Macroeconomic Theory Lecture 5

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Agenda

- Technical change, classical models of growth.
- This time: Neoclassical Growth Models and technical change. Important readings: GD Chapters 8 and 9.
- Data work with Extended Penn World Tables, FRED, and map-making.

The Solow-Swan Model

- Chances are very high you've seen this before.
- You probably haven't seen it like this, or in the context of the classical model.
- Big achievement of Solow and Swan was to show that full employment is compatible with steady state growth as long as the saving share was constant.
- Got there by assuming full employment as an *exogenous* variable.

Intensive form production function

- See Kinsella and Godin 2013 for a summary of just how rubbish production functions are.
- But we're not here for that rant, and you can't understand Solow/Swan without the thing.
- Real production subject to IRTS. But we assume CRS.
- Intensive form of the PF uses diminishing marginal product of capital to drive results on a concave surface.
- A basic assumption: Cobb/Douglas and Neoclassical PFs need to have an *infinity* of techniques available to them.
- The slope of the line up to the capital intensity k represents the output-capital ratio ρ. That's why the line becomes flat after k: adding more workers doesn't increase output.
- Historical assumptions abound in the classical theory. Here there is a broad menu of techniques at one time.

Population and Growth

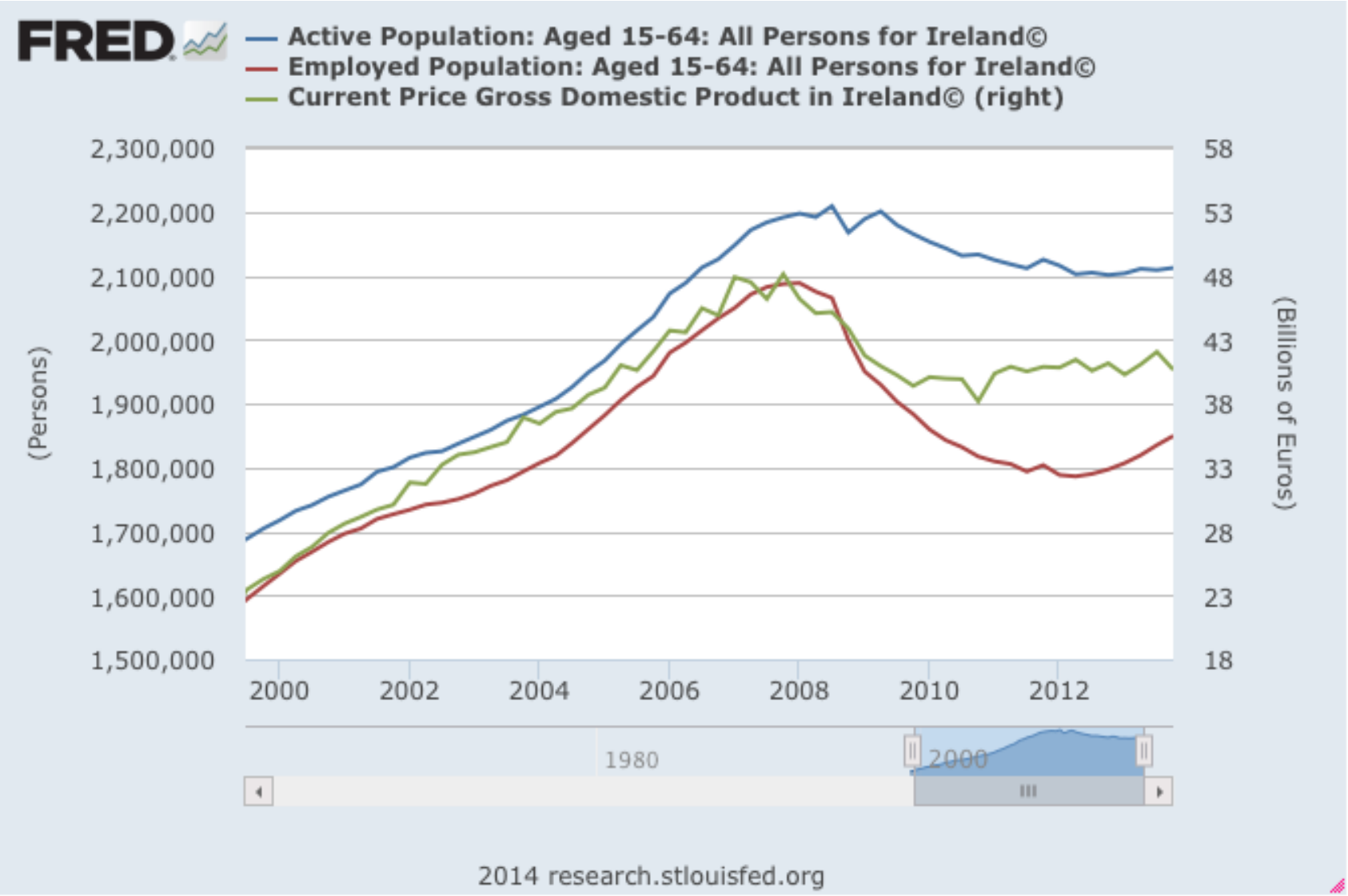


Figure 1: Active Population, Employment, and GDP, 2000-present

Net Household Saving as a percentage of Real GDP, USA

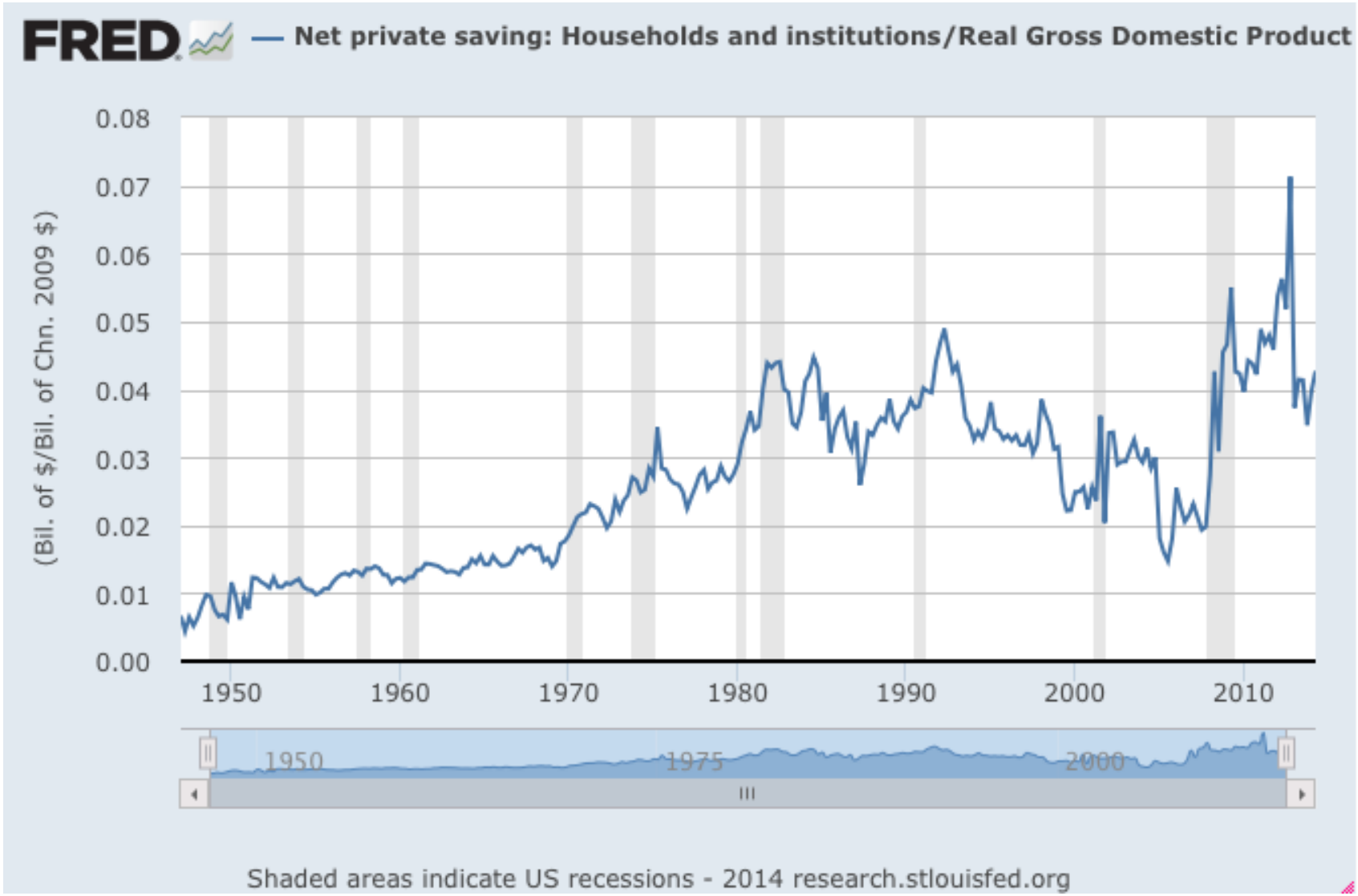


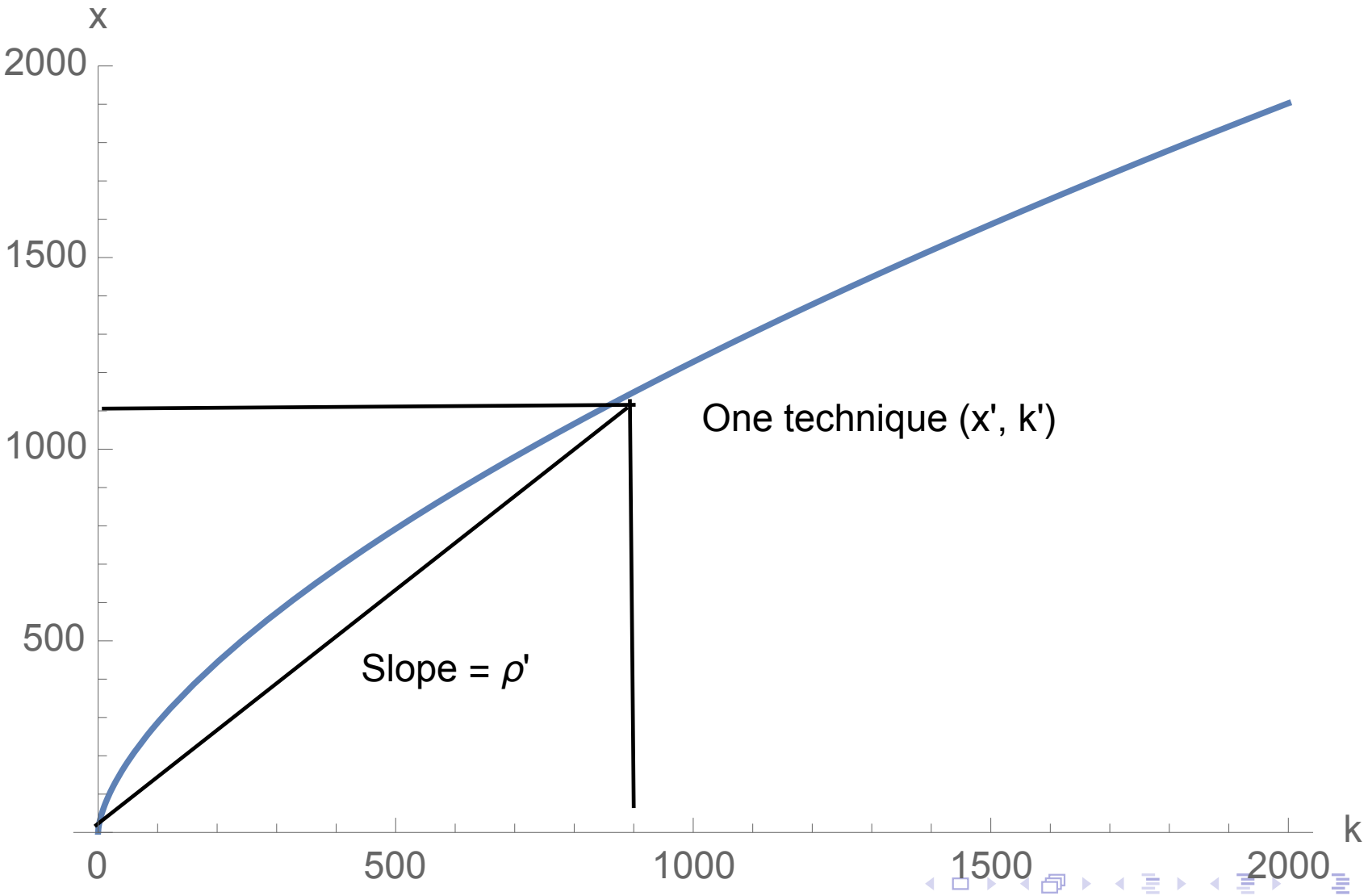
Figure 2: Net Household Saving/GDP

Saving, Population, and Growth

- Solow assumes savings are a constant fraction of output $S = sX$.
- Saving is a constant fraction of the flow of output. It's nt a constant fraction of the stock of wealth. Don't get stocks and flows mixed up in economics.
- Saving is equal to investment, implying the change in the capital stock each period is the excess of saving over depreciation: $K_{+1} - K = sX - \delta K$.
- Divide both sides by K, have that $g_K = \frac{sX}{K} - \delta = s\rho - \delta$.
- The Cobb-Douglas formulation of this is $g_K = sAk^{\alpha-1} - \delta$
- Labour force n grows exogenously.
- Approximately true that $g_K = (s\rho - \delta) - n$
- Equilibrium (in Cobb Douglas world) at $k^* = (sA/n + \delta)^{\frac{1}{1=\alpha}}$ & $x^* = Ak^{\alpha}$.

Intensive form production function.

