Econ 212a: Business Cycles
Lecture 4
RBC Model, part III

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Recap

- We introduced the RBC model
  - generated sizable business cycles driven entirely by technology shocks
  - extremely provocative!
- Today, we replay the historical fight over the RBC model
  - several **criticisms** ... and several **defenses**
- RBC theory as explanation for business cycles mostly lost the fight...
  - On the other hand, the RBC methodology clearly won!

Before we start ...

What do you think about the RBC model?

What does Larry Summers think?

Summers (1986):

> *My view is that **real business cycle models** of the type urged on us by Prescott **have nothing to do with the business cycle phenomena** observed in the United States or other capitalist economies. **Nothing in Prescott's papers** or those he references **is convincing evidence** to the contrary.*

The Barro-King problem and the RBC solution

- Before we dig into issues, let's understand why RBC was uniquely *successful*
- Consider a GE closed economy model in which eqbm is efficient
- In equilibrium with no gov spending, we must have

$$-\frac{U_N(C_t, N_t)}{U_C(C_t, N_t)} = A_t F_N(K_{t-1}, N_t) \tag{1}$$

$$C_t + I_t = A_t F(K_{t-1}, N_t) \tag{2}$$

- In the short run K_{t-1} is fixed. Then, without technology shocks A_t, (1) implies that C_t and N_t must comove *negatively*.
- For example, a "demand" shock (e.g. to β) that raises desired C has to make N fall. By (2), also means that I falls. C and I comove negatively too!
- **Conclusion:** demand shocks cannot generate the comovements in the data (Barro-King problem). But TFP can: this is what RBC does!

Roadmap

1. The labor supply response
2. Technology shocks
3. The comovement problem

The labor supply response

The first order condition for labor

- Assume separable preferences $U(C, N) = \log C - v(N)$
- First order condition for labor

$$C_t \cdot v'(N_t) = w_t = A_t F_N(K_{t-1}, N_t)$$

- **Two requirements for volatile labor:**
  1. **High Frisch elasticity:** Any given movement in w_t translates into large movements in N_t (holding $U_C = C_t^{-1}$, so C_t fixed)
  2. Real wage **more procyclical** than consumption! (which is more likely if the shock is not too persistent, b/c high ρ means stronger C response)
- Both are questionable

Frisch elasticity

- RBC assumes a Frisch elasticity of 4
  - strictly speaking captures **intensive margin hours** response to real wages
- Chetty Guren Manoli Weber (2011): micro data suggests ≈ 0.5
- That this was likely small was already known in the 80s!
- RBC comeback?$\rightarrow$ add **extensive (employment or participation) margin**

Extensive margin

- Main idea: each individual may have a small intensive margin elasticity...
  - ... but if employment responds at **extensive margin** to real wages ...
  - ... can still have significant fluctuations in total hours!
- How can we get the extensive margin to be active? $\rightarrow$ **fixed costs of working**
  - generally means introducing non-convexity of disutility v
  - e.g. v jumps at 0, $v(0) = 0$ but $\lim_{N \to 0} v(N) > 0$
- Seems appealing: most of total hours fluctuations are at the extensive margin (lecture 1)!
- Formalized in Rogerson (1988), Hansen (1985), Rogerson Wallenius (2009)

Modeling the extensive margin with indivisible labor

- We will consider extreme case: agents either work $\overline{n}$ or do no work at all
  - *zero* intensive margin hours elasticity!
  - $v(0) = 0$, $v(n) = v(\overline{n})$ for $n \in (0, \overline{n}]$, $v(n) = \infty$ for $n > \overline{n}$
- Let x be share of agents working, so total labor supply is $n = x \cdot \overline{n}$
- What's the effective utility of a planner that allocates c, n across agents?

$$\begin{aligned} \widehat{U}(c, n) = \max_{x} \quad & xU(c_E, \overline{n}) + (1 - x) U(c_U, 0) \\ \text{s.t.} \quad & xc_E + (1 - x) c_U = c \qquad \text{and} \qquad x \cdot \overline{n} = n \end{aligned}$$

- With $U(c, n) = \log c - v(n)$, we find $c_E = c_U = c$. So $\widehat{U}(c, n)$ becomes ...

$$\widehat{U}(c, n) = \log c - \frac{n}{\overline{n}} v(\overline{n}) - \left(1 - \frac{n}{\overline{n}}\right) v(0) = \log c - \psi n - const$$

- This is **linear** in n: **infinite Frisch elasticity** for the representative agent!

Indivisible labor amps up RBC! Doubles cyclicality of hours

- Hansen (1985) implements this in an RBC model. Works great!

Table 1

Standard deviations in percent (a) and correlations with output (b) for U.S. and artificial economies.

