Economics 704a Lecture 2: Real Business Cycles II: Critiques

Adam M. Guren

Boston University

Spring 2026

The RBC Model

- Last class we reviewed the Real Business Cycle Model.
  - Dynamic and stochastic version of neoclassical growth model with capital and endogenous labor supply.
  - Complete markets, no externalities.
  - Calibrate model, feed in shocks based on Solow residual.
  - Model fits surprisingly well.
- Today, we are going to critique the RBC model and search for ways forward.
  - RBC will be starting point for New Keynesian model.

Early Criticism: Summers vs. Prescott

1. Are the parameters right?
   - Particular focus on labor supply elasticity being high.
2. What are the shocks?
   - Where do they come from? Why don't we read about them? Can technology growth be so irregular?
   - Does technology really regress?
   - Other shocks matter – financial, for instance.
3. What about prices? "Price-free economics."
   - Some evidence on prices, and it does okay. But prices can be to measure.
4. What about exchange failures? No way Great Depression is Pareto optimal.
   - More philosophical. Keynesian view is next.
   - Prescott: "*I only claim that technology shocks account for more than half the fluctuations in the postwar period, with a best point estimate near 75 percent*."
   - Implicit: Nature of cycle has changed.

What Parameters Matter for Empirical Success?

1. A highly persistent and sufficiently volatile technology shock.
   - Need to match volatility and persistence of output.
2. Sufficiently elastic labor supply.
   - Need to match fluctuations in aggregate hours.
3. Reasonable steady state shares of consumption and investment in output.
   - Need investment share low to match that investment is more volatile than output and consumption is smoother than output.

Outline For Critiques of RBC

- Today we go beyond early critique and look in depth at:

1. Central Role of Technology Shocks and Internal Propagation
2. Labor Supply Elasticity and Extensive Margin
3. Solow Residual, Technology Shocks, and Capital Utilization
4. Next Class: Monetary Non-Neutrality

Why Does RBC Rely on Technology Shocks?

- Technology shocks are the *only* type of shocks that can create the positive comovement between C, Y, and N in the data.
- Take two of the non-linear equations in the model, MPL=MRS and the production function:

$$(1-\alpha)\frac{Y_t}{N_t} = \frac{\chi N_t^{\varphi}}{C_t^{-\gamma}}$$

$$Y_t = A_t K_t^{\alpha} N_t^{1-\alpha}$$

- Combine to get:

$$(1-\alpha) A_t K_t^{\alpha} = \frac{\chi N_t^{\varphi+\alpha}}{C_t^{-\gamma}}$$

  - LHS is predetermined, changes in K_t are small.
  - RHS = constant implies an *inverse* relationship between N_t and C_t. Only A_t shocks shift LHS and break inverse relationship.

Why Does RBC Rely on Technology Shocks?

- In a famous paper, Barro and King (1984) show this argument is quite general (not due to fn forms or modeling choices)!
  - It applies to all models with **separable preferences**.
- Intuition: With separable preferences, **MPL=MRS is static** because $\frac{\partial MU}{\partial N}$ does not depend on C
  - Economics: **Due to income effects, when output and consumption rise, labor must fall**.
  - If kill off income effects, no response, but cannot get positive comovement from labor-leisure.
- Implications:
  - Other shocks (news shocks, monetary shocks, expectations) cannot create a positive comovement.
  - Only other thing that can is χ, but that is unsatisfying (the business cycle is due to changing preferences for work).

Model Requires Large and Persistent Productivity Shocks

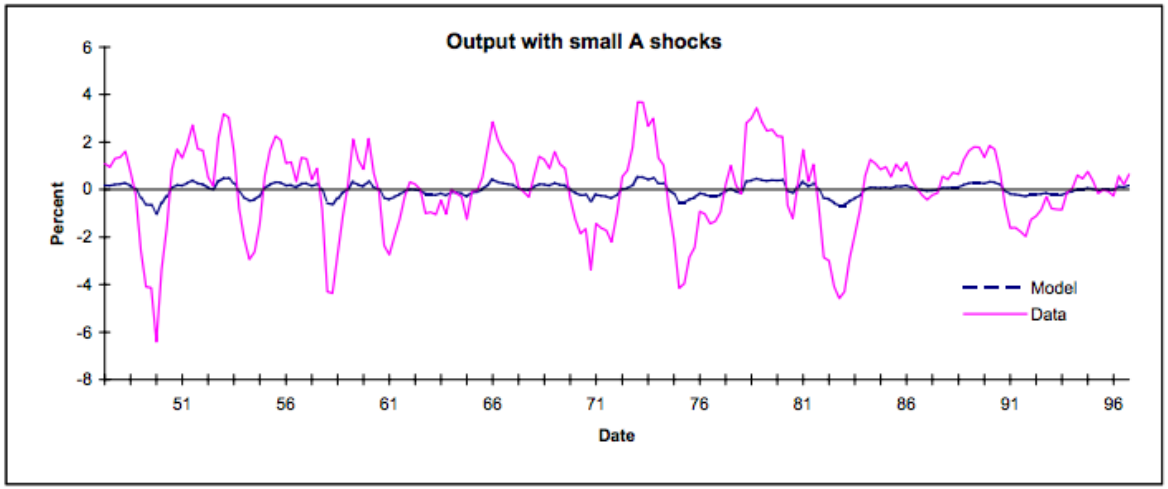
- Macroeconomic time series are highly persistent and volatile.
  - But the RBC model has very little *amplification* and *almost no internal propagation*.
  - To get persistent and volatile output, must feed in persistent and volatile shock process.

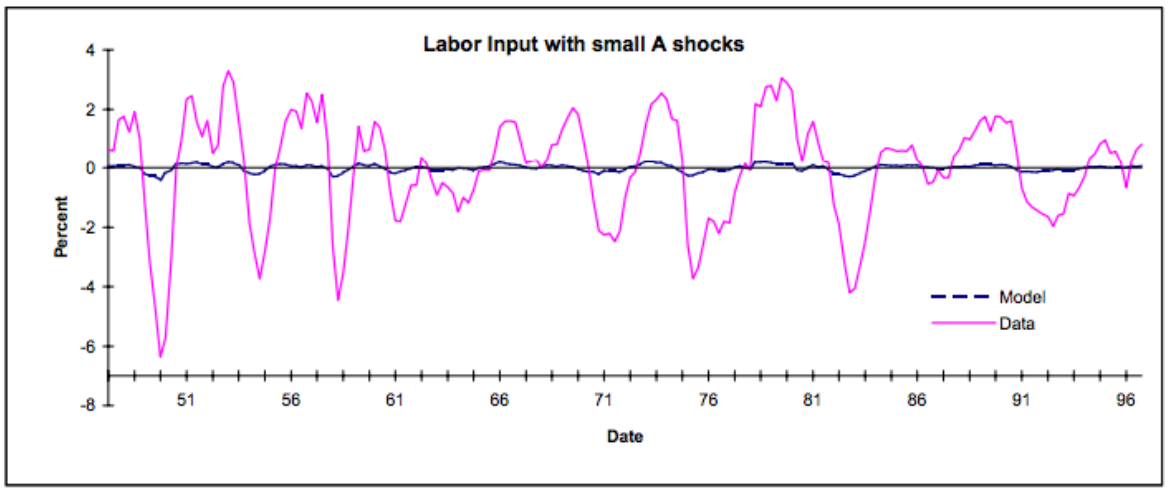
- Amplification: If $\hat{k}_t \approx 0$,

$$\hat{y}_t \approx \left(1 + \frac{1-\alpha}{\alpha+\varphi}\left(1-\gamma\psi_{ca}\right)\right)\hat{a}_t$$

  where ψ_{ca} is coefficient of $\hat{a}_t$ on $\hat{c}_t$ from the method of undetermined coefficients
  - $\alpha = 1/3$, $\varphi = 1 \Rightarrow \frac{1-\alpha}{\alpha+\varphi} = 1/2$.
  - So without offsetting wealth effect, would have $\hat{y}_t \approx \frac{3}{2}\hat{a}_t$.
  - Wealth effect pushes towards $\hat{y}_t = \hat{a}_t$.

