Topic 7: Real Business Cycles

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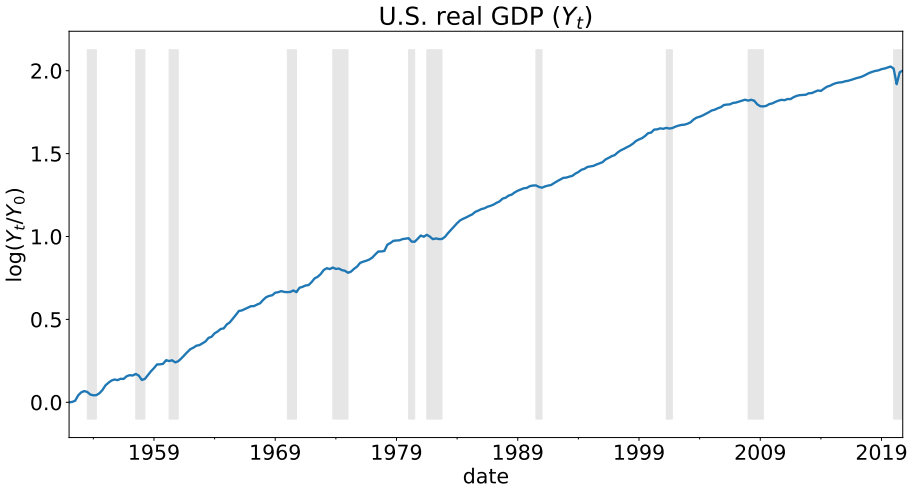
Overview

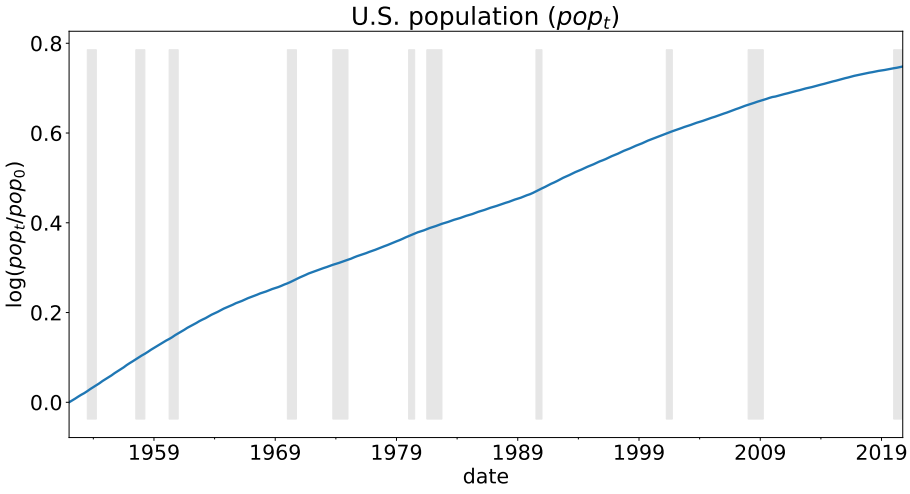
- So far: applied our microfoundations from Topics 1–3 to think about long-run Fiscal Policy (Topic 4) and Growth (Topics 5–6)
- This Topic: *real* business cycles
  - The same model that we have used to understand trends (g_A, g_Y, g_C, g_K) helps us organize and understand cyclical fluctuations around trend
  - Also helps us think about long-run nominal facts (money and inflation)
  - But also some important limitations, addressed in Topic 8

Outline

Real GDP over time



Population over time



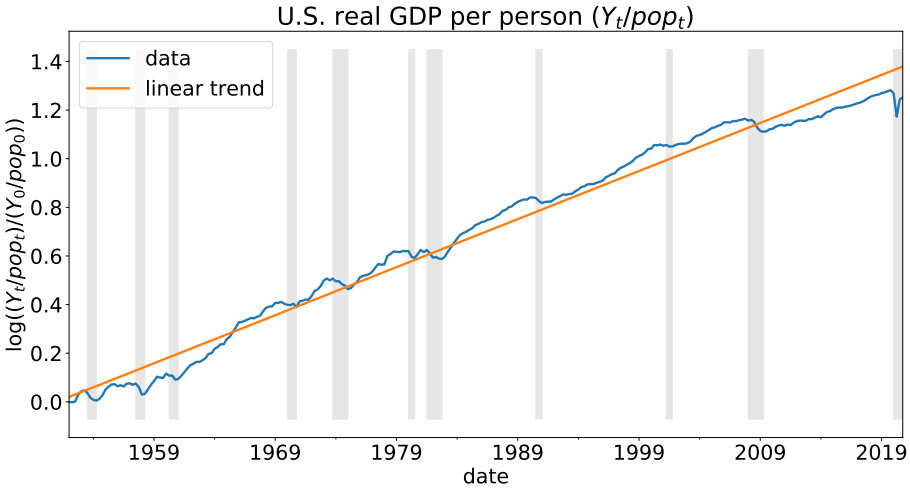
Trend growth rate varies over time

Average growth rates are uneven over long periods of time:

