Lecture 19: Neutrality of money

ECON30009/90080 Macroeconomics

Semester 2, 2025

Last Class

☐ Last class, we introduced money into the RBC framework via money-in-the-utility function

☐ Households derived utility from holding real money balances.

☐ Money is a dominated asset, opportunity cost of money equal to nominal interest rate

☐ We saw that money (nominal) and real money balances did not matter for real output, investment and consumption

☐ So if the monetary authority decides to change the amount of money supplied in the economy, what does it actually do?

Recap from last class

☐ Looking at the key real variables in the economy:

$$y_1 = z_1 k_1^\alpha$$

$$k_2 = \frac{\alpha\beta}{1 + \alpha\beta} z_1 k_1^\alpha$$

$$c_1 = \frac{1}{1 + \alpha\beta} z_1 k_1^\alpha$$

☐ Real output, investment and consumption (since $N = 1$) do not depend on M_1^s/P_1.

☐ Key take-away from RBC model with money-in-the-utility function: monetary policy (via money supply rule) does not impact real variables

Demand for real money balances

□ So what does money do?

□ "Unused" equations for optimal money demand in each period:

$$\frac{\gamma}{m_2} = \frac{1}{c_2} \implies m_2 = \gamma c_2 = \gamma \beta R_2 c_1$$

and

$$m_1 = \gamma c_1 \left(\frac{1}{i_2} + 1 \right)$$

Money market equilibrium and money supply rules

☐ In equilibrium, money supply equal money demanded. $M_t^s = M_t$ since $N = 1$

☐ Money supply rule between periods 1 and 2

$$M_2^s = \theta M_1^s$$

☐ which implies

$$\frac{m_2}{m_1} \underbrace{\frac{P_2}{P_1}}_{\Pi_2} = \frac{M_2^s}{M_1^s} = \theta$$

Money supply rules and the nominal interest rate

☐ Plugging in for m_1 and m_2

$$\frac{\gamma \beta R_2 c_1}{\gamma c_1 \left(\frac{1+i_2}{i_2}\right)} \Pi_2 = \theta$$

Money supply rules and the nominal interest rate

☐ Plugging in for m_1 and m_2

$$\frac{\gamma \beta R_2 c_1}{\gamma c_1 \left(\frac{1+i_2}{i_2} \right)} \Pi_2 = \theta$$

☐ Using Fisher equation, i.e., that $1 + i_2 = R_2 \Pi_2$:

$$\frac{\gamma \beta R_2 c_1}{\gamma c_1 \left(\frac{R_2 \Pi_2}{i_2} \right)} \Pi_2 = \theta$$

Money supply rules and the nominal interest rate

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☐ We arrive at:

$$i_2 = \frac{\theta}{\beta}$$

Money supply rules and the nominal interest rate

$$i_2 = \frac{\theta}{\beta}$$

☐ The money supply rule (how fast to grow money in the economy) affects the nominal interest rate. Opportunity cost of holding money is higher if money supply tomorrow larger

☐ Note mapping between θ (which controls money supply growth) and i_2. [Two ways of specifying monetary policy in the model]

Nominal variables and money supply

□ What about prices?

Nominal variables and money supply

☐ What about prices?

☐ From money supply rule in period 1 and applying equilibrium

$$M_1 = M_1^s = \bar{M}$$

which is the same as:

$$P_1 m_1 = \bar{M}$$

Nominal variables and money supply

☐ What about prices?

☐ From money supply rule in period 1 and applying equilibrium

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which is the same as:

$$P_1 m_1 = \bar{M}$$

☐ Using household optimal demand for m_1, can show:

$$P_1 = \frac{\bar{M}}{m_1} = \frac{\bar{M}}{\gamma c_1 \frac{1+i_2}{i_2}} = \frac{\theta \bar{M}}{\gamma c_1 (\beta + \theta)}$$

Nominal variables and money supply

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□ Money supply rules $(\bar{M}, \theta)$ affect the price levels as well.