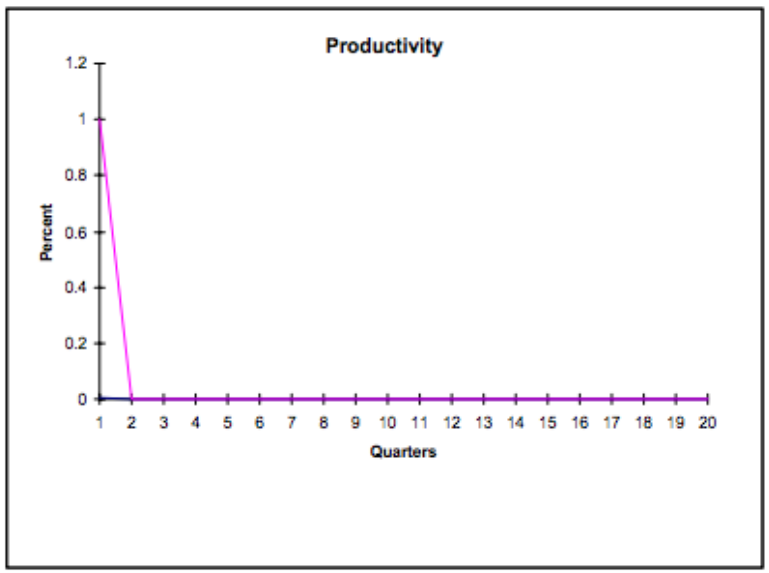
Model with Productivity Shock 1/6th Solow Residual

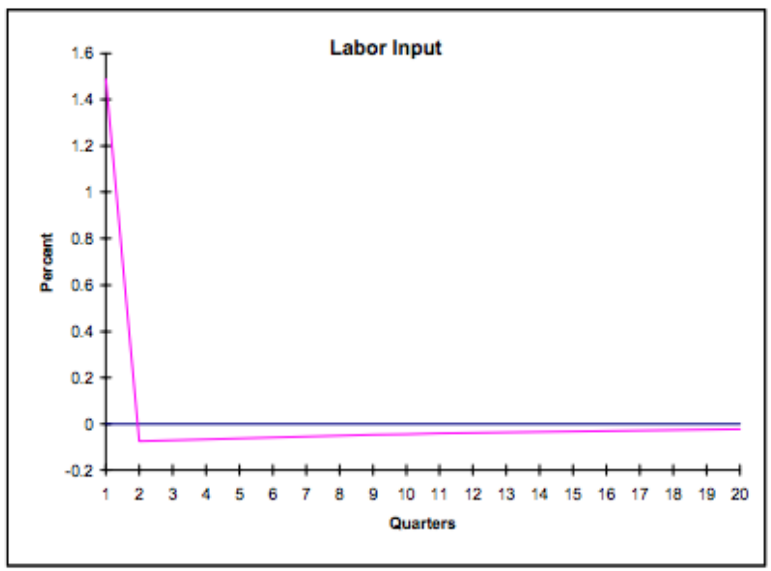




Lack of Internal Propagation: Response to Temp Shock

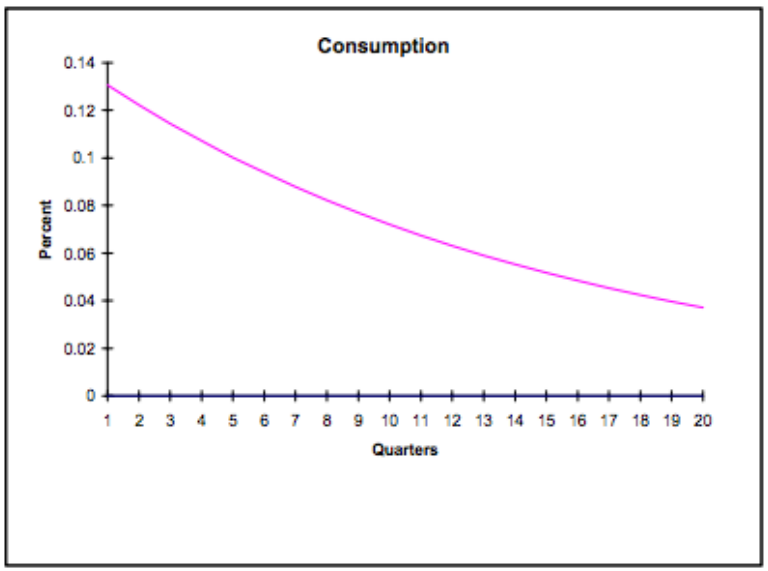
- To understand why there is so little internal propagation, consider impulse response to a one time productivity increase.
  - $\gamma = 1$, so perfectly offsetting income and substitution effects to permanent shock to productivity.
  - But with temporary shock, substitution dominates small income effect and labor supply rises.

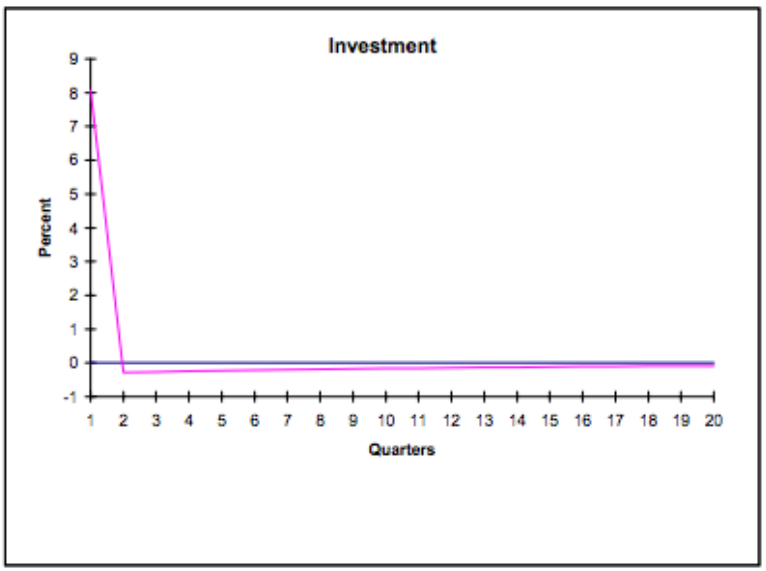




Lack of Internal Propagation: Response to Temp Shock

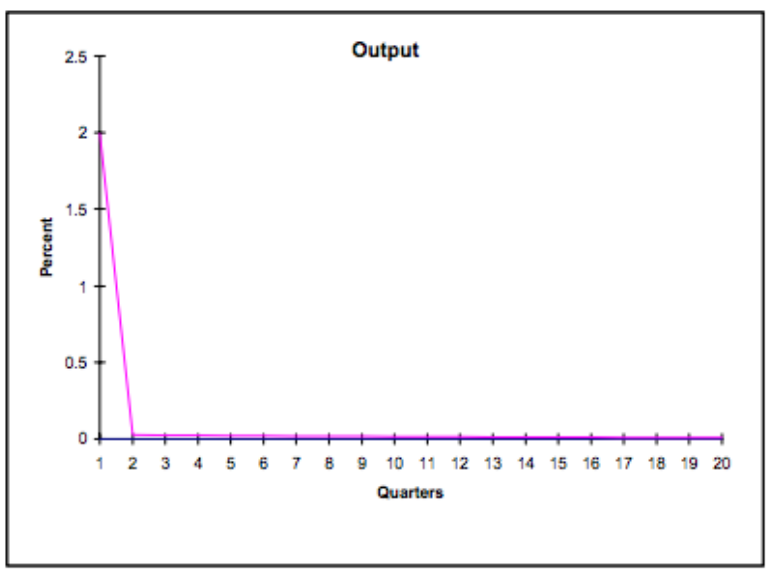
- Could spend all income now, but want to consumption smooth.
  - Saving rises, so investment rises today.

