

Lecture 20: The New Keynesian Model

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Making demand matter – the NK model

- Today we will start our analysis of the NK model
- Three main blocks:
 1. **Empirical motivation**: the real effects of monetary policy
 2. **NK model analysis**
 - Model solution
 - Optimal monetary policy and the zero lower bound
 3. Application to the **Great Recession**: a demand shock that the Fed only (partially) offset
- Next time: add fiscal policy

Outline

1. Empirical Evidence on Monetary Non-Neutrality

2. The Basic New Keynesian Model

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4. Midterm discussion

Econometric methodology

- **Q:** Does **monetary policy** have **real effects**? Challenging to answer **empirically**:
 - To isolate the effect of X on Y, you want *exogenous* variation in X. Say we run

$$y_t = \alpha + \beta r_t^n + \varepsilon_t$$

Problem: central bank sets r_t^n responding to macroeconomic conditions. I.e., r_t^n and ε_t are correlated. And the correlation is probably positive.

- For example, if times are bad ($\varepsilon_t < 0$, $y_t < 0$), central banks tend to cut rates, reflecting a belief that low rates boost output. But then $\beta > 0$!
[Q: what if the central bank manages to stabilize output perfectly by manipulating interest rates?]
- **Strategy:** isolate variation in rates that is not a response to the business cycle
 - Ideally: central bankers would flip coins. Unfortunately not the case.
 - How does the literature try to approximate this **experimental ideal**? rate changes due to changes in central banker preferences, long-run reputation or financial stability concerns, ...

Econometric methodology

- Statistical techniques to isolate “exogenous” variation in nominal interest rates:
“**Vector Autoregressions**” & “**Local Projections**”
 - Basic idea goes back to Sims (1980), awarded the Nobel Prize in 2011
Nobel scientific background posted on canvas, in case you are interested.
 - Long literature that leverages these techniques. We will just look at one recent application.
- **Bauer-Swanson (2023)**: look at interest rate surprises around FOMC announcements
 - Suppose private sector and Fed have same information about the economy. Then surprise component of interest rate change at FOMC announcement is *pure* rate surprise $\perp$ cycle.
 - Thus simple strategy: extract those surprises and see how they propagate. Study:
 1. Short-run effects on asset prices (“Wall Street”)
 2. Medium-run effects on real activity and overall prices (“Main Street”)

Interest rate hikes lower stock prices

Table 3
Asset Price Responses to Monetary Policy Surprises

	FOMC		Fed Chair Speeches	
	mps_t	$\text{mps}_t^\perp$	mps_t	$\text{mps}_t^\perp$
2-year yield:	.73	.74	.73	.72
t -statistic	(18.6)	(16.7)	(23.4)	(22.0)
R^2	.784	.689	.856	.827
5-year yield:	.63	.64	.66	.66
t -statistic	(14.4)	(13.8)	(16.5)	(15.8)
R^2	.626	.550	.737	.714
10-year yield:	.41	.41	.49	.49
t -statistic	(9.5)	(9.9)	(13.9)	(13.2)
R^2	.435	.363	.651	.627
30-year yield:	.25	.25	.39	.38
t -statistic	(6.3)	(6.7)	(10.5)	(10.1)
R^2	.206	.173	.479	.455
S&P 500:	-5.39	-5.50	-1.59	-1.56
t -statistic	(-7.7)	(-6.6)	(-2.5)	(-2.5)
R^2	.304	.266	.027	.025
Observations	322	322	295	295

Note: Estimated coefficients β and regression R^2 from high-frequency event-study regressions $y_t = \alpha + \beta \text{mps}_t + u_t$, where t indexes Federal Open Market Committee (FOMC) announcements or Fed chair speeches, y_t denotes the change in the 2-, 5-, 10-, or 30-year Treasury yield or log S&P (Standard & Poor's) 500 price index in a narrow window of time around each announcement, and the regressor mps_t is either the unadjusted high-frequency monetary policy surprise measure mps_t , or $\text{mps}_t^\perp$, the residual from regressing mps_t on the predictors in table 1. Heteroskedasticity-consistent t -statistics are in parentheses. Sample: 1988:1–2019:12. See text for details.

