and you finally get the story, the bottom line, which is the total output of the economy is growing. Why? One, not too surprising. It's exogenous technological progress. But the other is that this thing is growing. So employment in the enterprise sector relative to the whole economy, this thing is going up because the enterprise sector is expanding, drawing employment slowly. And here are the diagrams.

So one thing, I made a little joke about Thailand exhausting agriculture and no one living there anymore, and how you got this knife edge on the wage. They also have the same thing going on. At some point, this process slows down or stops. Now eventually, you'll draw employment out of that state-owned sector. It will disappear. And at that point the wage is going to start to go up. This isn't totally realistic because the wages are rising in China, to some extent. But they were low for quite a while. I don't know. The date's supposed to be 1992. Yes.

This is the firm employment share, which again, goes up until it hits 1. So you see the parallel with what we did before. It's just we've relabeled the sector, and the algebra and the assumptions are different. But here you get output growing, and then you hit the sort of diminishing returns at cap T . Is the end of China. No, just kidding. I keep looking at these guys. The T is when you've exhausted this transition process.

And here's the foreign surplus to GDP. We'll get to that in a minute. And here's the aggregate savings rate going up very dramatically. So by the way, that demography paper that claimed other people don't get an increase in the aggregate savings rate is wrong because it is happening in this model. Yes.

AUDIENCE: Do we know from later on the data from China on, I guess, state and private employment, and also, like you're saying, data on the wage, if we're to believe this model, how long the transition will go on.

ROBERT
TOWNSEND: Well, I guess that's the key question, and I don't think they focused on that, unlike the previous paper. The data, you're reminding me to say something about that. So they actually look by, I guess, it's province within China. And they're saying that areas with growth in private sector employment are areas that are basically having high savings rates. So they're actually fitting it a bit within the country.

The other thing I remember to say is China Data Center. So as per our continuing conversation about GIS, there's a --they're housed at Michigan, partly funded by Michigan, but also Purdue and the Luce Foundation and so on-- and they are putting tons of data on GIS archive, and you can generate maps.

Actually, MIT is a subscriber, so you can get a lot of this if you go to MIT GIS. You can find China Data Center. I actually put it on my syllabus and I'd forgotten to mention it up to this point. So there's probably a lot of interesting things you could do with the Chinese data. I'm not saying they have all of it there, and some of it's confidential.

All right. Here's the story of the capital outflows. You've got investment. Well, you've got deposits. Little lesson on flow of funds. You've got the deposits coming from the workers. Wages times employment. And they're going to put that times a parameter. They do eat some. And that money has to go somewhere. It can go into investment, or it could go in lending to the rest of the world. And they actually solve this equation with all this other algebra, which by now is too bewildering. You wouldn't be able to replicate it right off your head. But basically, this borrowing is coming from a constant term, lending to the rest of the world-- funny thing to call it-- B is coming from a constant term this increase in TFP, partly, that's driving it, and then this thing.

So the big story here is that when the state owned enterprise sector is shrinking, it's releasing resources. They're the big borrowers, and so they're borrowing less and less. So that's a big part of the money going abroad.

OK. So I'm going to just settle on giving you an outline of this paper and let you look at the slides at your leisure, so to speak. This is the motivation we've talked about, which is relative prices in TFP. Let me find key equations.

So there's two sectors, and there's a fixed cost, which is higher in manufacturing than service sector. There is this entrepreneurial ability, and there's wealth, and then there's this credit friction. Now again, this production technology looks like Cobb Douglas. It has decreasing returns to scale, but it's augmented by z , which was a, sort of a version of it.

And now what makes this more challenging is it's supposed to have a realistic optimization, infinite horizon. Everyone is maximizing discounted expected utility. There's no heterogeneity. But good luck solving this. They do, or partly computing. So it's sort of a CDS. There are two goods, the service sector and the manufacturing sector. And this pitchfork thing is sort of the weight between the two. You're picking up parameters, by the way. Be mindful of that. β , σ , something that looks like an ϵ . And this ϕ .

And there's going to be a calibration slide. They're going to have to choose all of these and others. So here's a picture like the one I showed. From the point of a person, you start off with a certain amount of wealth from previous period, and then you get a draw of your talent, which can vary depending on whether you go into the small or the large sector. You could be a worker and just work and produce and consume. Or you could go into one of these sector J 's and produce. This is work. This is produce and consume.

Now this γ , this is a bit more realistic version of talent or productivity. This z that you have at the beginning is likely to be the same at the end. But every so often, you lose your ability, or this is a stand-in for sectors that are changing in an unmodeled way here. In fact, they're going to draw this parameter from exits of firms in the US. Bad stuff happens, you have to go out of business, technologically.

So you have these value functions. They're going to have to iterate. You have ability and wealth today, and you're going to try to maximize wealth, your value for wealth and ability tomorrow with your contemporaneous utility, the choices. This is classic, very limited market-type stuff. You basically [INAUDIBLE] or save. Maybe you could borrow if this goes negative. You've got uses and sources of resources. You've got your wealth with interest today, and the wage if you're a worker. And you could either eat it or save it.

Now this p is because capital is denominated in units of the manufacturing good. So we've got a price, not just a wage and an interest rate, to worry about. If you're an entrepreneur, it looks a lot more complicated. But actually, this is the key financing constraint. So your capital can be higher than your wealth. But it's limited, and I'll show you where it's coming from. So otherwise, this is like that LEB thing. You've got profits, and then if you're in the intermediated sector, you have this return on wealth.

Basically they could have done it many, many ways. They just basically say, you can run off with the capital. So the idea is you borrow. You don't have to repay, but you pay for it. You lose the collateral, which is the wealth you had squirreled away in the bank. And then from then on, you're on your own. So they get of this autarchy thing, and the borrowing size is limited by the temptation to run off into autarchy, despite the loss of wealth, because you get to keep that k . But you do have to pay workers, for some reason. Never quite sure why they did that.

OK. So then what they have to do is compute the stationary equilibrium, which is basically a mapping. You've got all these many people with different wealths, all these many people with different talents, and you get this mapping till it settles down. That's what a stationary steady state means, that those histograms settle down. And at the steady state, you'll get interest rates and so on.

So they start grabbing parameters to match firm size distributions. They aggregate up. They have the lazy entrepreneurs who aren't so talented versus the poor guys who are talented but have very low wealth. And that's what's creating the credit friction. We've talked about that. And then they try to match. Now again, is this bragging rights, or is it a sad story? So you can decide here. Basically, these diamonds, they're calibrated predictions of capital output, TFP, and worker as you vary across countries. And the data are all down here, in many of these instances.

So clearly a lot more to do. But up to the point that they wrote this, no one had done anything like this before. So I think I'll just skip the rest because I want to end on time. So thank you.