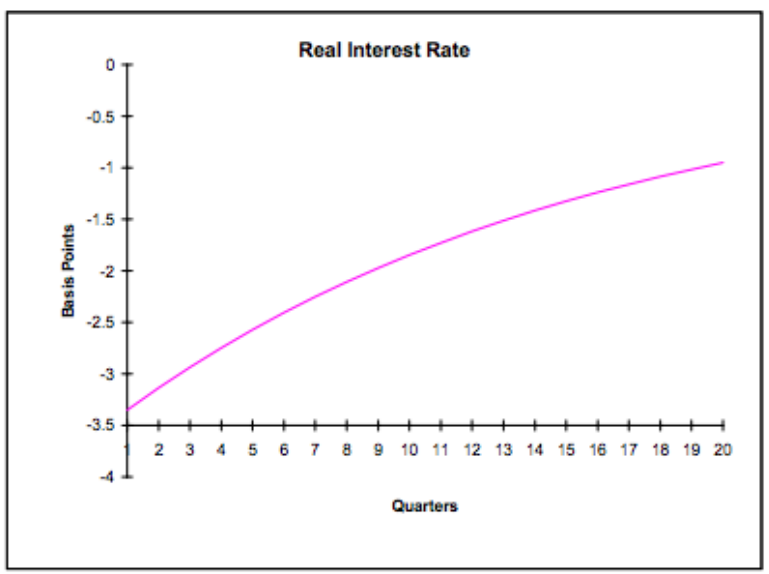




Lack of Internal Propagation: Response to Temp Shock

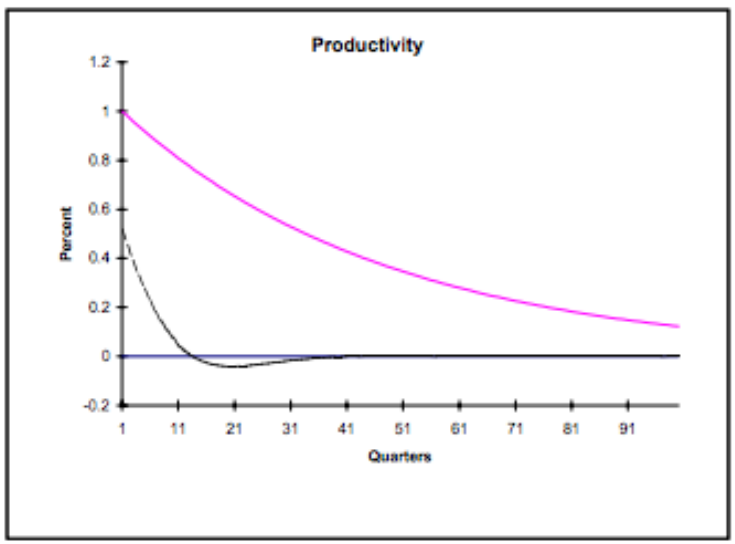
- After period 1, transitional dynamics of neoclassical growth model when capital above steady state set in.
  - Gradually reduce excess capital with high C and low N.
  - Real interest rate has to fall then gradually rise.
- Key point: No reason high Y and N followed by period of high Y and N in model. So no internal propagation of shock.

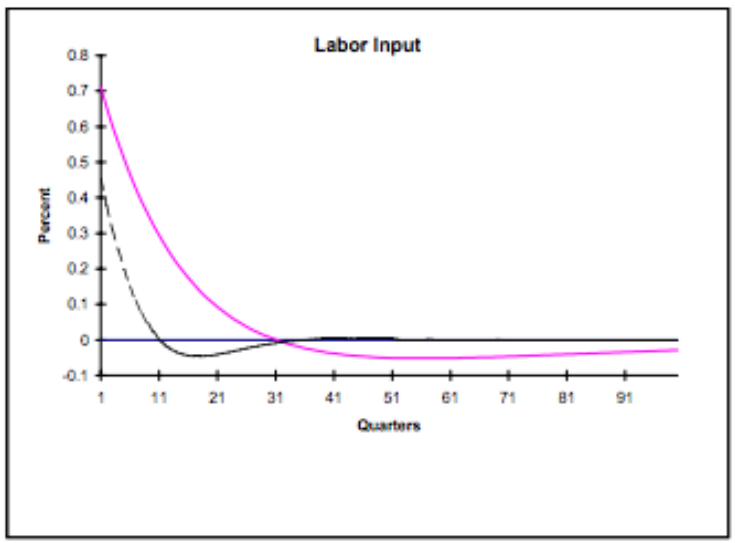




Propagation With Persistent Shock

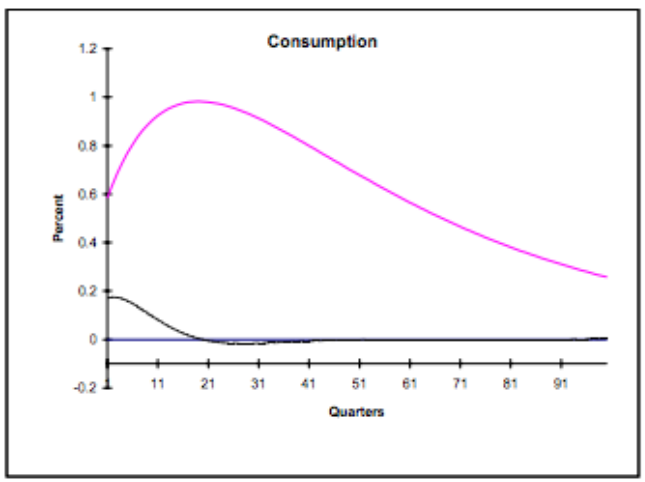
- Impulse response to a highly persistent shock.
  - Similar mechanisms drawn out over time.
  - Productivity is high for a long time, so workers increase labor supply for a while before cutting back as productivity declines

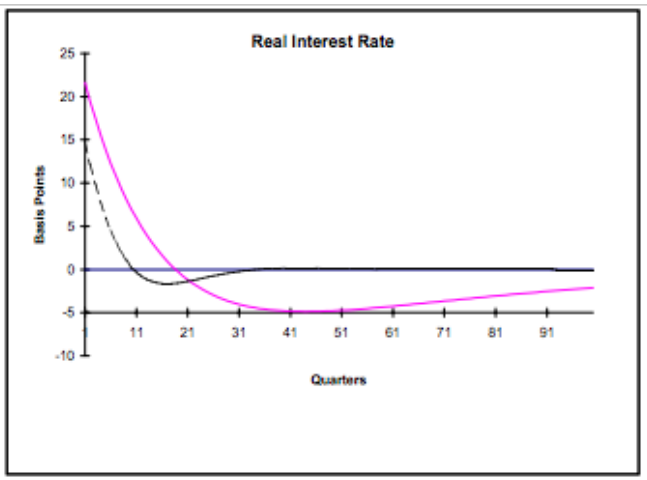




Propagation With Persistent Shock

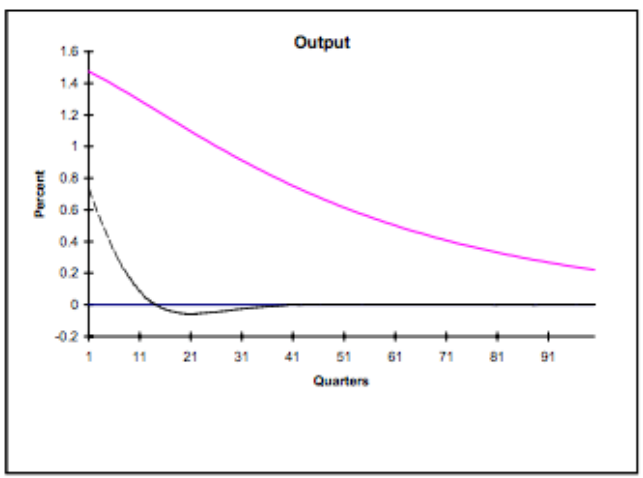
- Pushes up the real interest rate initially, which eventually goes below its steady state level and reverts.
  - MPK schedule is shifted upward by productivity shock and increase in labor.
  - Capital responds gradually via accumulation of investment.
  - So real interest rate rises then falls, and consumption is hump-shaped.