Interest rate hikes depress economic activity & prices

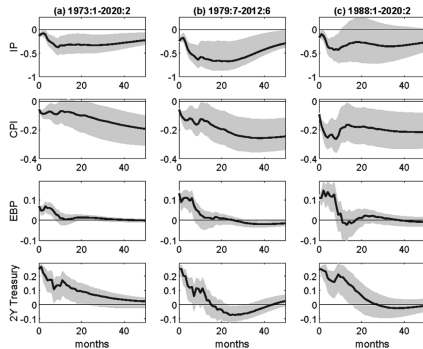


Fig. 2. Structural VAR with external instrument, different sample periods. Structural vector autoregression impulse response functions to a 25-basis-point monetary policy shock, identified using the unadjusted high-frequency mps measure around Federal Open Market Committee announcements for three different sample periods: (a) full sample, 1973:1–2020:2; (b) Gertler and Karadi’s sample, 1979:7–2012:6; and (c) 1988:1–2020:2, because our high-frequency mps data begin in 1988. Shaded regions report bootstrapped 90% standard-error bands. EBP = excess bond premium, CPI = Consumer Price Index, IP = industrial production. See text for details. A color version of this figure is available online.

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Overview

- The basic New Keynesian model is the labor-only RBC model of Lecture 15, but with two important twists:
 1. The New Keynesian Phillips Curve replacing that model's supply block
 2. The monetary authority setting nominal interest rates [which now matter]
- The NK model thus consists of three core equations:
 1. **Aggregate demand**: this is just the consumer Euler equation.
Today we do the permanent-income version, next time the hand-to-mouth version.
 2. **Aggregate supply**: optimal firm pricing + household labor supply gives the NKPC
This is what we derived in Lecture Note 19.
 3. **Monetary policy rule**: a rule describing how the monetary authority sets nominal rates
- Next slides: introduce the three equations + model solution

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Aggregate demand

- Recall the household Euler equation [“demand”] with CRRA preferences:

$$\theta_t c_t^{-\gamma} = \beta \mathbb{E}_t \left[\theta_{t+1} \frac{1 + r_t^n}{1 + \pi_{t+1}} c_{t+1}^{-\gamma} \right] \quad (1)$$

- Recall the usual interpretation: marginal utility of consumption today equals discounted marginal utility of consumption tomorrow, adjusted for returns
- To make our lives easy we consider a *linear* version of this equation:

$$-\gamma c_t = \underbrace{\mathbb{E}_t [r_t^n - \pi_{t+1}]}_{\text{effect of real rate}} - \gamma \mathbb{E}_t [c_{t+1}] - \underbrace{(\theta_t - \theta_{t+1})}_{\equiv \hat{\theta}_t, \text{demand shock}} \quad (2)$$

- You can formally justify (2) as a log-linear approximation to (1) [i.e., first-order approximation of (1) in log space]. Not necessary for you to know how to do that.
- $\hat{\theta}_t$ is the relevant demand shock: it captures θ_t relative to θ_{t+1}

Aggregate demand

- By output market-clearing [$c_t = y_t$] we can write this as

$$-\gamma y_t = \mathbb{E}_t [r_t^n - \pi_{t+1}] - \gamma \mathbb{E}_t [y_{t+1}] - \hat{\theta}_t \quad (3)$$

- (3) is our linear **aggregate demand block**:
 - Key: a negative relation between real rates and output *growth*. From our study of household consumption decisions we know where this comes from.
 - We see that both (i) real rates and (ii) $\hat{\theta}$ drive “aggregate demand.” In this simple model the mechanisms are (i) intertemporal substitution and (ii) impatience.
 - More generally, as we have seen: (i) reflects wealth effects, mortgage refinancing, investment, stock market, ...and (ii) comes from credit crunches, uncertainty, inequality, ...

Aggregate supply

- Recall from the last class that firm pricing – under the addt'l simplifying assumption of no adjustment costs from tomorrow onwards – gave

$$\frac{w_t}{A_t} = \frac{\varepsilon - 1}{\varepsilon} + \frac{\phi}{\varepsilon}(1 + \pi_t)\pi_t \quad (4)$$

Note that I am also simplifying things by assuming a linear production function.