Money neutrality

☐ So far we've shown that the money supply rule affects nominal variables such as the nominal interest rate and P_1,

☐ But from Fisher Equation, this also means it affects inflation (and thus P_2) since R_2 pinned down from firm optimality condition

$$R_2 \Pi_2 = 1 + i_2 = 1 + \frac{\theta}{\beta}$$

☐ In the flexible price RBC model, monetary policy – whether you set i_2 or θ (one-to-one mapping) – **only affects nominal variables not real variables**!

☐ Money neutrality: changes in the stock of money only affect nominal variables and not real quantities.

Classical Dichotomy

☐ **Classical Dichotomy**: an economy displays classical dichotomy if all real variables are determined independently of the nominal variables.

☐ This in turn implies that real and nominal variables can be analyzed separately.

☐ The RBC model with money features this dichotomy

Does monetary policy have no effect on real variables in the economy? Only inflation?

Response to a shock in the nominal interest rate

Federal funds rate

GDP

GDP deflator

M2
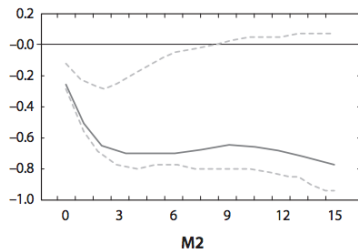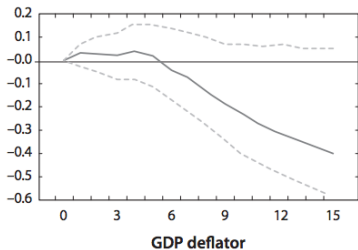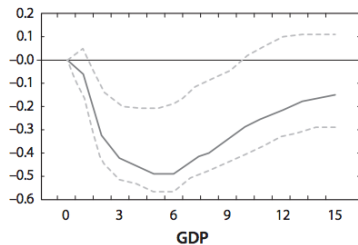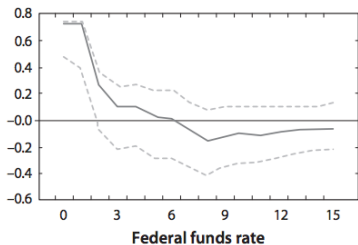
Observations from the data

☐ Empirically, economists have found that monetary policy shocks do have an impact on real variables

☐ A contractionary monetary policy (rise in the nominal interest rate) causes GDP to decline

☐ And inflation (as measured by the GDP deflator) to decline in the future (lagged response)

☐ And M_2 also falls (which suggests that the Federal Reserve needs to reduce money in circulation to induce the increase in i. RBC model with money also struggles with this)

RBC model with money

☐ Why does the RBC model with money-in-the-utility function struggle to match the data on monetary policy shocks?

☐ A look at the Fisher equation:

$$R_2 \Pi_2 = 1 + i_2$$

☐ Problem: Flexible prices

☐ Inflation changes one-for-one with nominal interest rate

☐ If prices are instead sticky, then changes in nominal interest rates can now affect real interest rates

RBC model with money

☐ Changes in the real interest rate does affects agents' decisions in our model

☐ These individual agents' decisions in turn will add up to affect real variables

☐ So we need to turn to introducing sticky prices.

Are prices sticky?

How sticky are prices in different industries?