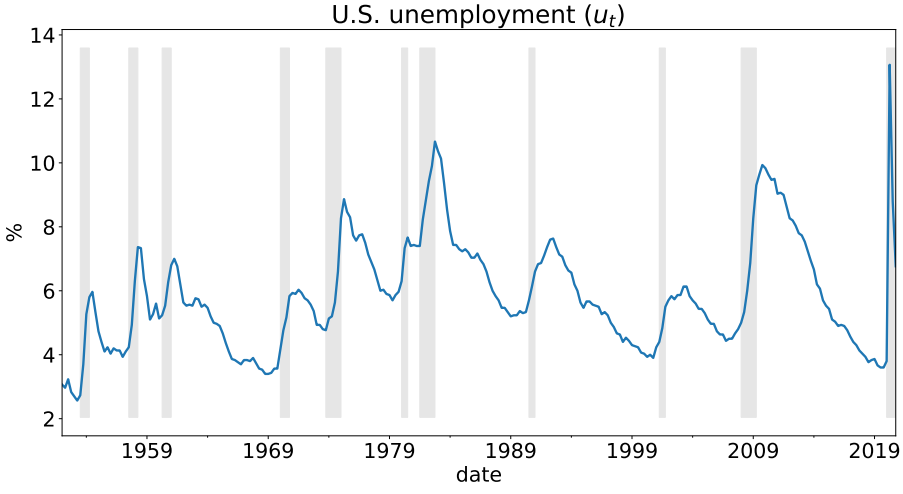
	1952-2020	1952-1969	1970-2000	2000-2020
g_Y	2.9%	3.7%	3.2%	2.0%
g_{pop}	1.1%	1.5%	1.0%	0.8%
$g_{Y/pop}$	1.8%	2.2%	2.2%	1.2%

(note: annualized log growth rates of real GDP, population, and GDP per person respectively)

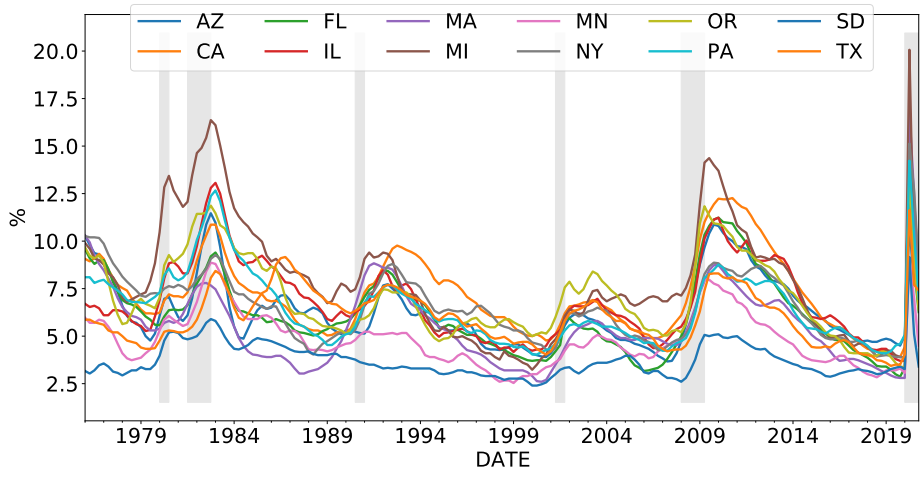
GDP per person vs a linear trend



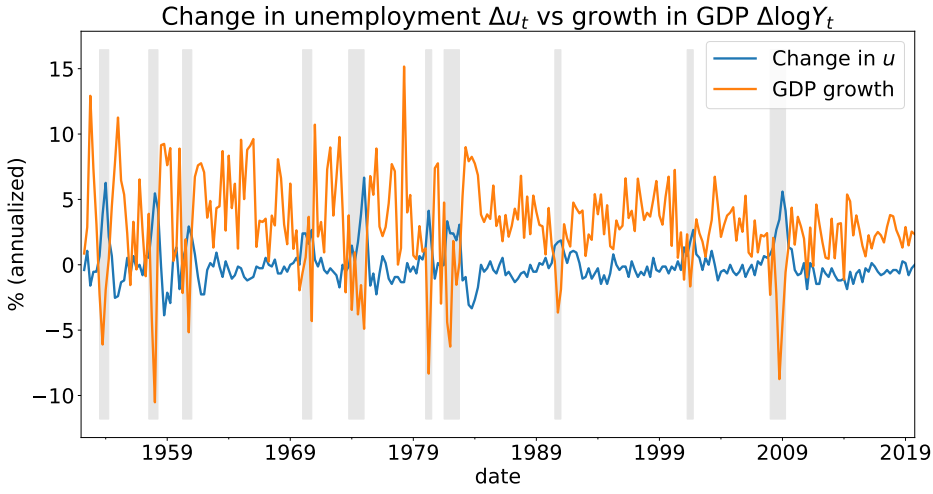
Unemployment over the cycle



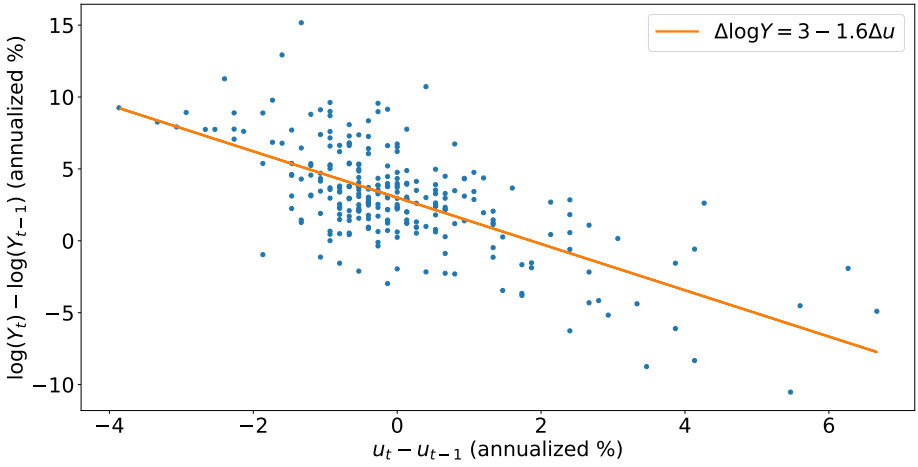
Unemployment correlated across states



Change in national unemployment vs GDP growth



Okun's law: $\Delta \log Y_t$ vs Δu_t



The business cycle

- Macroeconomic aggregates have a tendency to move together
- We call this phenomenon the “business cycle”
- The regularities suggests that an underlying theory can be helpful
  - to explain these comovements
  - to predict how effective policy will be, for instance, in mitigating the severity of recessions