- Combining this with optimal household labor supply:

$$\frac{\ell_t^{\frac{1}{\phi}} c_t^{\gamma}}{A_t} = \frac{\varepsilon - 1}{\varepsilon} + \frac{\phi}{\varepsilon}(1 + \pi_t)\pi_t = \frac{\left(\frac{y_t}{A_t}\right)^{\frac{1}{\phi}} y_t^{\gamma}}{A_t} \quad (5)$$

- Also for comparison recall that, with flexible prices [i.e., $\phi = 0$] together with perfect competition [i.e., $\varepsilon \rightarrow \infty$], we get

$$y_t = A_t^{\frac{\frac{1}{\phi} + 1}{\frac{1}{\phi} + \gamma}}$$

We derived this in Lecture Note 15. Make sure you see how (5) with $\phi = 0$ and $\varepsilon = \infty$ reduces to this.

Aggregate supply

- We yet again consider a *linear version* of this **supply equation**. Can show that this is

$$\pi_t = \underbrace{\kappa \cdot \left(y_t - \frac{\frac{1}{\phi} + 1}{\frac{1}{\phi} + \gamma} \hat{a}_t \right)}_{\text{effect of marginal costs}} \quad (6)$$

Sketch argument on the board. For our purposes the details of the linearization are not important, just take (6) as given. With future adjustment costs (6) would also feature future inflation.

- κ is a parameter that depends on ϕ : $\kappa = 0$ if $\phi = \infty$, and $\kappa = \infty$ if $\phi = 0$.
- $\hat{a}_t$ is the supply/TFP shock – our second business-cycle shock
- The term in brackets is what we get with flexible prices— y_t just follows $\hat{a}_t$.
This is all that matters if $\phi = 0$ and so $\kappa = \infty$. Inflation is irrelevant, and the economy is entirely supply-determined, i.e., we're back to the RBC model.
- With sticky prices, if y_t doesn't follow $\hat{a}_t$ as it should, we get prices changing = inflation.

Monetary policy

- The central bank sets nominal interest rates. Assume it follows a *rule*:

$$r_t^n = \phi_\pi \pi_t + \hat{m}_t \quad (7)$$

(7) is an example of a so-called “Taylor rule”

- Proposed in 1992 by John B. Taylor as description of past central bank behavior. Can be shown to be “optimal” under certain assumptions. Later.
 - $\phi_\pi > 1$ or $\phi_\pi < 1$? do rates increase more or less than 1-1 with inflation?
Common wisdom is to adjust more than 1-1. Then real rates increase when π is high, lowering demand and so stabilizing the economy. Will discuss at length later.
 - Richer versions also respond to output and move interest rates only gradually.
- $\hat{m}_t$ is our third business-cycle shock – a “monetary policy” shock. Interest rates being higher/lower for reasons orthogonal to business-cycle concerns.

This is what the empirical evidence reviewed in the beginning is supposed to identify. A change in monetary policy that is not driven by any other shocks.

Equilibrium

- Our definition of equilibrium combines the three key equations that we've derived – aggregate demand & supply + the monetary policy rule

Definition

Given stochastic processes for $\{\hat{\theta}_t, \hat{a}_t, \hat{m}_t\}_{t=0}^{\infty}$, an equilibrium is a collection of stochastic paths of output $\{y_t\}_{t=0}^{\infty}$, inflation $\{\pi_t\}_{t=0}^{\infty}$, and nominal interest rates $\{r_t^n\}_{t=0}^{\infty}$, such that the following all hold:

1. *aggregate demand (3),*
2. *aggregate supply (6),*
3. *the monetary policy rule (7).*

- Note how this embeds our usual requirements: **optimization** + **market-clearing**