A comparison of average price spells (the length of time that a product's price remains the same) across various sectors of the U.S. economy. There is also significant variation within each sector, owning to differences in supply chains, organizational heirarchies, customer expectations, and management philosophies.
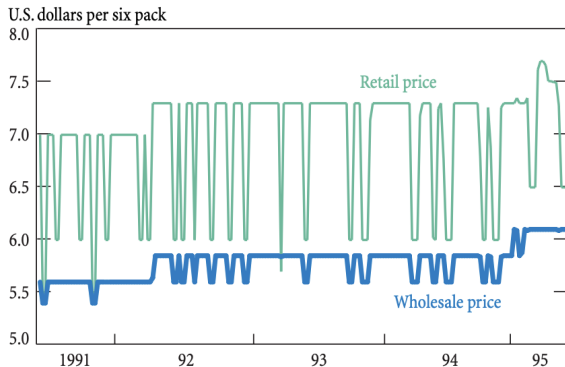
Average time between price changes (months)
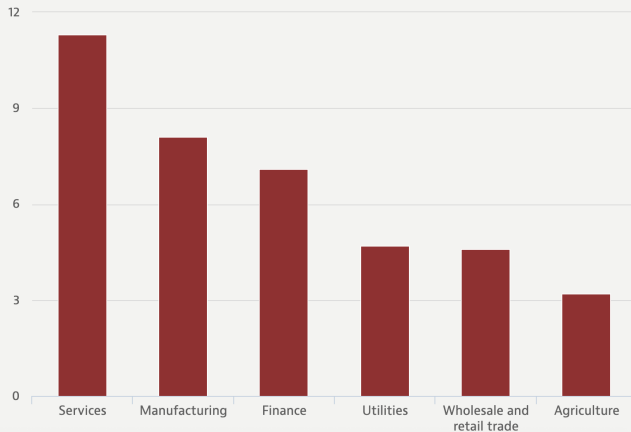
Source: adapted from Table 1 of Gorodnichenko & Weber (2016)

What do we mean by price stickiness

**Weekly Retail and Wholesale Prices for *Britannia* Beer**

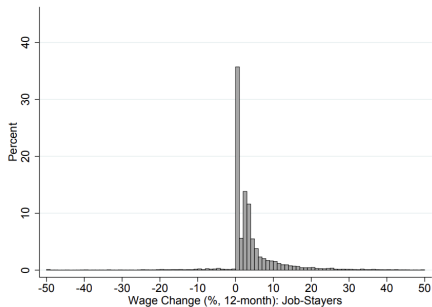U.S. dollars per six pack

Retail price

Wholesale price

- Price stickiness: tendency of prices to remain constant despite changes in supply and demand

- "When Coca-Cola was first introduced in 1886, the price of a bottle was set at five cents. The Coca-Cola Company did not change this price again for more than seventy years, despite experiencing a number of large increases in its costs over the period..."

Downward nominal wage rigidity

Figure 2: 12-Month Nominal Base Wage Change Distribution, Job-Stayers
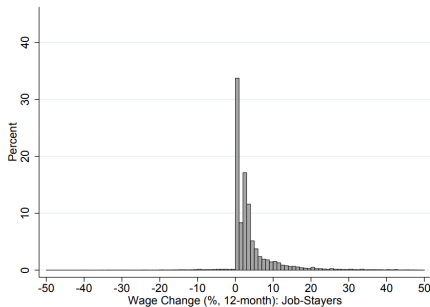
PANEL A: HOURLY WORKERS   PANEL B: SALARIED WORKERS

Notes: Figure shows the annual change in nominal base wages for workers in our employee sample (including commission workers) who remain employed on the same job for 12 consecutive months.

Source: Grigsby, Hurst and Yildirmaz (2021)

Downward nominal wage rigidity

☐ Nominal cuts to pay are rare

☐ Originally, Keynes argued that wages were sticky, and do not fall enough in a recession to clear the labour market

☐ Bewley (1999) "Why wages don't fall during a recession?": main reason why firms don't cut pay is that it affect employee morale

   ○ which in turn affects productivity

   ○ and hiring/retention

5. The explanation of wage rigidity

Resistance to pay reduction came primarily from employers, not from workers or their representatives, though it was anticipation of negative employee reactions that made employers oppose pay cutting. The claim that wage rigidity gives rise to unexploited gains from trade is not valid, because a firm would lose more money from the adverse effects of cutting pay than it would gain from lower wages and salaries.

What restrained employers from cutting pay was the belief that doing so hurts morale and increases labor turnover. The increase in turnover occurs both because pay is lower relative to competing employers and because of bad morale. Morale is acceptance of and willingness to contribute to organizational objectives and is important because people tend to benefit those who help them and to hurt those who harm them. The impact of mood is also a significant aspect of morale, for people work better when in a good mood. However, employers do not require that workers enjoy their work, for it is recognized that many jobs are boring and unpleasant and because good morale implies willingness to make personal sacrifices for the good of the organization. Nevertheless, it is thought to be highly desirable that workers be happy in some general sense.