Defining cyclicality

Procyclical $\equiv$ goes up in expansions, goes down in recessions

e.g. Y, N, C, I, firm entry rate

Acyclical $\equiv$ no clear correlation with the cycle

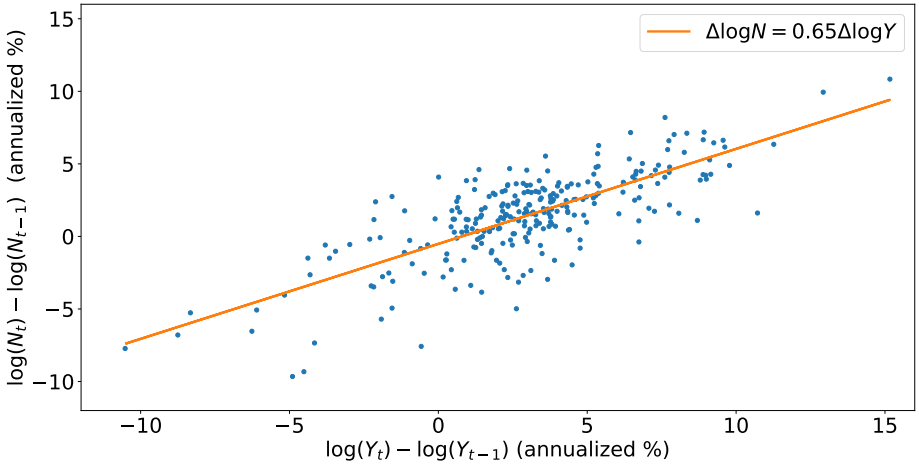
e.g. K, G, the real interest rate r, the inflation rate π

Countercyclical $\equiv$ goes down in expansions, up in recessions

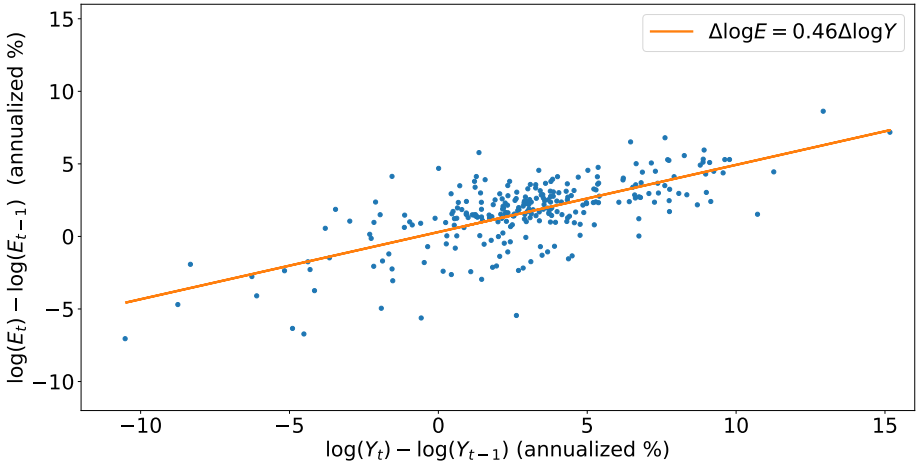
e.g. u (the unemployment rate), firm exit rate

Next: in the data, how cyclical are N, K? how about C, I and G?