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Solution

- We will assume that all shocks $\{\hat{\theta}_t, \hat{a}_t, \hat{m}_t\}$ only last for one period. Then can show that $\mathbb{E}_t[y_{t+1}] = \mathbb{E}_t[\pi_{t+1}] = 0$, i.e., the economy is static, just like our RBC model.
 - In general this is not true, as price stickiness makes the firm problem dynamic.
 - We abstract from this through our as'n on price stickiness only lasting for one period.
- We have then reduced everything to a *static* demand-supply-policy system:

$$-\gamma y_t = r_t^n - \hat{\theta}_t \quad (3')$$

$$\pi_t = \kappa \cdot \left(y_t - \frac{\frac{1}{\varphi} + 1}{\frac{1}{\varphi} + \gamma} \hat{a}_t \right) \quad (6')$$

$$r_t^n = \phi_\pi \pi_t + \hat{m}_t \quad (7')$$

- Linear system: three equations, three unknowns. Solution gives us the response of output, inflation, and interest rates to the three shocks – demand, supply, and monetary policy
- Make sure you see the economic intuition of each equation.

Solution

- Solving the system we obtain the following:

1. Output

$$y_t = \frac{1}{\gamma + \phi_\pi \kappa} \left(\phi_\pi \kappa \frac{\frac{1}{\varphi} + 1}{\frac{1}{\varphi} + \gamma} \hat{a}_t - \hat{m}_t + \hat{\theta}_t \right)$$

Positive supply and demand shocks increase output, and negative monetary policy shocks lower it.

2. Inflation

$$\pi_t = -\frac{\gamma}{\gamma + \phi_\pi \kappa} \kappa \frac{\frac{1}{\varphi} + 1}{\frac{1}{\varphi} + \gamma} \hat{a}_t - \frac{\kappa}{\gamma + \phi_\pi \kappa} (\hat{m}_t - \hat{\theta}_t)$$

Positive supply and negative monetary policy shocks lower inflation, while positive demand shocks increase it.

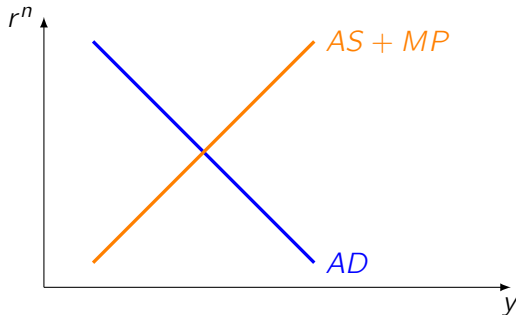
3. Interest rates

$$r_t^n = -\frac{\gamma \phi_\pi}{\gamma + \phi_\pi \kappa} \kappa \frac{\frac{1}{\varphi} + 1}{\frac{1}{\varphi} + \gamma} \hat{a}_t + \frac{\kappa \phi_\pi}{\gamma + \phi_\pi \kappa} \hat{\theta}_t + \frac{\gamma}{\gamma + \phi_\pi \kappa} \hat{m}_t$$

Positive supply shocks lower interest rates, while positive demand and negative monetary policy shocks increase interest rates.

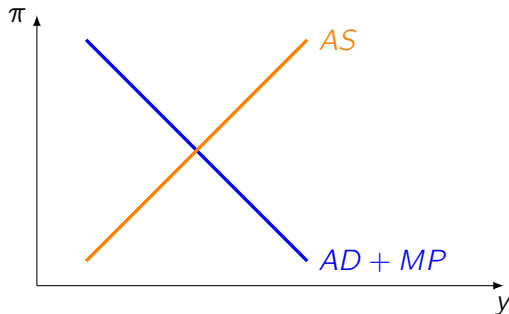
Figure I: output & nominal interest rate space

To be clear: our linearized system is centered at zero. I'm adding constants back in to move everything to the top right quadrant. I.e., y here = y_t from linear system plus constant.