- Capital intensity measured as $\rho = Ak^{\alpha-1}$



Solow: A worked example

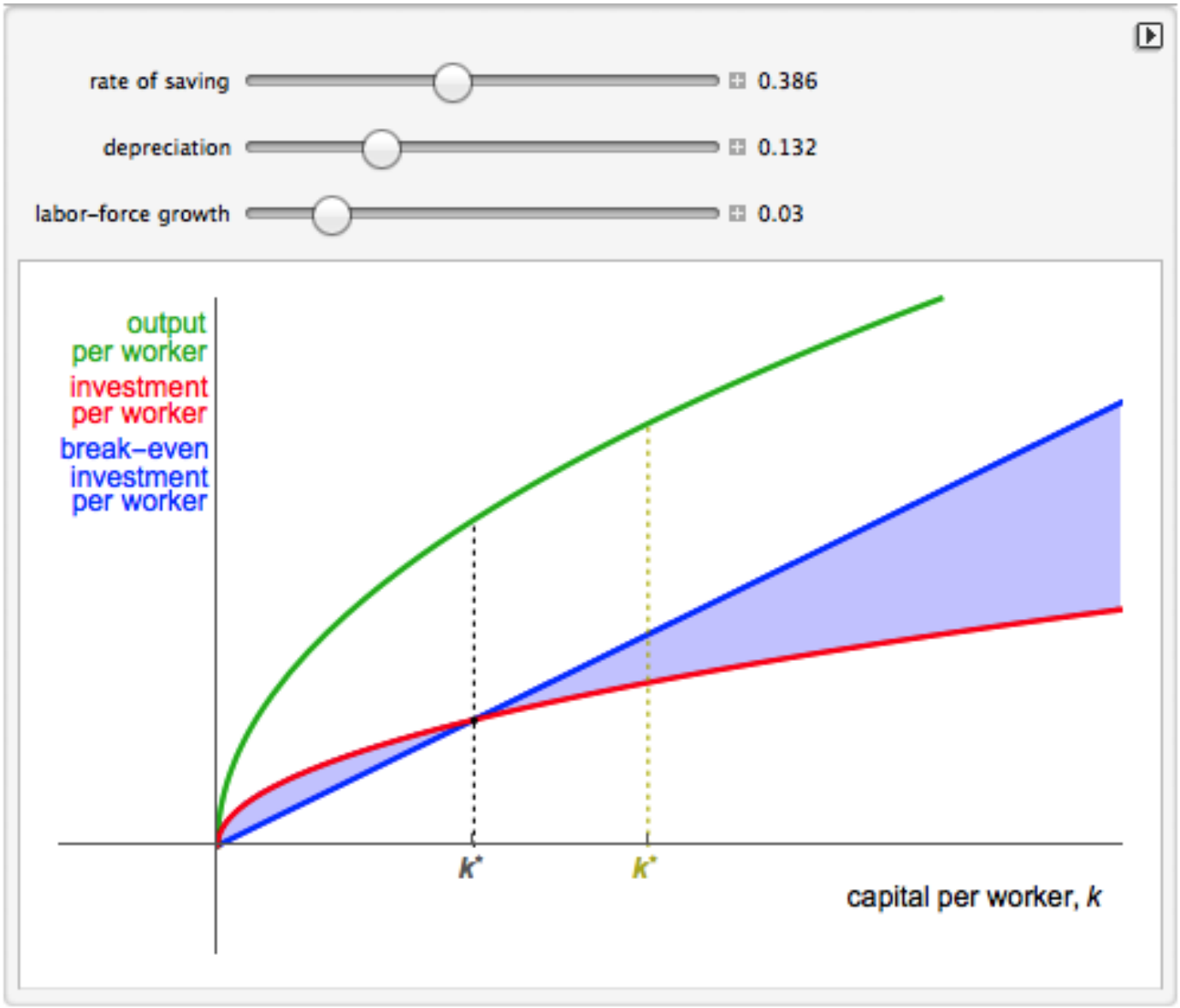


Figure 4: Source
http://demonstrations.wolfram.com/SolowGrowthModel/

Exercises

Find the value x of ρ for the Cobb-Douglas production function $X = AK^{\alpha}N^{1-\alpha}$ when $k = 14000$ dollars per worker $A = 1000$dollars and $\alpha = 0.2$.

Now Change the value of α to 0.7. What happens?

Solow/Swan and Growth-Distribution

- Efficiency frontier (PPF) has all relevant technological information encoded.
- In Solow, the savings propensity determines consumption per worker and output of capital stock.
- Classical model: fix wages at $\bar{w}$ and tangent to efficiency frontenr is k.
- Solow fixes capital intensity $\bar{k}$ per period, so in growth distribution space the tangent for a given technique is $-k$.
- So what? Consumption is $c = (1 - s)x$, growth rate of capital stock is determined by growth/distribution schedule.
- Let's look at the model.

Short run, Steady State, and Long Run Equilbria

let's look at the handout.

Elasticitaaay

See recent work by Taylor et al estimating elasticities of substitution: `http://ineteconomics.org/sites/inet.civicactions.net/files/Lance%20Taylor-Piketty%20Paper.pdf`

- Call $\sigma = \frac{\%\Delta(K/N)}{\%\Delta(w/v)}$
- As economy converges to k^* from below, wages are rising and profits are falling. Entrepreneurs start using capital-intensive technologies. If $\sigma > 1$ the capital intensity ratio will increase faster than the proportional change in wages/profit ratios.
- Labour input per unit of output will fall relative to wage increase.
- If $\sigma < 1$, the rise in wages will cause the share of labour to rise and the ratio of capital to fall.

Rise of the robots?

September 25, 2014 10:42 am

Robots are our saviours, not the enemy

By Peter Thiel

The alternative is a world in which wages fall and prices rise, writes Peter Thiel

Figure 5: PayPal's Peter Theil, FT Sept 25.