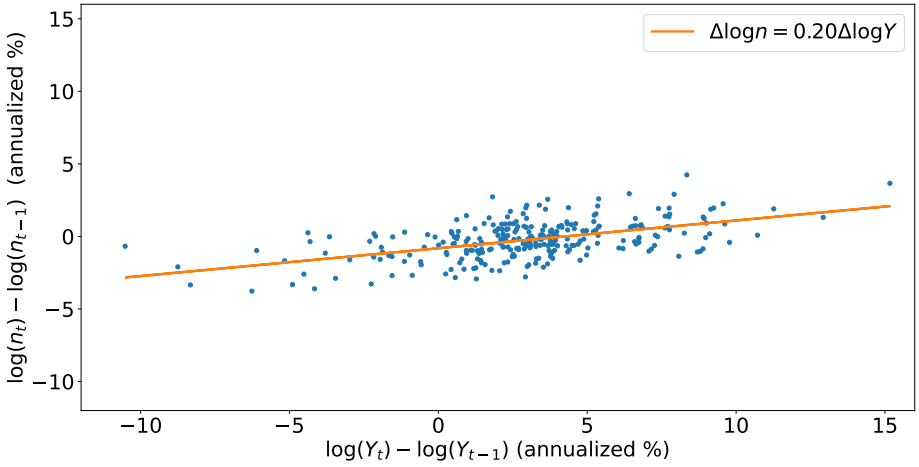
Total hours: less cyclical than Y



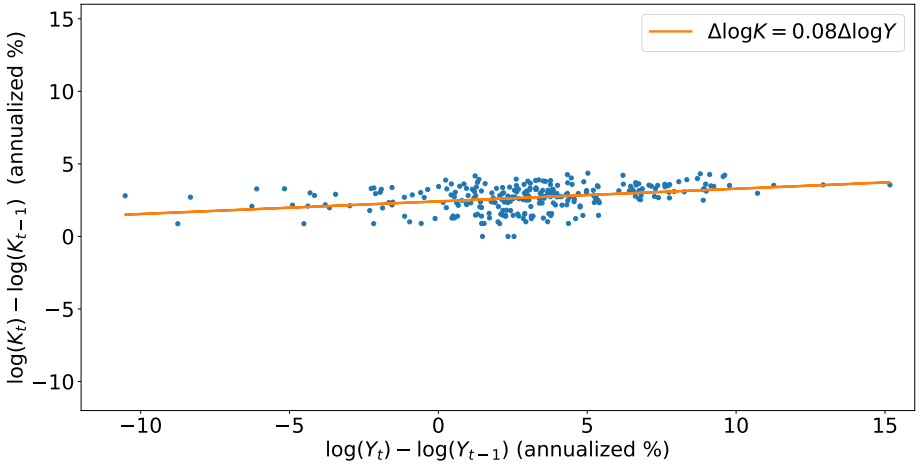
Employment cyclicality



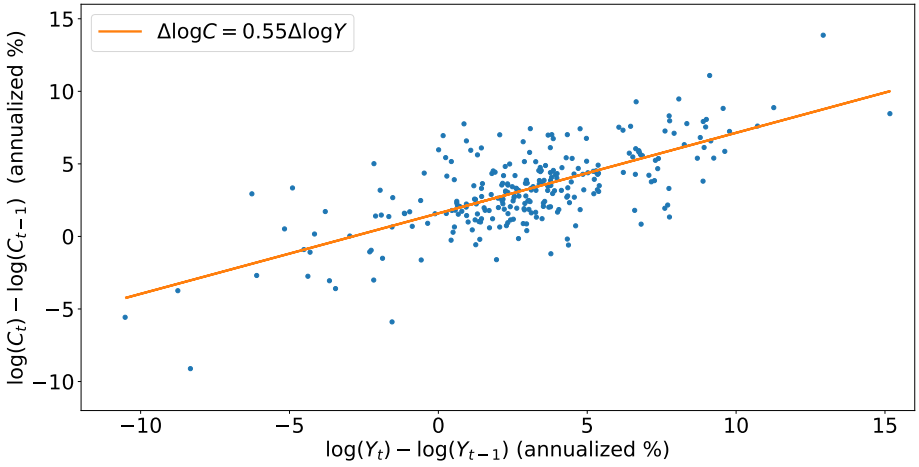
Cyclicality in hours per person



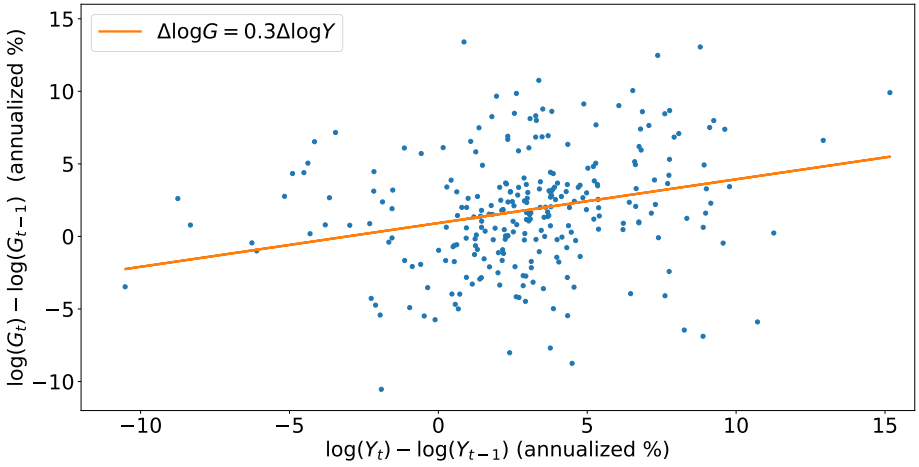
Capital: acyclical



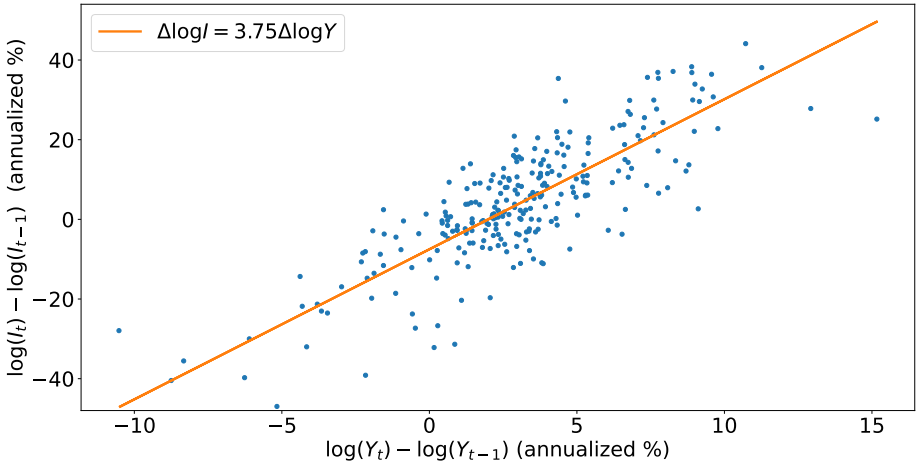
Consumption: less cyclical than Y



Government spending: much less cyclical than Y



Investment: much *more* cyclical than Y



Another way to see this: contributions to growth

- Contributions to growth in four recent recessions:

$$\frac{\Delta Y}{Y} = \frac{\Delta C}{Y} + \frac{\Delta I}{Y} + \frac{\Delta G}{Y} + \frac{\Delta X}{Y} - \frac{\Delta I}{Y}$$