- Blue: demand relation (3). Shifted by demand shocks $\hat{\theta}_t$. Slope: $-\gamma$.
- Orange: supply relation (6) + monetary rule (7). Slope: $\phi_\pi \kappa$.
 - Combining the two, we get an increasing relation between y and r^n
 - Shifted by supply shocks $\hat{a}_t$ and monetary policy shocks $\hat{m}_t$

Figure II: output & inflation space



- Orange: supply relation (6). Shifted by supply shocks $\hat{a}_t$. Slope: κ .
- Blue: demand relation (3) + monetary rule (7). Slope: $-\gamma/\phi_\pi$.
 - Combining the two, we get a decreasing relation between y and π
 - Shifted by demand shocks $\hat{\theta}_t$ and monetary policy shocks $\hat{m}_t$

On interest rates and inflation

- Note that, in this model, the central bank hiking nominal interest rates – i.e., $\hat{m}_t > 0$ – *decreases* inflation
 - This is consistent with the empirical evidence that we reviewed at the beginning.
 - Why? higher rates lower demand. If the economy is demand-determined, then lower demand lowers output and inflation. Travel along NKPC.
- This is very different from the nominal RBC model, where nominal rates and inflation move *together*, as we discussed in Lecture Note 19
 - Recall the Fisher eq'n: $1 + r_t = \frac{1+r_{t-1}^n}{1+\pi_t}$ and r_t is determined from the real part of the model. Prediction of a positive association between r^n and π is known as *Neo-Fisherian* principle.
 - NK model breaks this because monetary authority can move real rates r_t and drive demand
- **Overall takeaway** from recent literature: negative co-movement between π and r^n in the short run, positive co-movement in the long run

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Divine coincidence

- So far our analysis was *positive*: what happens given a certain monetary policy rule?
- Natural next **Q**: what *should* monetary policy do?
- Answer here is straightforward: try to replicate the **RBC model outcomes**!

Why? Remember that the RBC model was efficient – competitive eq'm outcomes = planner solution.

- How to do this? Key idea: set nominal rates to hit zero inflation
Should interpret “zero” inflation here as target inflation, i.e., around 2%.
- Then can show “divine coincidence”: if you set rates to stabilize inflation, then output will also be where it should be, at the “natural” RBC level
- Intuition: prices now don't do the adjustment (because they are sticky), so the central bank steps in and implements optimal outcomes via r^n
- Next slide: mathematical details of this “divine coincidence”

Divine coincidence

- Recall first what happens in RBC model: [= NK model with $\phi = 0$, so $\kappa = \infty$]
 - Demand shocks are offset by interest rates, supply shocks affect output as

$$y_t = \frac{\frac{1}{\varphi} + 1}{\frac{1}{\varphi} + \gamma} \hat{a}_t$$

- Thus from the aggregate demand relationship (3) we have that

$$r_t = \hat{\theta}_t - \gamma \frac{\frac{1}{\varphi} + 1}{\frac{1}{\varphi} + \gamma} \hat{a}_t$$

1. Interest rates adjust 1-1 to offset **demand shocks**
2. Positive **supply shocks** boost output. Rates decline, to offset incentive to save.

Divine coincidence

- **Q:** How can the central bank achieve these outcomes in the sticky-price NK economy?
- **A:** Just set

$$r_t^n = \hat{\theta}_t - \gamma \frac{\frac{1}{\varphi} + 1}{\frac{1}{\varphi} + \gamma} \hat{a}_t$$

Verify that demand (3) and supply (6) then give $\pi_t = 0$ and output at the RBC level.

- **Policy prescription: set interest rates to stabilize inflation!**

That's what the Fed does: set rates so that inflation is (expected to be) at target. Can attain with Taylor rule that responds aggressively to inflation, $\phi_\pi = \infty$.

Practical challenges

- The theory developed on the previous slides is the basis for what central banks do in practice: “**flexible inflation targeting**”

“The Fed has a rule. The Fed’s rule is that we will go for a 2 percent inflation rate. [...] We will give you information about our projections about our interest rates.”—Bernanke (2015).

- But there are two important **practical challenges**:
 1. For some shocks “divine coincidence” fails—so-called “**cost-push shocks**”
 - Shocks such that $y_t = y_t^{RBC}$ and $\pi_t = 0$ are not attainable. E.g., changes in firm market power, or tax changes (like tariffs). We didn’t model those.
 - In that case face a trade-off between stabilizing output and stabilizing inflation. In practice Fed tries to balance both.

We will return to this later, when discussing tariffs (if time permits).

2. **Lower bound** on nominal interest rates, i.e., you can’t set nominal rates to be (too) negative. But then may be unable to offset strong negative demand shocks.
This is what happened in the Great Recession. Will discuss next.