Technological change Limerick. No really.

From @thelimerickking:

> *Our new technological dawn Resembles a giant black swan Efficiency gains Cause harsh labour pains Our jobs. . . like our morals. . . are gone!*

Technical Change in the Neoclassical Model

- Growth models with technical change don't normally converge on a steady state without Harrod-neutral assumptions about the innovation process.
- Solow can't explain modern economie's behaviour.
- Need to assume a process of *exogenous* technical change.
- Assume $X = AK^{\alpha}(1+\hat{\gamma})^{t}N)^{(}1-\alpha)$.
- Cobb Douglas case gives us $\bar{x} = A\bar{k}^{\alpha-1}$.
- Note the conceptual difference between Classical and Neoclassical technical change: one requires differential capital/labor subsitution to move across the production function. Assumption is globally exogenous.
- Classical approach requires a 'historical' discovery of new techniques. Assumption is locally exogenous.

Harrod neutral technical change with neoclassical production function

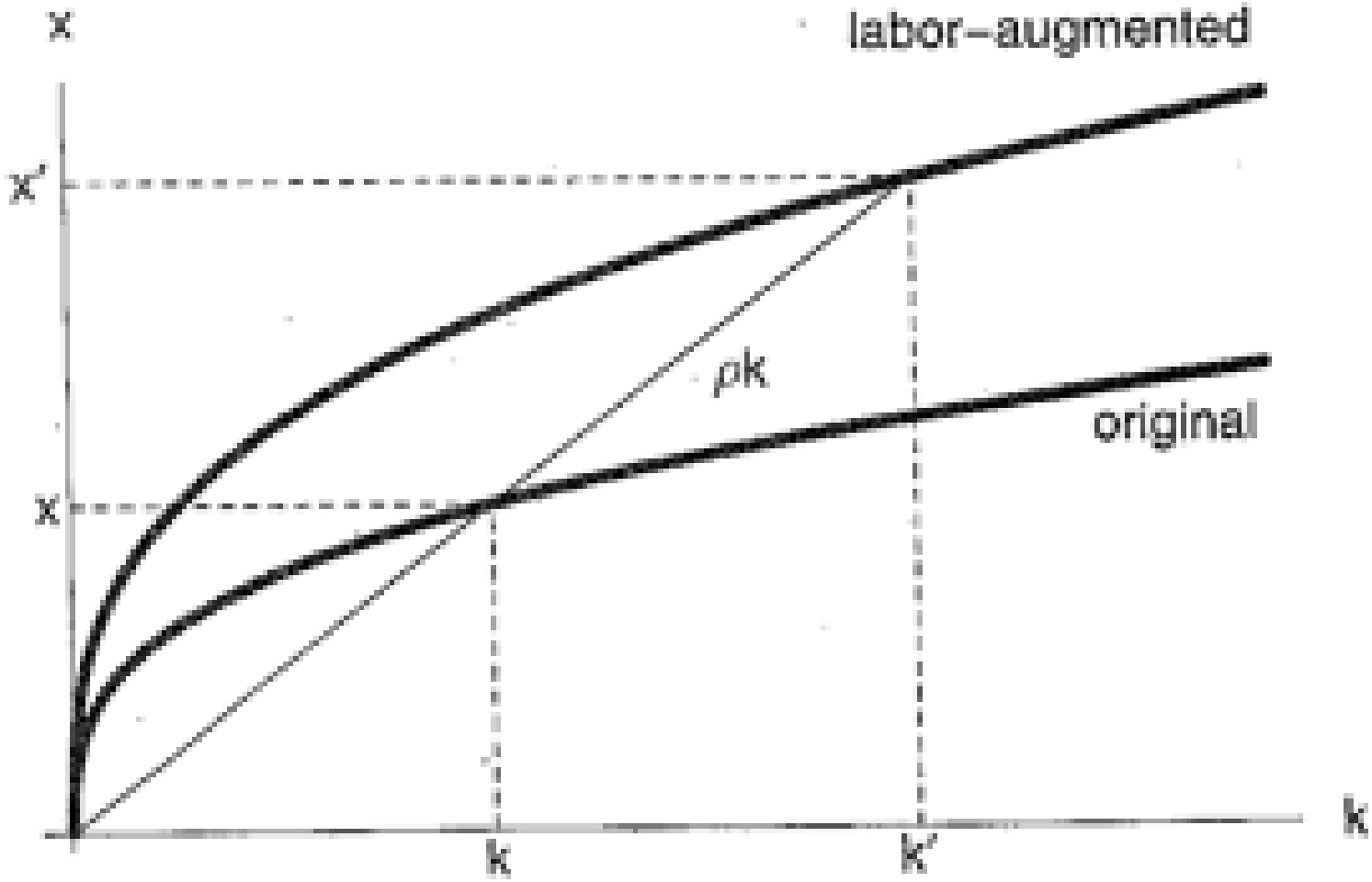


Figure 9.1: Harrod-neutral technical change with a smooth neoclassical production function.

Growth Accounting

- Given $X = F(K, N; T)$, Denote marginal products of K and N by F_K, F_N.
- Have that $\Delta X = F_K \Delta K + F_N \Delta N + F_T$.
- Divide by X and rearrange to get $g_X = g_K \pi + (1 - \pi) g_N + F_T$.
- Connection of the marginal products to the distribution of income is only possible when neoclassical assumptions hold. This is the *Solow Decomposition*.