Recession	$\Delta Y/Y$	$\Delta C/Y$	$\Delta I/Y$	$\Delta G/Y$	$\Delta X/Y$	$-\Delta I/Y$
1980:01–1980:07	-2.4%	-0.6%	-2.9%	-0.1%	0.1%	1.3%
1990:07–1991:03	-0.9%	-0.4%	-1.6%	0.4%	0.3%	0.5%
2001:03–2001:11	0.3%	0.9%	-1.1%	0.5%	-1.1%	1.2%
2007:12–2009:06	-3.4%	-1.5%	-5.3%	0.9%	-1.7%	4.2%

Data vs model

- Our neoclassical growth model:

$$C + I + G = Y = AF(K, N)$$

  is consistent with various features of the data:

  1. In the short-run, K is fixed in both data and model
  2. Consumption moves less than output, consistent with a consumption smoothing motive

- In terms of driving forces:

  1. G is not very cyclical.
  2. A is quite procyclical: $\Delta \log A = \Delta \log Y - \alpha \Delta \log K - (1 - \alpha) \Delta \log N$

- **Next**: can we explain business cycle movements in I? in N, C?

Why is investment so cyclical?

To increase the growth rate of the capital stock by 1% in one year, one needs a bigger than 1% increase in the flow of investment.

Why? Investment (say 15% of GDP) is smaller than the Capital Stock (say 200% of GDP). This reflects durability ($\delta << 1$).

Upshot: The more durable the K (or consumer good), the more cyclical the flow of I (or durable C).

Long-run effect of a permanent increase in A

Review Question: Consider our exogenous growth / endogenous investment / exogenous N model. Suppose there is a permanent 1% increase in the level of TFP A.

What is the % increase in Y, K and I in the long run?

Short-run effect of a permanent increase in A

New Question: Assume that $\alpha = 1/3, g_A = 0, g_N = 0$ and $\delta = 0.10$. Suppose there is a permanent 1% increase in the level of TFP.

What % increase in I is needed to reach the LR K in *1 year*?
(Assume *K* and I were at their steady state values beforehand.)

Time path of capital and investment in the previous question

Example 1: Houses

Suppose there are 100 million homes.

1 million are built and torn down each year ($\delta = .01$).

Now suppose you want 101 million homes next year, a 1% increase in the stock.

Q: Required % increase in new housing construction?

A: 100% increase from 1 to 2 million homes ($= 1/\delta \cdot 1\%$).

Example 2: Rental Cars

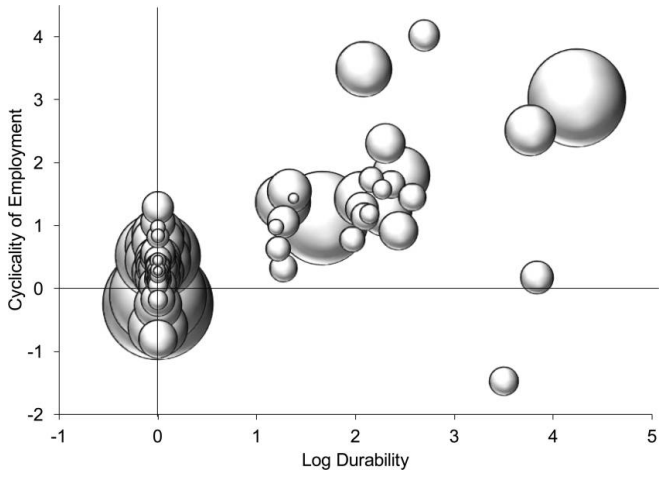
Say the industry has a fleet of 10 million cars. It junks 2 million every year and buys 2 million new ones ($\delta = .20$).

Now suppose the industry wants to expand its fleet to 10.1 million cars, a 1% increase in the stock.

Q: Required % increase in new car purchases?

A: 5% increase from 2 to 2.1 million cars ($= 1/\delta \cdot 1\%$).

Durability can explain why some sectors are so cyclical



Source: Bils, Klenow and Malin, NBER Macro Annual, 2013

Notes on Durability and Volatility

The expected life of a product in years is $1/\delta$. δ is the annual depreciation rate.

Our calculation of trying to change the stock by 1% in a single year is for exposition purposes. In reality, things like production capacity (and interest rates) can slow down the transition so that the surge in investment occurs over (say) 5 years rather in a single-year burst.

But the math illustrates the basic idea: the more durable a product (the higher is $1/\delta$), the larger the stock relative to the investment flow. Thus we need a bigger % change in the investment flow to move the stock by a given percentage (1% in our examples).

This works on the down side as well. A firm can cut back on its investment a lot on % terms without losing its entire stock. This same logic applies to consumer durables, and is why consumer durables spending (like new car purchases) are much more volatile than spending on perishables (e.g. fresh food) and services - for which $\delta = 1$.

Why are consumption and employment both procyclical?

Our neoclassical model can explain the cyclicality of I. How about C and N?

Question: assume that $\tau_N = \tau_C = 0$, $u(C, N) = \frac{C^{1-1/\sigma}}{1-1/\sigma} - \frac{N^{1+1/\phi}}{1+1/\phi}$ and $Y = AK^{\alpha}N^{1-\alpha}$. Derive a relationship between C, N, K and A.