	Quarterly U.S. time series[a] (55.3–84.1)		Economy with divisible labor[b]		Economy with indivisible labor[b]	
Series	(a)	(b)	(a)	(b)	(a)	(b)
Output	1.76	1.00	1.35 (0.16)	1.00 (0.00)	1.76 (0.21)	1.00 (0.00)
Consumption	1.29	0.85	0.42 (0.06)	0.89 (0.03)	0.51 (0.08)	0.87 (0.04)
Investment	8.60	0.92	4.24 (0.51)	0.99 (0.00)	5.71 (0.70)	0.99 (0.00)
Capital stock	0.63	0.04	0.36 (0.07)	0.06 (0.07)	0.47 (0.10)	0.05 (0.07)
Hours	1.66	0.76	0.70 (0.08)	0.98 (0.01)	1.35 (0.16)	0.98 (0.01)
Productivity	1.18	0.42	0.68 (0.08)	0.98 (0.01)	0.50 (0.07)	0.87 (0.03)

[a] The U.S. time series used are real GNP, total consumption expenditures, and gross private domestic investment (all in 1972 dollars). The capital stock series includes nonresidential equipment and structures. The hours series includes total hours for persons at work in non-agricultural industries as derived from the *Current Population Survey*. Productivity is output divided by hours. All series are seasonally adjusted, logged and detrended.

Side note: Can decentralize this economy using "employment lotteries": agents sell a commitment to working $\bar{n}$ with probability x_t

Is the extensive margin the solution?

- In micro data, extensive margin Frisch elasticity **even smaller** than intensive margin Frisch, around 0.3. So apparently not ∞!
- Example: 1987 Zero-Tax Year in Iceland. Fairly ideal experiment for Frisch (temporary change in wage, looking at macro response)

Is the extensive margin the solution?

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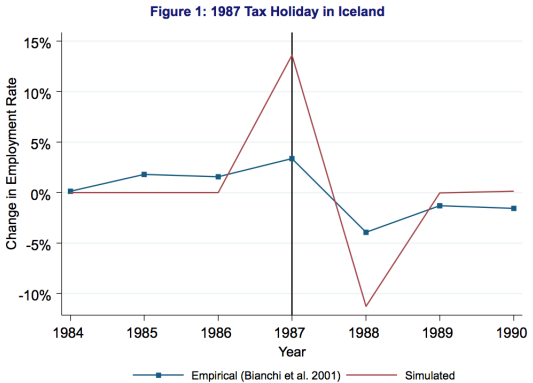
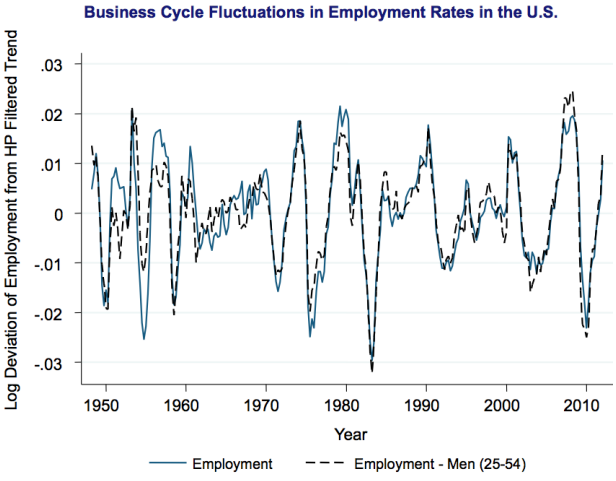
- Observed employment response is about 5x smaller than predicted by Rogerson Wallenius (2009) model (a state-of-the-art macro-labor model of the extensive margin)



Further evidence: prime-aged men have lower extensive elasticity in data, yet...

... very strong employment fluctuations!



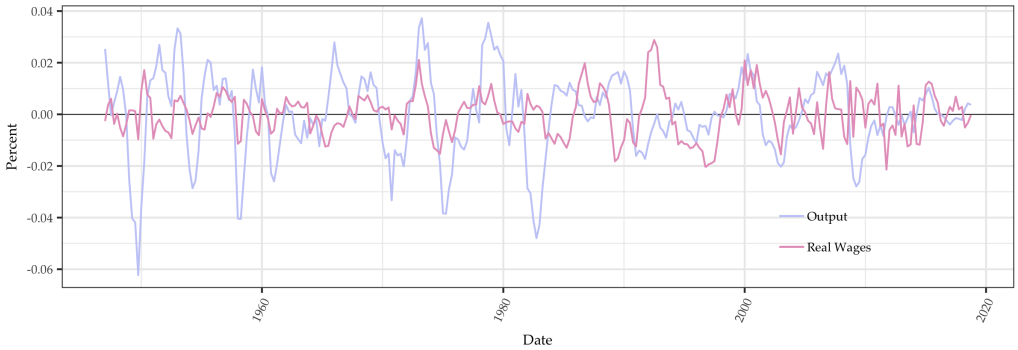
Summary: micro-macro disconnect for Frisch elasticity