Labour productivity and wage changes

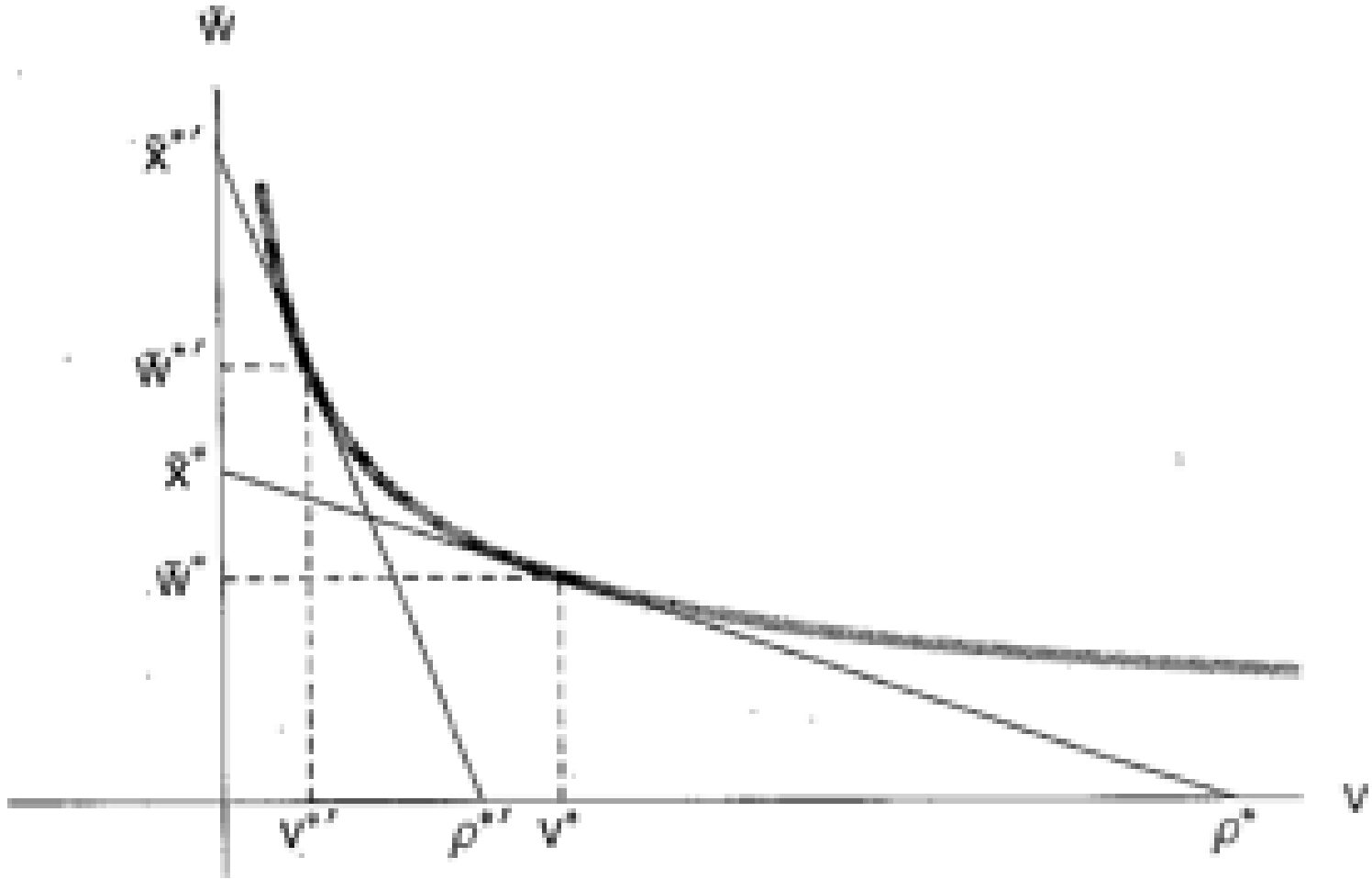


Figure 9.4: The steady state effective worker wage rises with a productivity slowdown.

Viability of economies and Solow

- Classical models put huge weight on technical progress to change labour productivity.
- Neoclassical/Hicks neutral model assumes

TFP and the Solow Residual

- Various interpretations of total factor productivity/measure of our ignorance/etc.
- See Aghion and Howitt, Capital, innovation, and growth accounting, 2007.
- Lots of problems with how you measure TFP. For example, if capital stock is overvalued in national accounts, TFP looks mich higher.

Data on TFP

Table 1: Growth accounting in OECD countries: 1960–2000

Country	Growth rate	TFP growth	Capital deepening	TFP share	Capital-deepening share
Australia	1.67	1.26	0.41	0.75	0.25
Austria	2.99	2.03	0.96	0.68	0.32
Belgium	2.58	1.74	0.84	0.67	0.33
Canada	1.57	0.95	0.63	0.60	0.40
Denmark	1.87	1.32	0.55	0.70	0.30
Finland	2.72	2.03	0.69	0.75	0.25
France	2.50	1.54	0.95	0.62	0.38
Germany	3.09	1.96	1.12	0.64	0.36