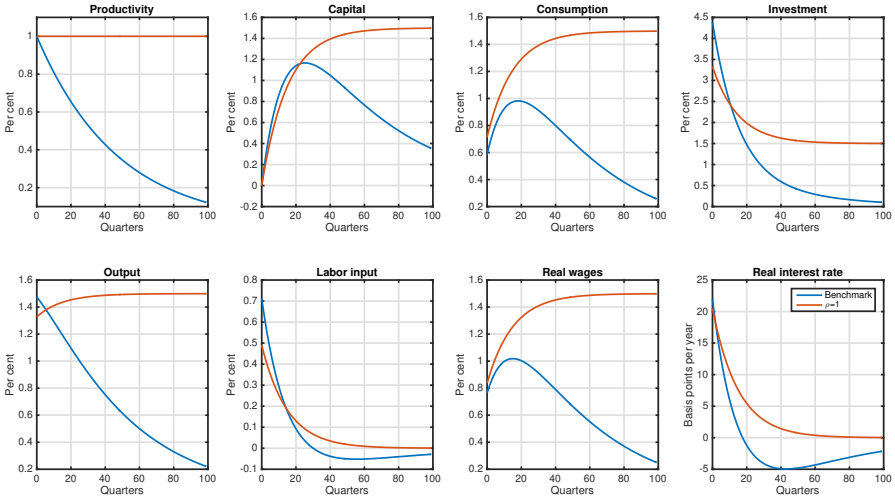
Cyclicality of C and N under various assumptions

Question: can the model explain why C and N are both procyclical in the short-run:

a) If A is constant

b) If A is procyclical

Time path after transitory and permanent A shock



Notes on business cycle comovements in the RBC model

A real business cycle ("RBC") model is a model that explains business cycle comovements by assuming that the neoclassical growth model describes the economy well both in the short and the long-run. In particular, prices and wages are flexible at all times.

These models rely on increases in TFP A to explain comovements. Demand shocks, which do not change A, cannot explain why C and N move in the same direction.

This rules out: shocks to G, shocks to monetary policy, shocks to consumer preferences or constraints that lower C without changing technology.

The Real Business Cycle model of Kydland and Prescott was the first to show that observed movements in TFP A can explain observed business cycle comovements both qualitatively and quantitatively.

The view that TFP shocks are the main drivers of business cycles is controversial. But it influential. That the neoclassical model can do so well was a surprise to many economists.

Policy implications of the RBC model

In the simplest RBC model, the economy is efficient.

Booms and recessions are the natural response of the economy to movements in A.

There is nothing the government should do to change this.

Governments should have positive consumption G to the extent that it enters utility $u(C, N, G)$, but have no reason to use G (or Tr) to manage the business cycle.

Optimal G in an RBC model

Question: suppose that the utility function is $u(C, N, G) = \frac{C^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} - \frac{N^{1+\frac{1}{\phi}}}{1+\frac{1}{\phi}} + \lambda \frac{G^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}$ and the resource constraint is $C + G = Y = AN$. How should the government set G?

Sticky prices and wages

A critical assumption in the RBC model is that prices and wages are flexible in the SR

Why is this critical? Flexible prices imply that firms set

$$p = \frac{w}{MPN}$$

even over short horizons.

Flexible wages imply that workers can choose C and N so that

$$\frac{(1-\tau_N)\,w}{(1+\tau_C)\,p} u_C = -u_N$$

even over short horizons.

Prices are sticky

In the U.S., the typical consumer price changes every 4 months or so (8 months if one excludes temporary price discounts).

The typical producer price also changes every 8 months.

Prices are even stickier in the Euro Area, changing closer to once a year.

See the survey in Klenow and Malin (2011).

Wages are sticky

Wages are even stickier than prices, typically changing once a year in the U.S. and Euro Area.

Wage declines are uncommon even in economies with low inflation.

The two are related: labor-intensive goods exhibit the stickiest prices.

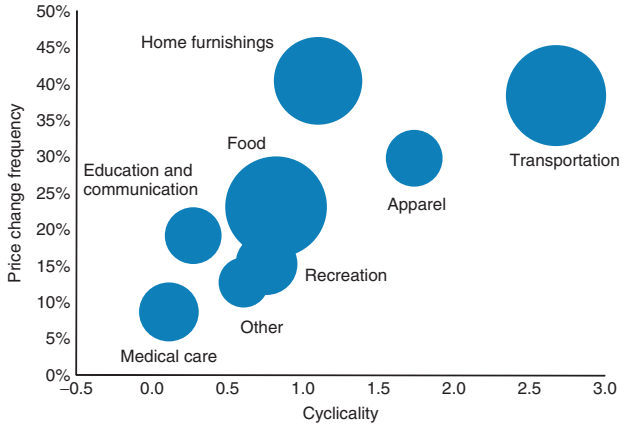
Why Do RBC Models Exist?

Some macroeconomists are skeptical that price and wage stickiness matters a lot for business cycles:

Prices are stickiest for services (not so cyclical) and most flexible for durables (very cyclical).