- Chetty et al (2011)'s summary of estimates

		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

- Big disconnect between what you need for RBC ("macro") and what you actually find in micro data.
  - Summers: *"To claim that its [RBC model's] parameters are securely tied down by growth and micro observations seems to me a gross overstatement. The image of a big loose tent flapping in the wind comes to mind."*
- Lots of loose flapping tents in macro… great inspiration for empirical work!

What about real wages?



- Real wages not that cyclical in the data (not more than *C*)
- But they are **strongly cyclical in the model** (much more than *C*)

Business cycle accounting: the labor wedge

- One way to quantify deviation from RBC: compute "labor wedge"

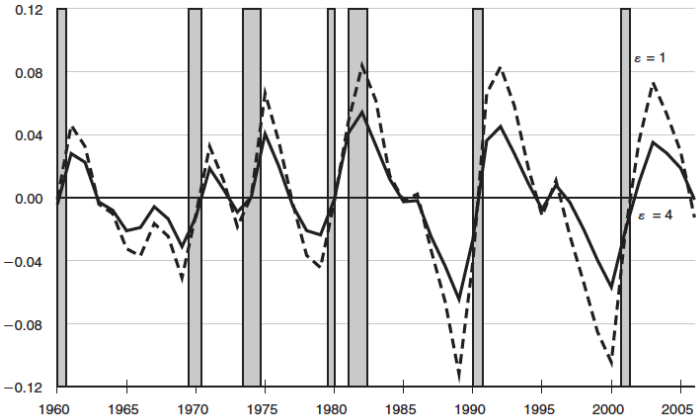
$$\tau_t^L = 1 - \frac{C_t v'(N_t)}{A_t F_N(K_{t-1}, N_t)}$$

  given functional form assumptions, this can be done with aggregate data

- Very useful tool to quantify where the RBC model fails/lacks frictions: see Patrick's classes for more on this

- Chari Kehoe McGrattan (2007): Labor wedge is large and countercyclical

Countercyclical labor wedge



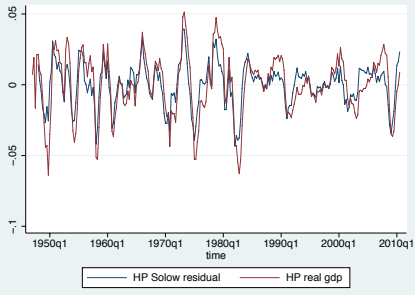
Technology shocks

Criticizing the Solow Residual

- Everything in the RBC model hinges on technology shocks, which are detrended Solow residuals

$$\log A_t = \log Y_t - \alpha \log K_t - (1 - \alpha) \log N_t - \text{trend}_t$$

- Any possible issues with this? Are these "true" technology shocks?



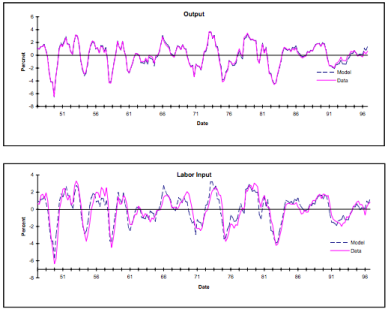
Issues with the Solow residual

The Solow residual ...

1. ... implies high probability of technological regress
2. ... is predictable by military spending, monetary policy, oil shocks, etc
3. ... has higher volatility than plant-level measures of productivity
4. ... is likely mismeasured, since it ignores **variable utilization:**
   - proxies for capital utilization and effort / labor hoarding are highly pro-cyclical
   - Solow residual treats this variation as part of productivity!

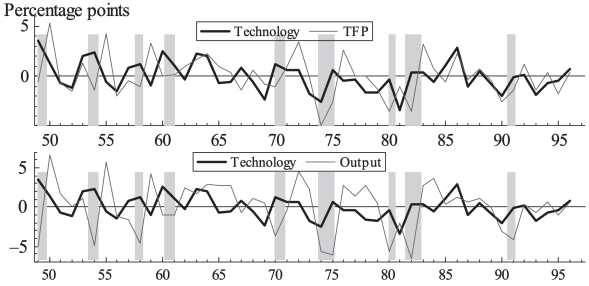
Is missing variable utilization even a problem?