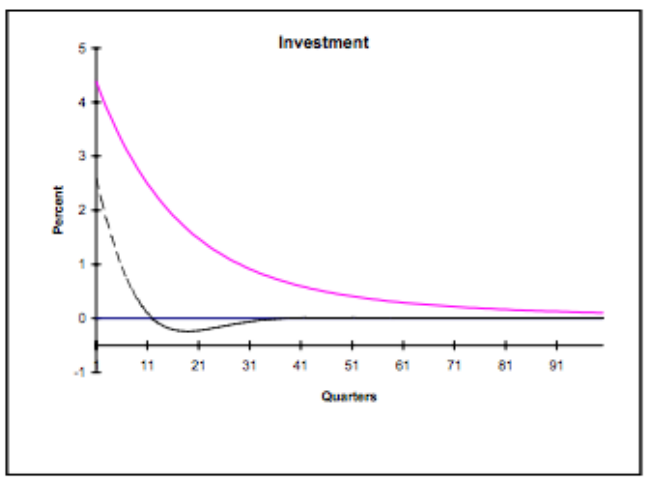




Propagation With Persistent Shock

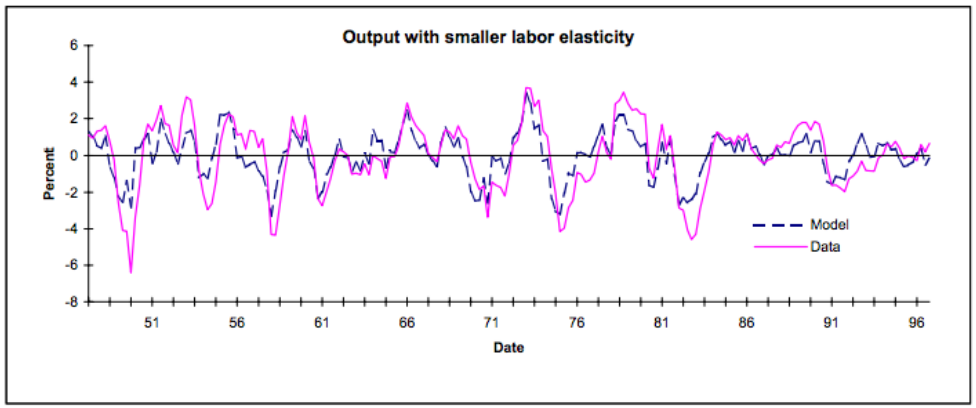
- Response of output is very persistent.
  - Initial part determined by productivity shock. But now much longer so labor and output are high for a while.
  - Later part determined by transitional dynamics.

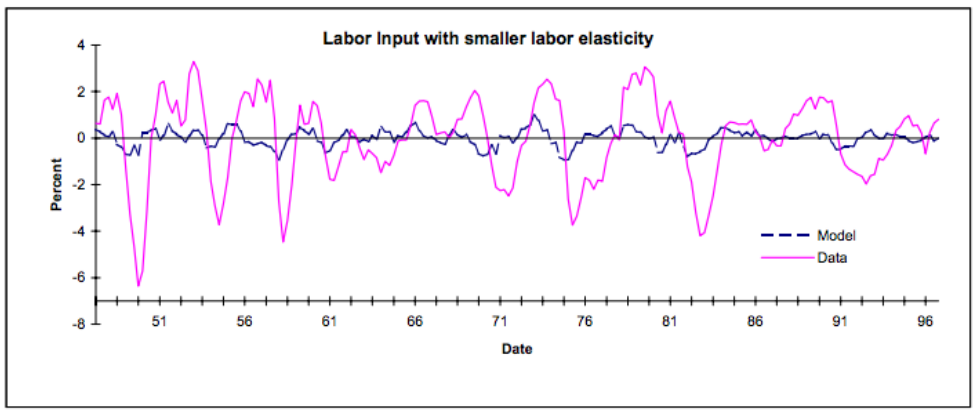




Model Requires Large Labor Supply Elasticity

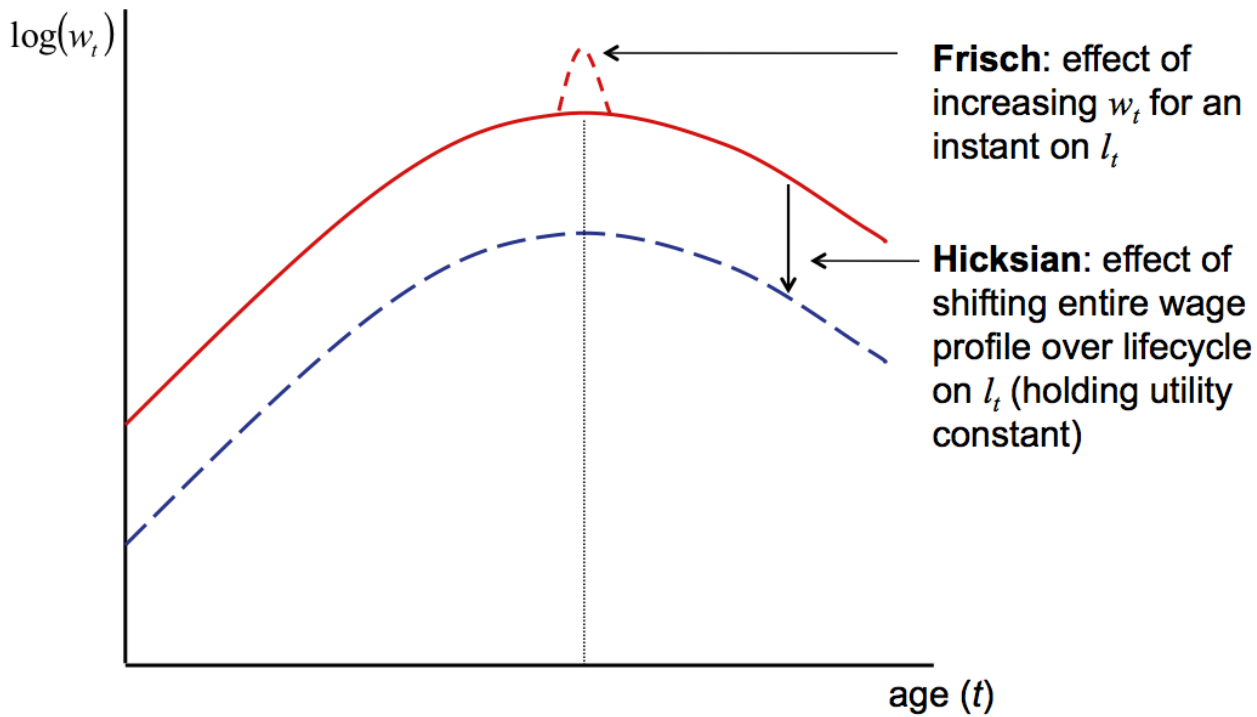
$$\hat{n}_t = \frac{1}{\alpha + \varphi}\left(\hat{a}_t + \alpha \hat{k}_t\right) - \frac{\gamma}{\alpha + \varphi}\hat{c}_t, \text{ Frisch Elasticity} = \frac{1}{\varphi}$$





The Frisch Labor Supply Elasticity

- What is the Frisch elasticity?
  - Elasticity of labor supply to wage *holding λ (the marginal utility of income) constant*.
  - RBC requires 2-4.