Greece	1.93	1.66	0.27	0.86	0.14
Iceland	4.02	2.33	1.69	0.58	0.42
Ireland	2.93	2.26	0.67	0.77	0.23
Italy	4.04	2.10	1.94	0.52	0.48
Japan	3.28	2.73	0.56	0.83	0.17
Netherlands	1.74	1.25	0.49	0.72	0.28
New Zealand	0.61	0.45	0.16	0.74	0.26
Norway	2.36	1.70	0.66	0.72	0.28
Portugal	3.42	2.06	1.36	0.60	0.40
Spain	3.22	1.79	1.44	0.55	0.45
Sweden	1.68	1.24	0.44	0.74	0.26
Switzerland	0.98	0.69	0.29	0.70	0.30
United Kingdom	1.90	1.31	0.58	0.69	0.31
United States	1.89	1.09	0.80	0.58	0.42
Average	2.41	1.61	0.80	0.68	0.32

Figure 8: Data on TFP

To the computers!

- Exercise. Using EPWT, let's do some growth accounting.

Summary

- Technical change is incredibly important in growth economics
- Effectively in the neoclassical model long run growth is not possible without sustained technological change. The neoclassical model implies that the growth rate of output per worker in the long run will be the rate of labour-augmenting technological progress.
- Beware accounting versus causation
- Next week, read chapter 13 of GD.
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