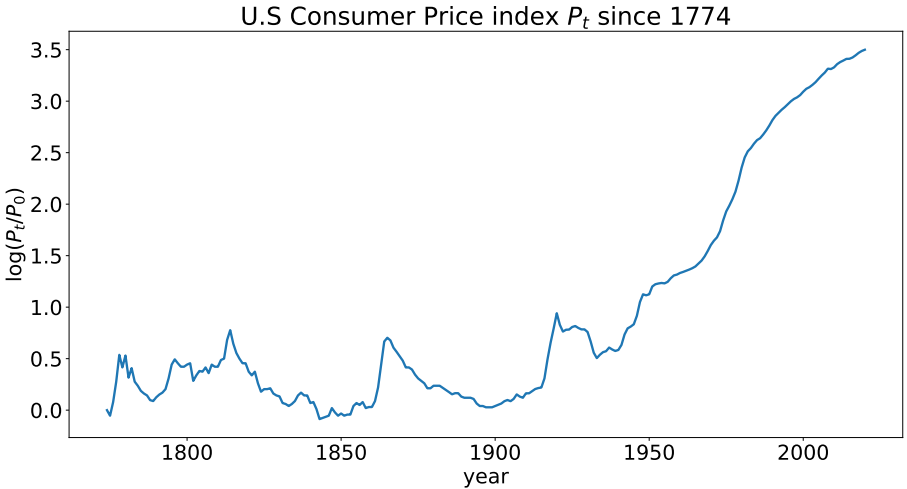
Wages are sticky for existing employees, but are more flexible for new hires (and the hiring rate is very cyclical).

Price flexibility vs output cyclicality



Source: Klenow and Malin, Handbook of Monetary Economics, 2011

Inflation over the long run in the United States



Source: Lawrence H. Officer and Samuel H. Williamson, MeasuringWorth, 2021.

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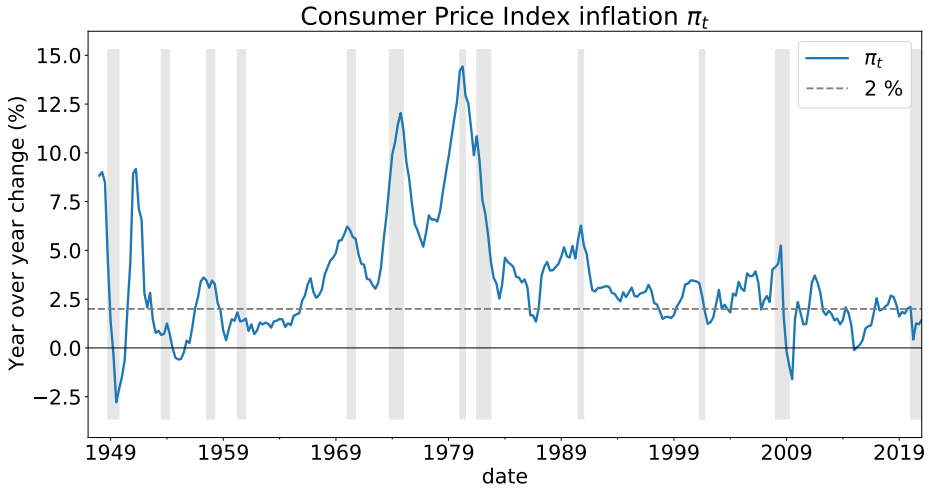


Why is inflation relevant?

So far our models have been silent on the determinants of inflation

We have talked about determinants of r, $\frac{w}{p}$, but not i, w or p.

Yet inflation ($\pi = g_p$) is clearly a relevant macroeconomic phenomenon:

- Hyperinflations (eg Germany 1920s) create big disruptions
- Unexpected π creates a transfers of wealth between debtors and creditors
- Interacts with tax brackets & generates other distortions in the tax code
- Generates confusion between relative prices and absolute increases in prices
- Associated with high nominal interest rates, which make mortgages difficult to afford

The quantity theory of money

How does the RBC model determine P and W? What is the role of the central bank?

Answer: the quantity theory of money

$$Mv = PY$$

For simplicity, we will *assume* that velocity $v = 1$.

Since real factors determine Y, the implication is that P is determined by M. In particular

$$\pi = g_M - g_Y$$

According to the RBC model, the central bank controls g_M but not g_Y.

This is sometimes referred to as the "neoclassical dichotomy".

Notes on the quantity theory equation $Mv = PY$

$M \equiv$ stock of liquid assets = "the money supply"

e.g. M1 = deposits + cash in public circulation, M2 = M1 + savings + MMFs

$PY \equiv$ nominal GDP

$v \equiv$ Velocity

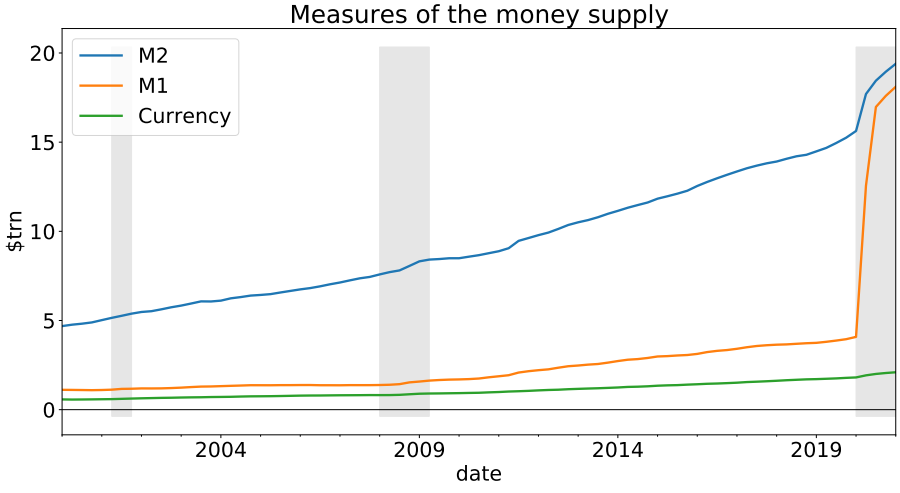
Think how fast cash moves around to carry out transactions.