The Frisch Labor Supply Elasticity

- In our RBC model from last time, the Frisch elasticity is $1/\varphi$.
  - Simple proof that you will do in Problem Set 4.
- Have already shown this is the relevant elasticity for log-linearized RBC model!
  - The Frisch thought experiment — a temporary wage change holding lifetime income fixed — gives the relevant elasticity for temporary productivity changes

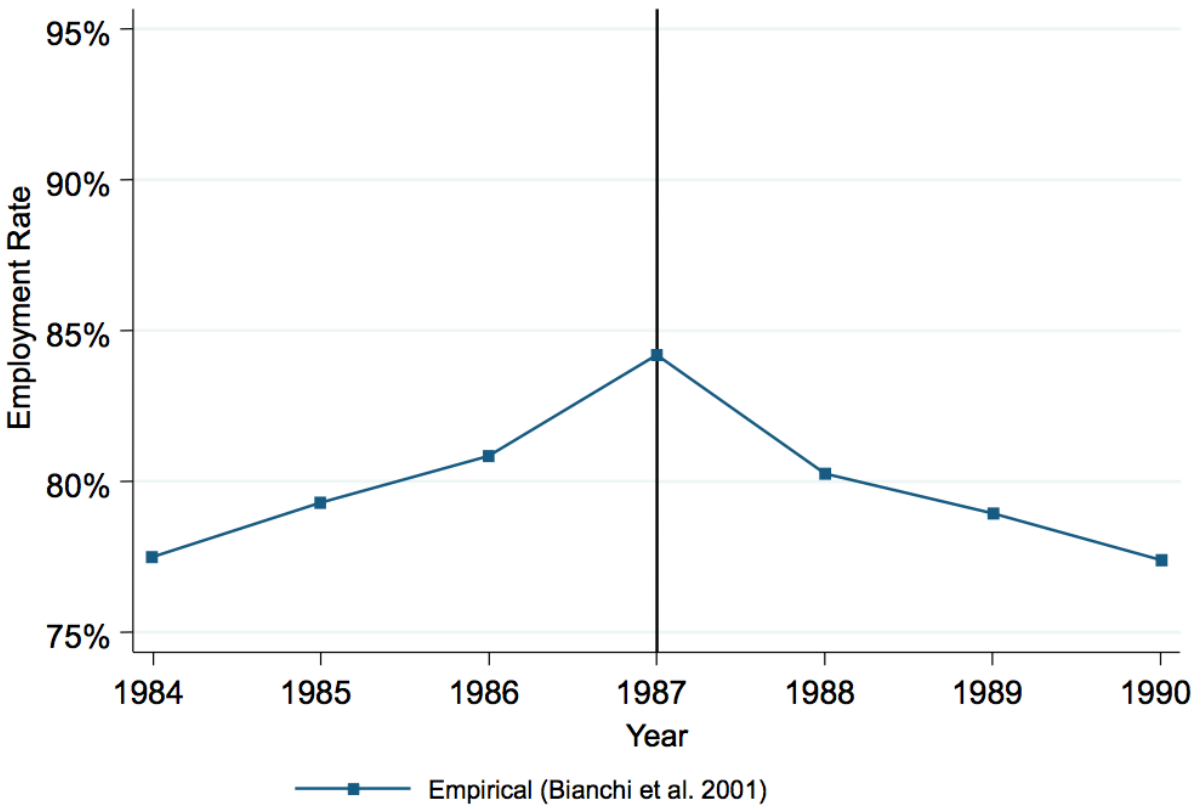
Indivisible Labor and the Extensive Margin

- Problem: Micro estimates of intensive (conditional on employment) Frisch elasticity of hours to wages is 0.5.
- Solution: Add extensive (employment) margin (Hansen, 1985; Rogerson, 1988).
  - Initially job lotteries.
  - More recently, non-convex disutility (e.g., Rogerson and Wallenius, 2009).
- Idea:
  - Employment more volatile than hours of employed.
  - So model this margin and make as elastic as necessary!
  - Strength determined by distribution of reservation wages at margin.

Is the Extensive Margin the Solution?

- Chetty, Guren, Manoli, and Weber (2012): Also good micro evidence on the extensive margin.
  - Example: 1987 Zero-Tax Year in Iceland. Ideal experiment for Frisch (temporary change in wage).

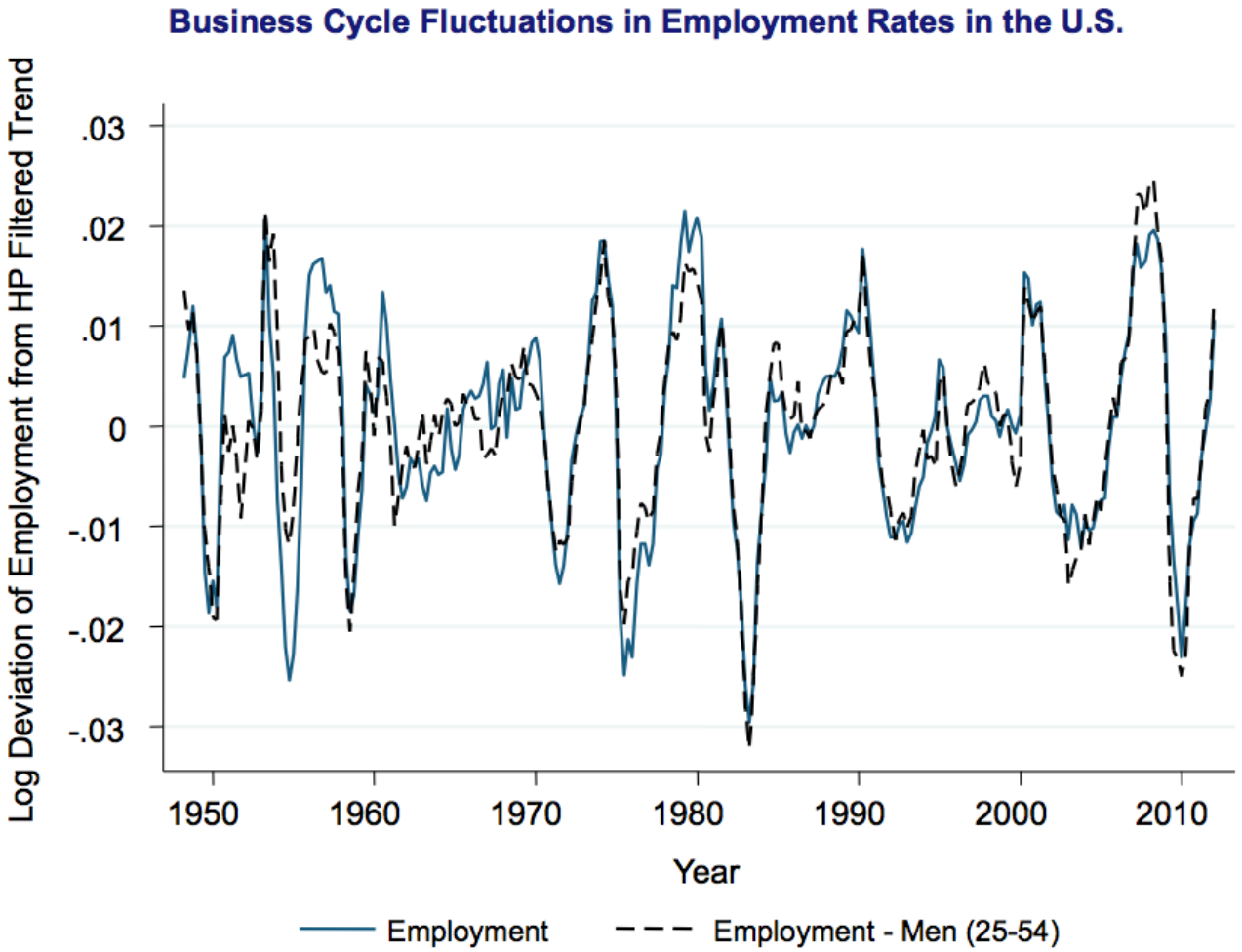
Figure 1: 1987 Tax Holiday in Iceland



Is the Extensive Margin the Solution?

Is the Extensive Margin the Solution?

Further Evidence: Prime Aged Men Have Lower Extensive Elasticity in Data But...



Is the Extensive Margin the Solution?