- King and Rebelo (1999): No! With variable utilization, even a smaller TFP shock can have large consequences!
- They put indivisible labor and variable capital utilization into RBC
- They match observed Solow residuals, back out “true” technology shock
- Model does very well !



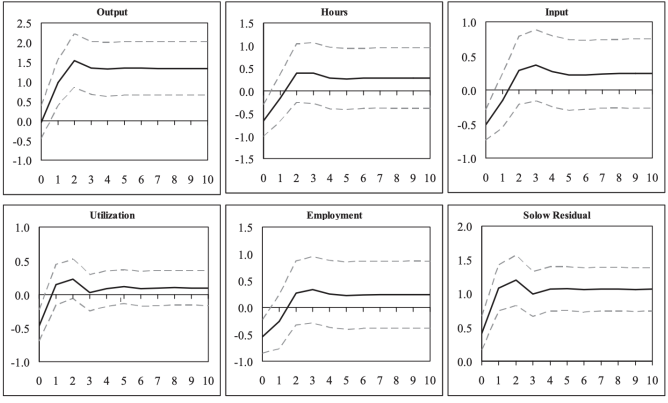
Purifying the Solow residual

- King-Rebelo use **model** to back out technology
  - requires a lot of trust in their model of utilization!
- Basu Fernald Kimball (2006) measure technology **directly**
  - account for several confounders: aggregation effects, varying utilization of *K* and *L*, non-constant returns to scale, imperfect competition
- Basu et al find nearly **acyclical technology**



Impact of technology shocks

- Basu et al also study impact of technology shock on outcomes directly



- Does not look like a business cycle at all! E.g. hours **fall** after positive shock!
  - confirms earlier results by Gali (1999)

The comovement problem

Comovement problem

- Recall that we want to think of a technology shock as an *aggregate shock* that affects all sectors equally
- With single sector, can't speak to the issue of comovement
- **Simple reinterpretation:** consumption and investment are two goods produced with their own technology

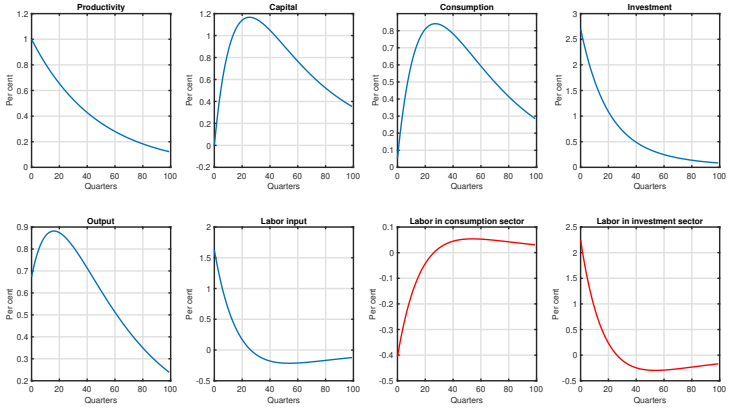
$$C_t = A_{Ct} F(K_{Ct}, N_{Ct}) \quad I_t = A_{It} F(K_{It}, N_{It})$$

- Factors are perfectly mobile between sectors:

$$N_{Ct} + N_{It} = N_t$$
$$K_{Ct} + K_{It} = K_{t-1}$$

- If the technology shock is an aggregate shock $A_{Ct} = A_{It}$, it must be that the relative price of investment is always $p_t = 1$. [Show this]
- What implication of a technology shock?

Impulse response to techology shock



Comovement problem

- This is known as the “comovement problem” in the literature
  - For example Christiano and Fitzgerald (1998)
- Many solutions have been proposed:
  - Costly movement of factors between sectors
  - Home production
  - More complex input-output structures
- Still an important starting point for current macro literature thinking about cross-sectoral implications of macro models

Summary and other critiques

We have seen that ...

- RBC model cannot explain fluctuations in hours
- technology shocks are unlikely driver of business cycle
- model has trouble getting sectoral comovement right

Moreover:

- Seems implausible that fluctuations in unemployment are Pareto efficient
- or that demand shocks/monetary policy play no role at all

How can we do better?

- Many of these issues will be solved in the New-Keynesian model
- But this will rely on sticky prices or wages
- That assumption also won't be entirely satisfactory, see Summers:

> *"**Partial breakdowns in the exchange mechanism** are almost surely dominant factors in cyclical fluctuations. ... Firms had output they wanted to sell. Workers wanted to exchange their labor for it. But the exchanges did not take place... The **traditional Keynesian approach** is to postulate that the exchange mechanism fails because **prices are in some sense rigid**, so they do not attain market-clearing levels and thereby frustrate exchange... **This is far from being a satisfactory story**."*

- still, but it takes a theory to beat a theory!