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The Taylor principle

- Earlier I mentioned that $\phi_\pi > 1$ vs. $\phi_\pi < 1$ was an important question
 - Terminology: if $\phi_\pi > 1$ then we say that the **Taylor principle** is satisfied: nominal rates increase more than 1-1 with inflation, so real rates increase
 - But we didn't see $\phi_\pi > 1$ vs. $\phi_\pi < 1$ mattering in our simple model. Why? real rates are

$$r_t = r_t^n - \mathbb{E}_t[\pi_{t+1}]$$

but $\mathbb{E}_t[\pi_{t+1}] = 0$, so there is no feedback from inflation to real rates

- This is the key limitation of our static model—in dynamic models you always see this feedback effect, which is at the heart of the Taylor principle
- To deal with this let us consider the following *ad hoc* adjustment to the demand block:

$$-\gamma y_t = r_t^n - \pi_t - \hat{\theta}_t \quad (8)$$

- (8) adds feedback from *current* inflation to demand. Mimics full dynamic model.
- Next slide [and problem set]: work out what happens in this case

Aggregate demand and the Taylor principle

- We now have the following demand and monetary policy equations:

$$\begin{aligned}-\gamma y_t &= r_t^n - \pi_t - \hat{\theta}_t \\ r_t^n &= \phi_\pi \pi_t + \hat{m}_t\end{aligned}$$

- Combining the two:

$$-\gamma y_t = (\phi_\pi - 1)\pi_t + (\hat{m}_t - \hat{\theta}_t)$$

- We see that aggregate demand is decreasing in π_t only if $\phi_\pi > 1$, i.e., only if the Taylor principle is satisfied! What is going on?
 - Suppose inflation is high. If $\phi_\pi > 1$, then the Fed hikes nominal rates so much that real rates increase, lowering demand, stabilizing the economy.
 - Conversely, if $\phi_\pi < 1$, then real rates drop, so demand increases, increasing inflation even more, destabilizing the economy.

Make sure you see that, in this case, the AD curve is *upward-sloping*.

- This is why $\phi_\pi > 1$ is widely regarded as important. More in problem set.

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Demand shocks & the Great Recession

- Consider a very negative **demand shock**, $\hat{\theta}_t \ll 0$, and suppose $r_t^n = \theta_t$ is not feasible, because of the ZLB constraint on nominal rates. E.g., $r_t^n = 0$.

- Then we have

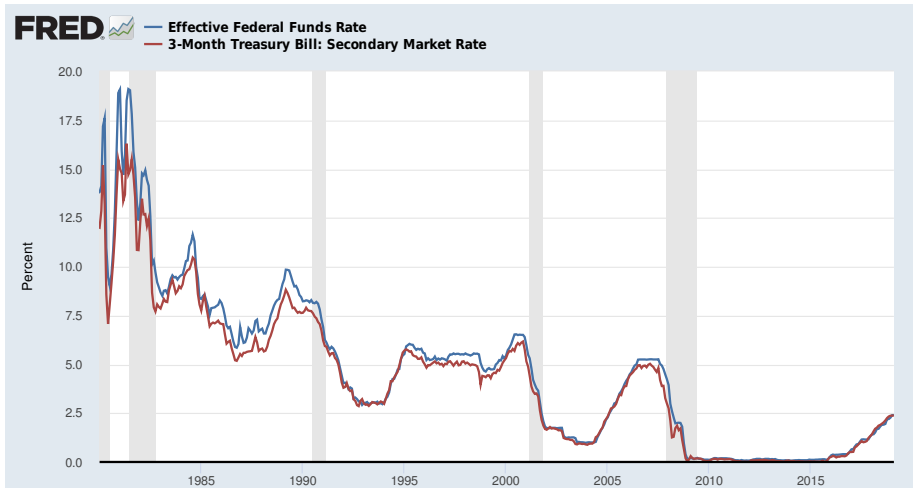
From now on we return to our baseline aggregate demand relation, i.e., without the ad-hoc adjustment.

$$y_t = \frac{1}{\gamma} \hat{\theta}_t < 0, \quad \text{as well as} \quad \pi_t = \kappa y_t = \frac{\kappa}{\gamma} \hat{\theta}_t < 0$$

We get a demand recession—low output and inflation.