		Extensive Margin	Intensive Margin	Aggregate Hours
Steady State (Hicksian)	micro	0.25	0.33	0.58
	macro	0.17	0.33	0.50
Intertemporal Substitution (Frisch)	micro	0.32	0.54	0.86
	macro	[2.77]	[0.54]	3.31

- Even with indivisible labor, Frisch elasticity of aggregate hours > 1 is inconsistent with micro evidence.
  - Suggests labor market frictions and unemployment margin are important.

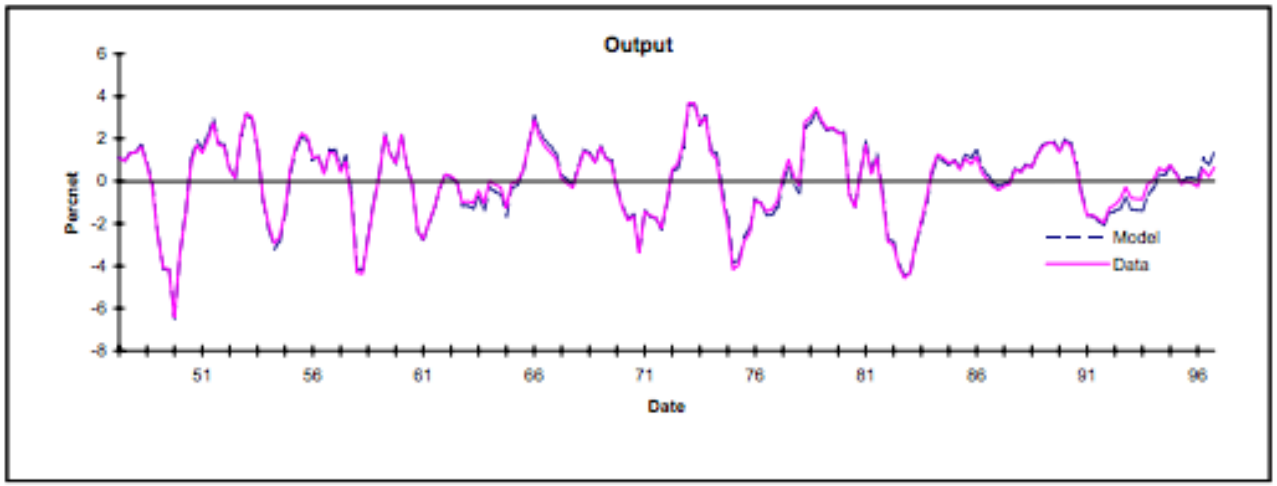
Criticizing the Solow Residual

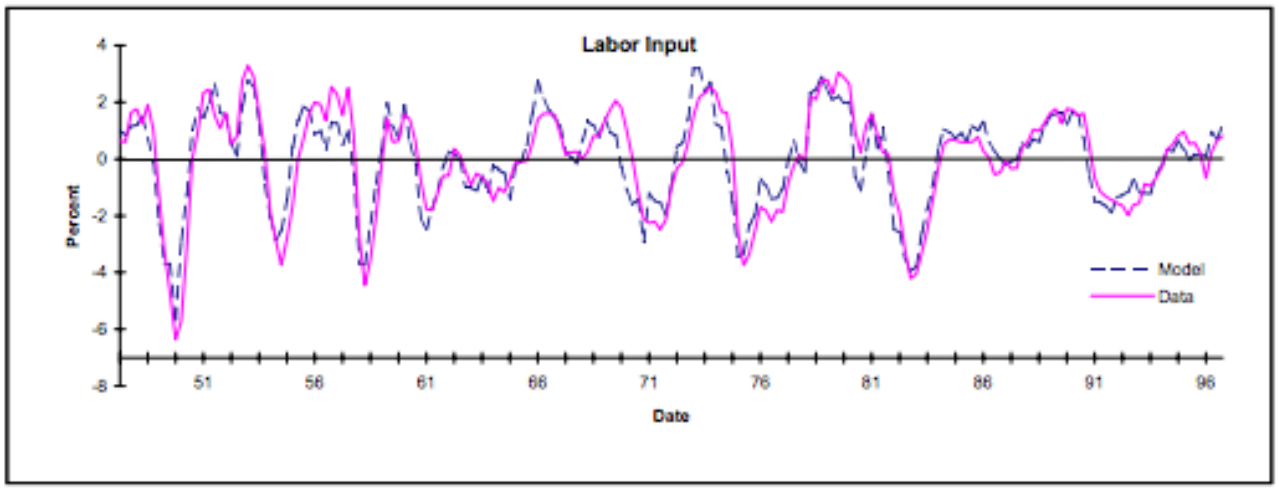
- Perhaps the most powerful critiques of the RBC model argue that the Solow residual is a bad measure of technology.
  - It is predictable.
  - It implies implausibly high probability of technological regress.
  - Plant-level measures of productivity suggest smaller volatility.
- Biggest issue: Variable utilization.
  - Proxies for capital utilization and labor hoarding/effort are highly pro-cyclical.
  - Solow residual picks up this variation in utilization in addition to "true" technology.
  - When "correctly" measure technology shocks, not so volatile.
    - RBC with 1/6 volatility of Solow at beginning represents this.

King and Rebelo: Resuscitating RBC Models

- King and Rebelo (1999) take criticism seriously.
  - Put indivisible labor, variable capital utilization into RBC.
  - Feed in Solow residuals adjusting for variable utilization.
- Model does very well principally because labor demand and supply schedules are more elastic.
  - Supply is elastic due to indivisible labor.
  - Demand is elastic due to variable utilization.
  - Variable utilization also makes output more volatile.

King and Rebelo: Resuscitating RBC Models



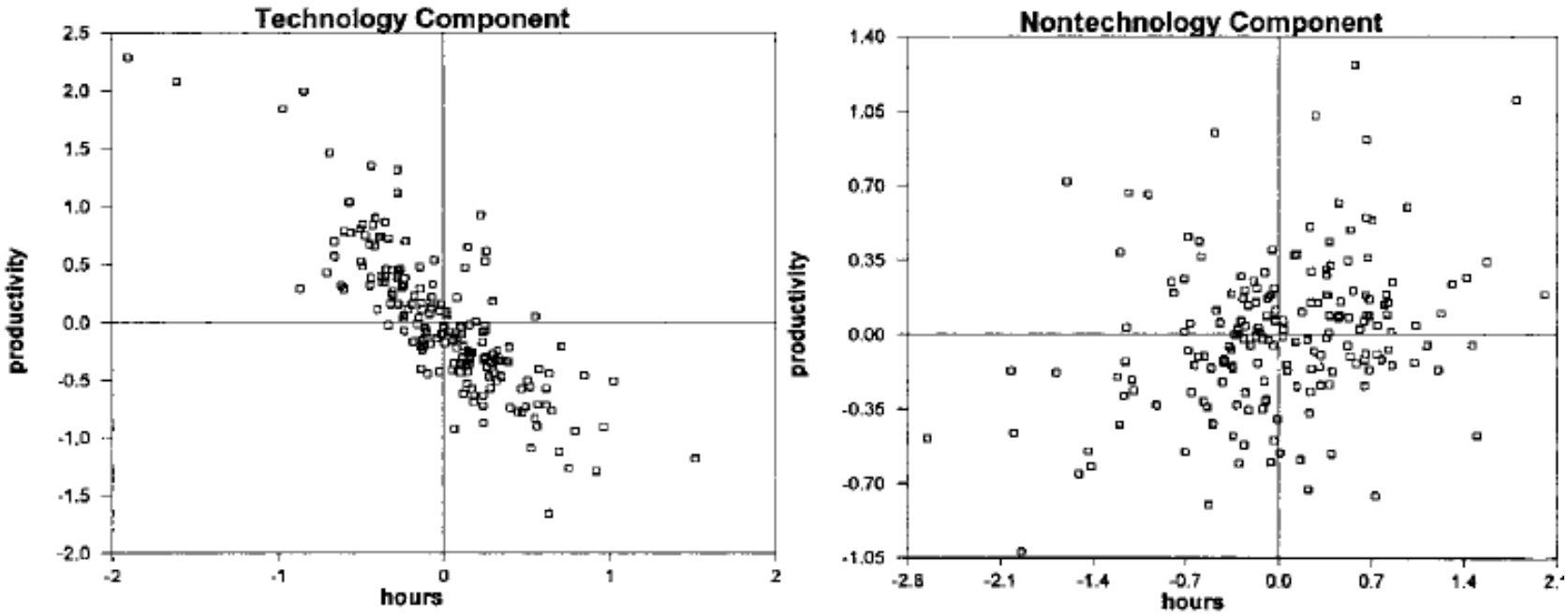


Gali: Technology and Non-Technology Shocks

- Gali (1999) critique:
  - Matching variances and covariances of time series is a weak test when there may be multiple shocks.
    - Really just correlations.
    - Can we fit variances and covariances of consumption, labor, output, etc. with several shocks?
  - Model makes predictions for *impulse responses to particular shocks*, which provide sharper test.
    - Rather than correlations, conditional moments.
    - Is the response to a tech shock in particular correct?