$v = \frac{PY}{M}$. It is a definition, rather than an equation

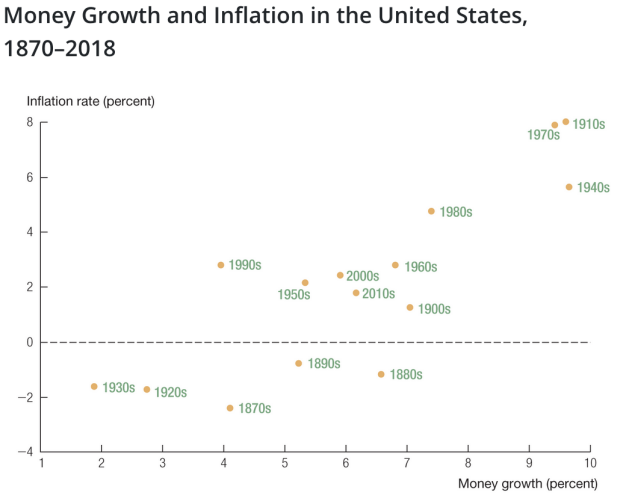
One can define a different v for any measure of M.

Still, it *is* helpful for conveying that M flows into PY.

M2, M1 and currency in the U.S. since 2000

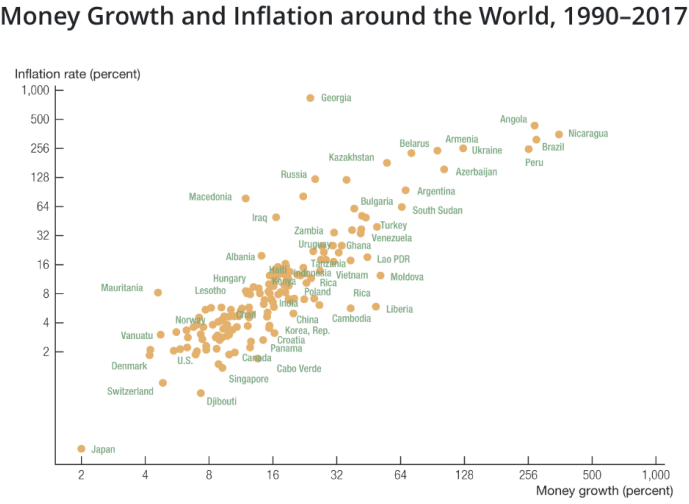


Money growth vs inflation, 1870-2018



Source: Jones textbook, chapter 8

Money growth vs inflation across countries



Source: Jones textbook, chapter 8

The RBC model and interest rates

We saw how the central bank determines π. How about i?

Recall the Fisher equation:

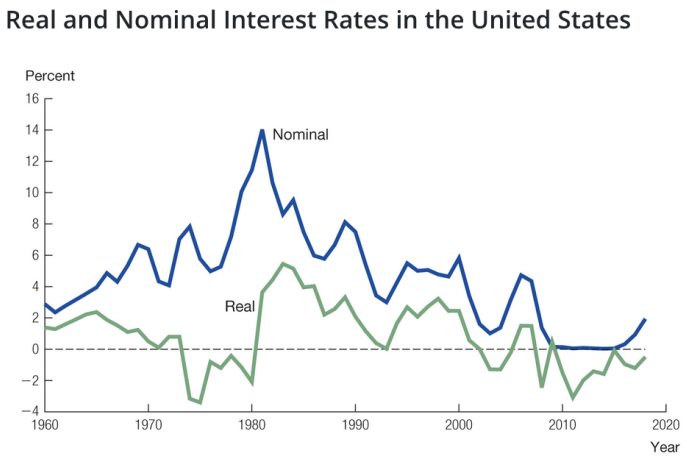
$$i = r + \pi$$

The neoclassical model determines r. The central bank determines π. This gives us i.

In our standard neoclassical model, $r = \rho + \frac{1}{\sigma} g_{Y/N} = \rho + \frac{1}{\sigma} \frac{g_A}{1-\alpha}$.

$\rightarrow$ the central bank cannot affect the real interest rate.

Nominal vs real interest rates



Source: Jones textbook, chapter 8

Other factors influencing real interest rates

In Topic 8 we will see that the central bank *is* able to influence real interest rates in the SR when prices or wages are sticky

All economists agree that prices are flexible in the LR. Most theories agree that

$$i = r + \pi$$

explains well the determination of long-run nominal rates.

Beyond productivity growth, factors that economists think influence long-run r include:

- Demographics
- Public debt
- The "Global Savings Glut"

How demographics affects the real interest rate

See Auclert, Malmberg, Martenet and Rognlie “Demographics and Wealth in the 21st Century”

Limitations of the RBC model

No way to understand:

- how demand shocks could be causing recessions
- why monetary policy appears to influence real interest rates in the short run
- why monetary policy appears to influence *economic activity* (C, I, Y, N, etc.)
- why countercyclical fiscal policy could be a good idea

Partly as a result of these deficiencies, few economists think that the RBC model provides a good theory of short run fluctuations. But most would agree that it describes the long-run well.

Conclusion on real business cycles

The RBC model provides an explanation for the business cycle

Real shocks drive Y, C, I, N, K, r and w/p.

Nominal shocks (esp. the amount of money M) drive π, i, w and p.

The role of policy in the model is very limited – it should set G to equalize u_C and u_G, and keep inflation low.

While the RBC view of business cycles is disputed, it provides a useful starting point to understand the data.

Since prices adjust in the long-run, the RBC model describes the long-run well.