- This is the conventional account of what happened in the **Great Recession**:
 - Collapse in housing market, crisis in financial system, so private demand declines.
 - Fed slashed interest rates as became clear financial crisis would hit real economy. Trying to cushion economy against the adverse shock to demand.
 - Interest rates hit zero. Economy needed more, $r_t^n \ll 0$, but not possible.

Interest rates in the Great Recession



Open questions

- This is the **conventional account** of what happened in the Great Recession.
- Raises two natural **follow-up questions**:
 1. How do we really know that it was a **demand shock**? Why did the Fed view it as such?
Coming up now.
 2. Economy needed more stimulus, ZLB binding. **What else** could be done? [later]
 - Monetary policy: “quantitative easing” [direct purchases of financial assets] and “forward guidance” [promises of low rates for long]
 - Fiscal policy: government purchases and stimulus checks

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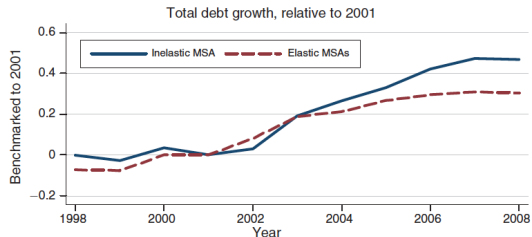
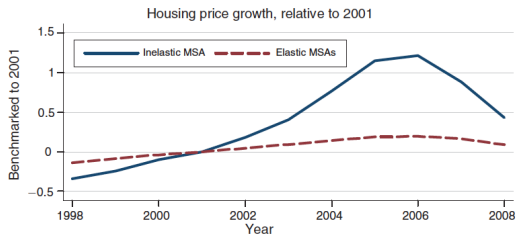
Towards empirical evidence

- How do we know this was a **demand shock** rather than a **supply shock**? Can we detect the role of demand and isolate it from other factors?
 - Delicate. In macro, “everything is endogenous.”
 - In recent years has become popular to address questions like this using a “micro-to-macro” empirical approach. That is, trying to answer macro questions using micro data.
- A well-known example of this approach is Mian and Sufi (2014)
 - **Main result:** increased unemployment during Great Recession caused by negative demand shock, triggered by collapse in housing market and debt deleveraging by households
 - **Empirical strategy:** use heterogeneity across geographic locations (across Metropolitan Statistical Areas, MSAs) in severity of the housing market collapse

Mian and Sufi (2014)

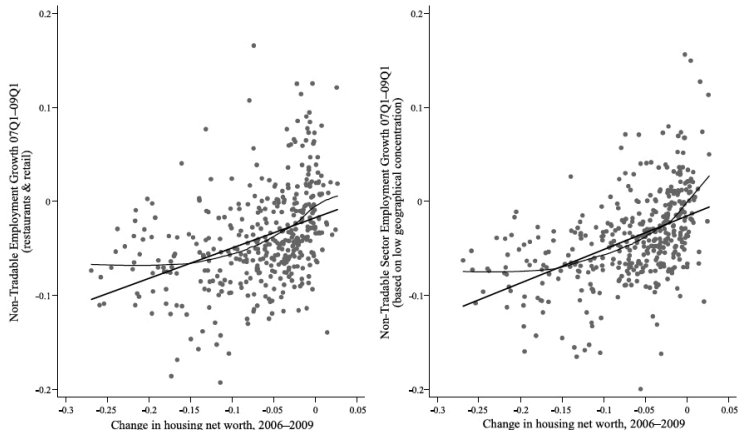
- Remember from our earlier discussion on consumer aggregate demand—Mian and Sufi had shown that regions with less elastic housing supply experienced ...
 - ... more borrowing, bigger boom in house prices before the Great Recession
 - ... more home-equity losses, bigger price drops during the Great Recession
- **Hypothesis:** by depressing aggregate demand, these losses explain the increase in unemployment after 2008
- **Strategy:** compare response of (i) *non-tradable* employment relative to *tradable* employment to (ii) house price declines at regional level.
 - Why? if local demand conditions are important, then we should see a larger movement in non-tradable employment because demand for non-tradables is local while demand for tradeables is national (or global)
 - Uses housing supply elasticity as *instrument* for housing net worth (i.e., exogenous variation in local demand) What are the arguments for IV relevance and exclusion?