- Uses structural VAR to decompose technology and non-technology shocks.
  - Will explain SVAR next class.
  - Idea: Only tech shocks have permanent effect on productivity. Other shocks may have temporary effects on productivity.

Gali: Technology and Non-Technology Shocks

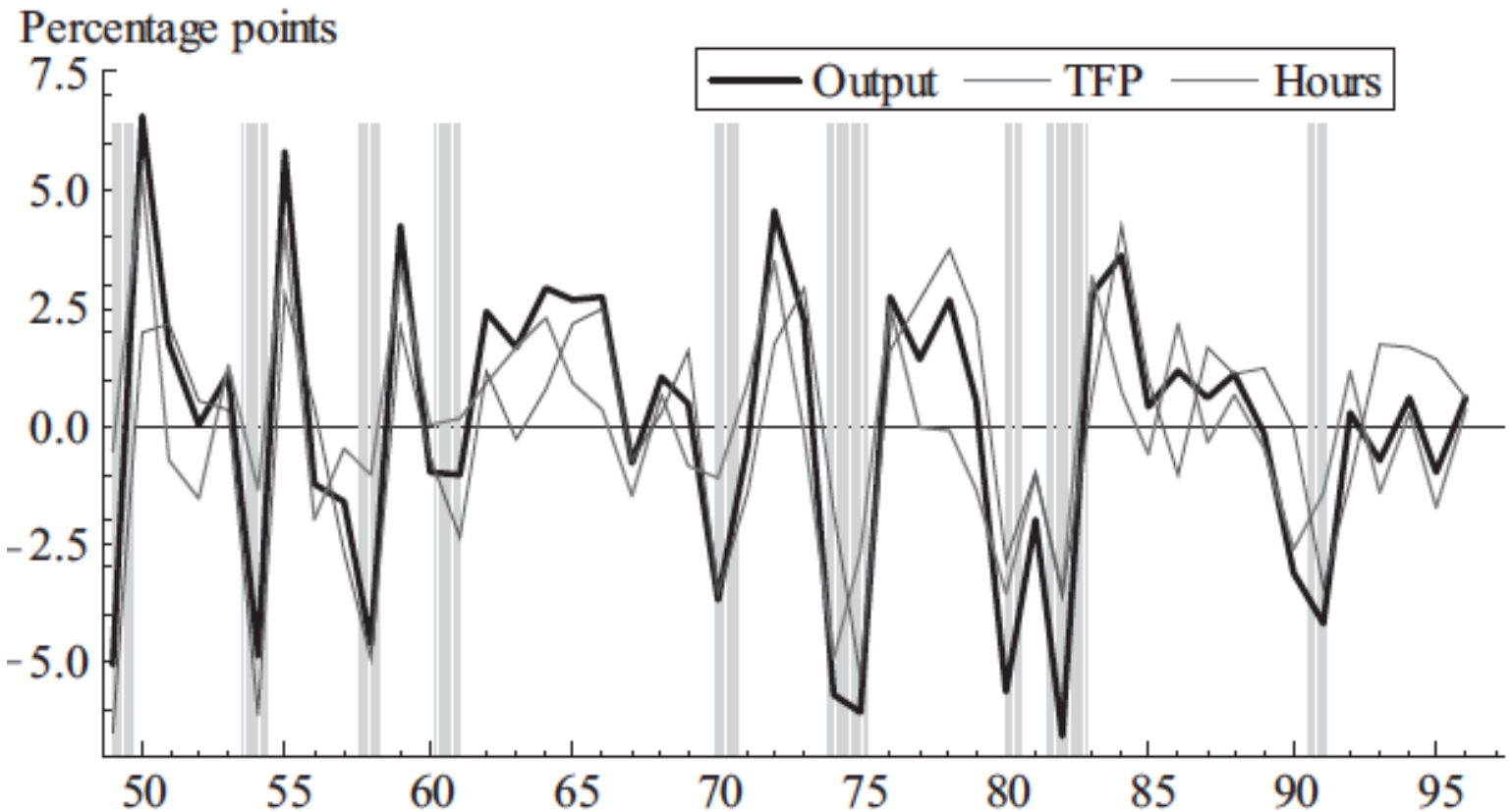


- Pos tech shock $\rightarrow$ hours *fall*; non-tech shocks drive comovement

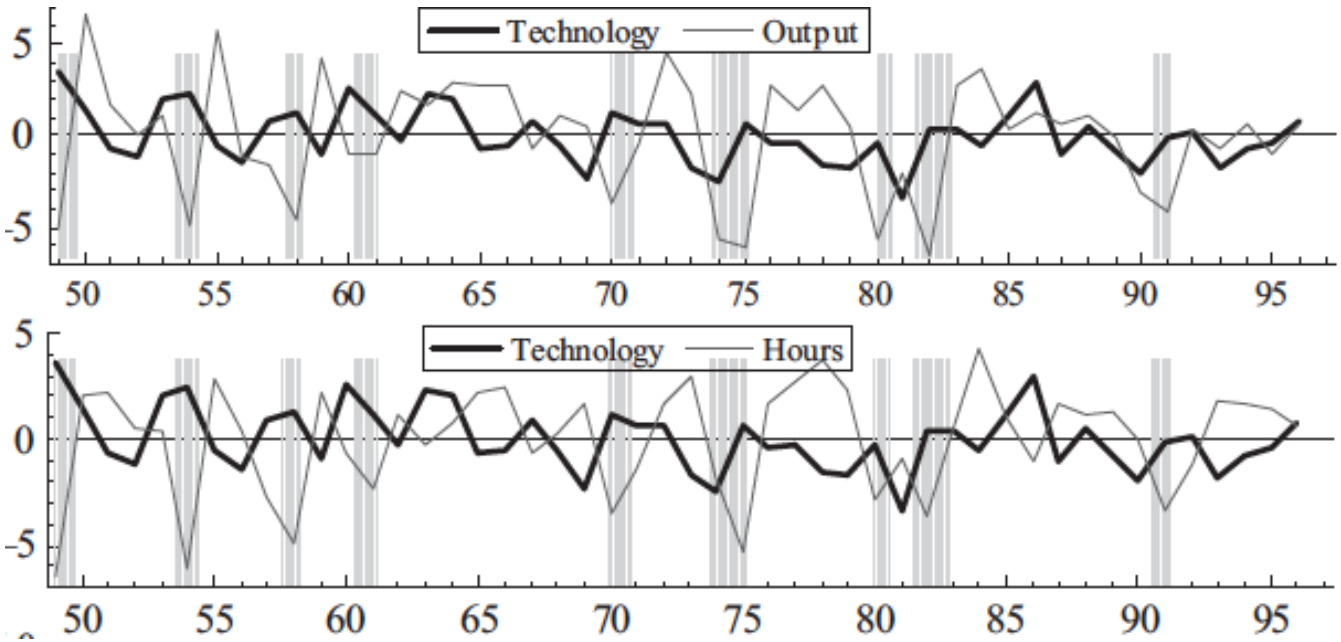
Basu et al. (2006): "Purifying" The Solow Residual

- Newer, more econometrically sophisticated measure of technology controlling for capital and labor utilization.
  - Control for aggregation effects, varying utilization of K and L, non-constant returns to scale, imperfect competition.
  - Varies half as much as TFP.
  - Shocks are permanent and serially uncorrelated.
- What happens when technology improves?