Why are prices sticky

☐ Idea that sticky prices represent a friction: prices cannot adjust flexibly every period

☐ Why might prices be sticky?

  ○ Menu costs: e.g. print new menus if change prices

  ○ Information costs: acquiring information is costly, requires firms to pay attention to business environment to know what to price

  ○ Customer/worker retention

Modeling price stickiness

☐ Many ways to model price/wage stickiness

- ○ Calvo pricing: exogenous probability of being able to change price

- ○ Adjustment cost of changing prices/wages

- ○ Information costs of changing prices/wages

☐ We will do something even simpler: **nominal wage rigidity**, i.e., fixed nominal wages.
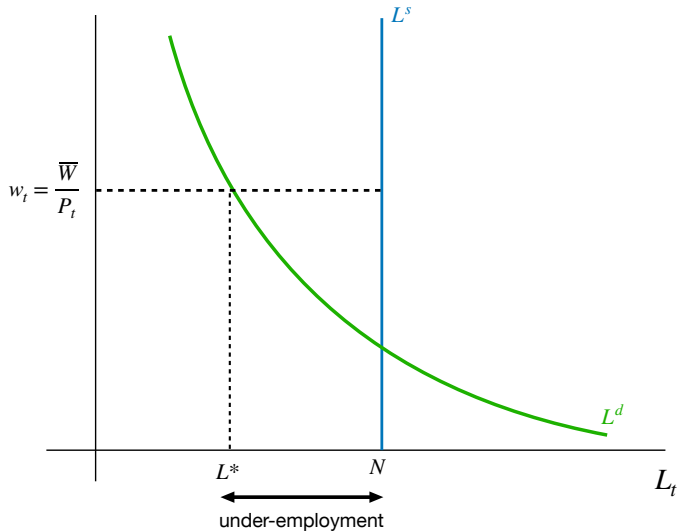
Nominal wage rigidity

☐ Idea that there is some nominal wage norm: $\overline{W}$.

☐ Nominal wages might be fixed, but real wages are not

$$w_t = \frac{\overline{W}}{P_t}$$

☐ What matters for firms' labour demand decision is the real wage

☐ Contracting money supply which leads to falling prices can raise real wages.

☐ Similarly, expanding money supply which leads to rising prices can lower real wages

Labour markets need not clear with nominal wage rigidities

Nominal wage rigidity

☐ Note that simple addition was one fixed price: nominal wages are fixed.

☐ But from now changes in nominal variables will affect the real wage, and thus affect the firm's demand for labour

☐ No disutility from work. Households supply as much labour as required by firms

☐ How much labour is used in equilibrium, in turn has impact on output produced, consumption and investment

An AS curve

$$AS = Y(z, K, L_t^d)$$
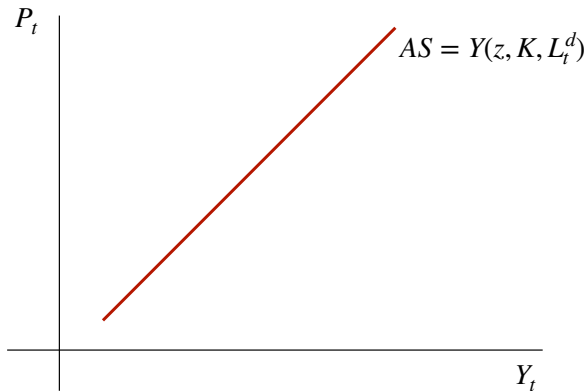
○ How much labour is used in equilibrium, in turn affects how much output can be produced

Next class

☐ Static model with nominal wage rigidity.

☐ Some notes: what we will do next class is a much simpler, scaled-down version of the NK model

☐ Note no imperfect competition, only sticky wages