House prices and debt



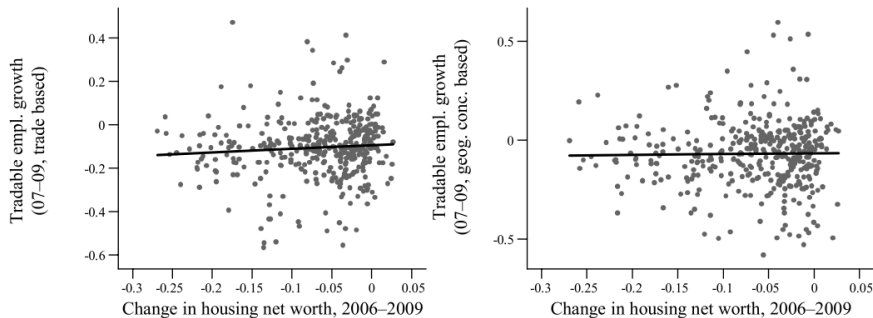
Recall from our earlier discussion: differential effects of housing crisis across regions with different elasticities of housing supply.

Non-tradeables



Non-tradeables: strong effect of local shock on local employment, consistent with the idea that reduction in local demand caused a drop in local employment and output of goods consumed locally.

Tradeables



Tradeables: roughly zero effect of local shock on local employment, consistent with the idea that reduction in local demand did not affect the production of the goods that could be sold elsewhere (for which the equilibrium quantity produced depends on economy-wide rather than local demand).

Summary

- Evidence that cross-regional variation in **demand**, due to differential exposure to housing collapse, appears to have caused cross-regional variation in employment and output.
 - Consistent with idea that fluctuations in aggregate demand can drive business cycles.
 - Important caveat: the evidence is at regional rather than national level
 - Could be that AS curve is steeper at national level than at the regional level, if so would mitigate role of demand shocks at national level. But converse may also be possible.
 - Evidence here is a useful benchmark; an area of lively research to understand links between fluctuations at national and regional levels
- Overall takeaway: an example of empirical evidence supportive of the **Keynesian view** that business cycles can be driven by fluctuations in **aggregate demand** and can be associated with output “gaps” that policy should try to close
i.e., not all fluctuations are “efficient,” as predicted by the RBC model.

Recapping the Great Recession

- Housing/financial crisis triggered a drop in aggregate demand $\hat{\theta}$.
- Absent the ZLB, monetary policy could have offset the drop in aggregate demand and closed the output gap by reducing interest rates enough.
- But the ZLB was binding—the shock to aggregate demand was sufficiently large, so the required cut in rates was not feasible.

And other monetary policy tools were imperfect substitutes. Later, if time permits.

- Next up: **fiscal policy** options

Outline

1. Empirical Evidence on Monetary Non-Neutrality
2. The Basic New Keynesian Model
 - The Three Model Equations
 - Shock Propagation
 - Optimal Monetary Policy
 - The Taylor Principle
3. Application: Great Recession
 - The Monetary Policy Response
 - Was It A Demand Shock?
4. Midterm discussion

Midterm discussion

- Midterm on Wednesday. Closed book, 85mins. Structure similar to past years:
 1. Relatively short yes/no/uncertain questions with brief discussion
Taken from entire class, up to the lecture before the exam.
 2. Two longer questions [model-based: RBC, consumption, investment, NK model]
- Main modeling skills for longer questions
 - RBC model: demand and supply shocks, labor-leisure static model, intuition for infinite-horizon dynamics
 - Consumption: permanent-income, hand-to-mouth, Euler equation, lifetime budget constraint, borrowing constraints, ...
 - Investment: neoclassical investment model, financial frictions, q -theory
 - NK model: firm market power, sticky prices, three-equation model

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