Basu et al. (2006): Solow Residual



Basu et al. (2006): "Purified" Solow Residual



- Technology improvements are *contractionary* in the short-run.
  - Totally inconsistent with RBC.
  - However, long-run effects consistent with RBC/Neoclassical Growth model.
  - Will return to this with NK.

Business Cycle Accounting

- Where to go from here?
- Add various frictions to model.
  - Pricing.
  - Labor market.
  - Financial.
- Which to add?
- Idea: Match data by adding time-varying implicit labor and investment taxes to RBC.
  - See which "implicit taxes" or "wedges" matter.
  - Chari et al. (2007) show how different frictions map into different wedges.
    - E.g. Financial frictions affect capital wedge.

Labor and Capital Wedges

- A labor tax on workers gives worker and firm FOCs of:

$$\left(1-\tau_t^N\right) W_t = \chi \frac{N_t^{\varphi}}{C_t^{-\gamma}} \text{ and } W_t = (1-\alpha)\frac{Y_t}{N_t}$$

- The implicit tax is called the *labor wedge*:

$$1-\tau_t^N = \frac{\chi N_t^{\varphi} C_t^{\gamma}}{(1-\alpha)\, Y_t/N_t} = \frac{MRS_t}{MPL_t}$$

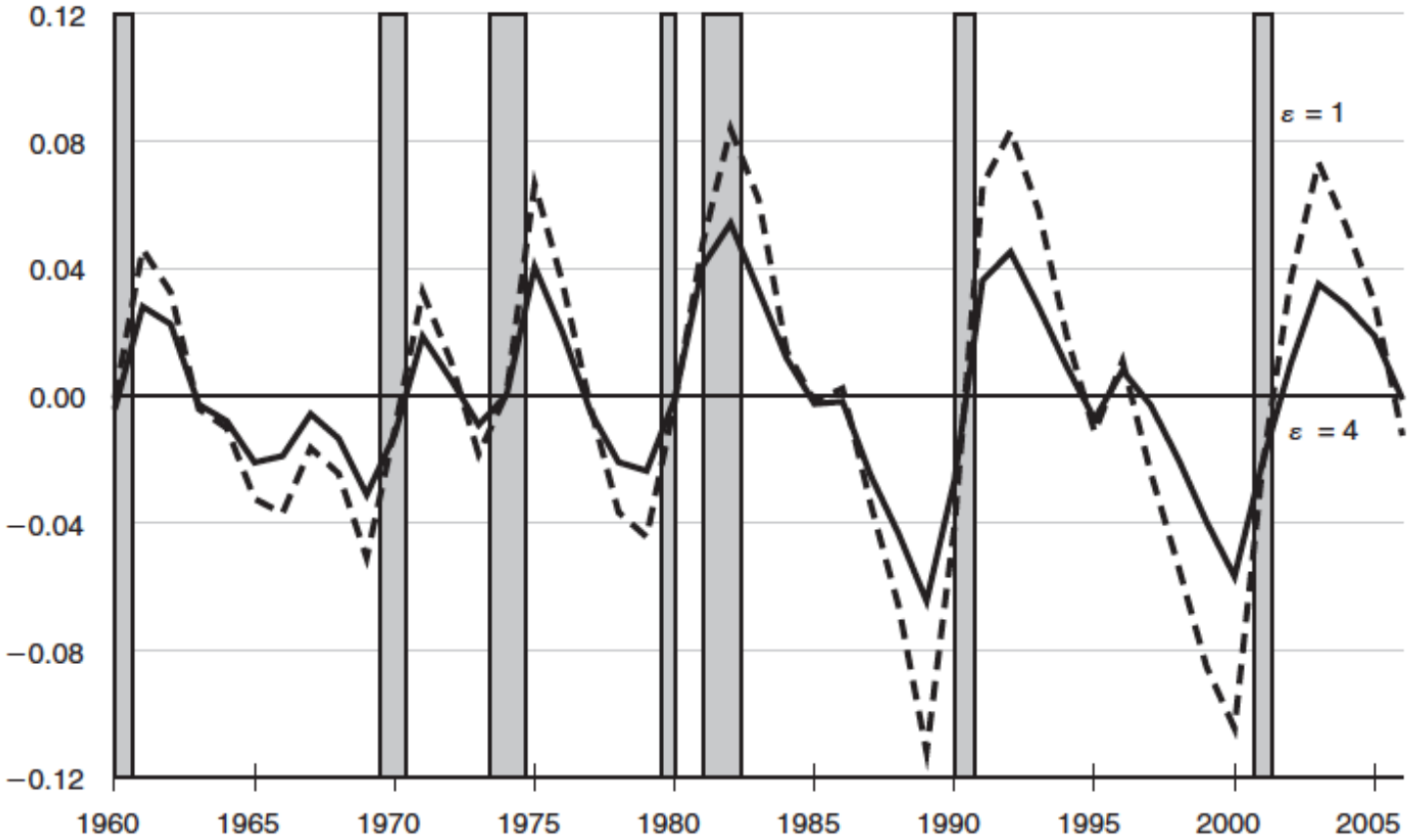
  - With data on Y_t, N_t, C_t, and assumptions for φ, γ, and α can compute in the data (usually in log deviations from trend so χ differences out).

- Similarly, one can define the implied *investment wedge* $1-\tau_{t+1}^K$:

$$1-\tau_{t+1}^K = E_t\left\{\frac{\beta C_{t+1}^{-\gamma}}{C_t^{-\gamma}}\left[\alpha\frac{Y_{t+1}}{K_{t+1}}+(1-\delta)\right]\right\}$$

Finding: τ^N is Countercyclical

$$\tau^N = 1 - \frac{MRS_t}{MPL_t} \Rightarrow MPL_t > MRS_t \text{ in Recessions}$$



Source: Shimer (2009)

Deconstructing the Labor Wedge

- Does the labor wedge imply that the relevant frictions are in the labor market?
  - Not exactly
- The labor wedge *combines labor and product market distortions.*
  - Labor market distortion (written as gross wage markup):

$$1 + \mu_t^W = \frac{W_t/P_t}{MRS_t}$$

  - Product market distortion (written as gross price markup):

$$1 + \mu_t^P = \frac{P_t}{MC_t} = \frac{P_t}{W_t/MPL_t} = \frac{MPL_t}{W_t/P_t}$$

  - Then the labor wedge can be written as a markup as:

$$1 + \mu_t^N = \frac{1}{1-\tau_t^N} = \frac{MPL_t}{MRS_t} = \left(1+\mu_t^P\right)\left(1+\mu_t^W\right).$$

Deconstructing the Labor Wedge

$$1 + \mu_t^N = \frac{1}{1 - \tau_t^N} = \left(1 + \mu_t^P\right)\left(1 + \mu_t^W\right)$$

- For τ_t^N and μ_t^N to be countercyclical, *either* gross price markups *or* gross wage markups are countercyclical.
- But which matters?
  - Construct $1 + \mu_t^P$ and $1 + \mu_t^W$ with same data as for labor wedge plus P_t and W_t.
  - Find that $1 + \mu_t^W$ explains almost all variation – motivates search and unemployment literature.
- Bils et al. (2018) argue that this has measurement issues.
  - W_t is smoothed measure of true marginal labor cost.
  - Use alternate metrics for marginal cost of labor and find labor wedge and product wedge are equally important.

Next Steps

- Labor wedge suggests we should add labor and product market frictions to the RBC model.
  - But for prices to matter, need to think about a non-real model.
  - Related to final RBC criticism: What does monetary policy do?
- Need to introduce *money*.
  - Next: What do money and monetary policy do in the data?
  - After: Add money and see how model does.
- For next class, read Stock and Watson (2001) *JEP*.