Intermediate Macroeconomics
Lecture 8 - Price Misperceptions and Nominal Rigidities

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Sciences Po

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Last week:

- technology shocks affect $Y$ and $i$, and thereby influence the real demand for money: $L(Y, i)$
- if the supply of money, $M$ does not respond to this shock, $P$ will move in the opposite direction as $L(Y, i)$
- in this case the model predicts that $P$ would be counter-cyclical
- if the monetary authority wants to stabilise the price level, then $M$ should be adjusted to balance the changes in $L(Y, i)$
- in this case $M$ would be pro-cyclical

**main result**: *neutrality of money*: changes in the money supply do not affect any real variables
empirical evidence suggests that money is not as neutral as predicted by our equilibrium business-cycle model

the price-misperception model provides a possible explanation for the non-neutrality of money

observation: households sometimes misinterpret changes in nominal prices and wage rates as changes in relative prices and real wage rates

households have **incomplete current information** about prices in the economy

this usually impacts the labour supply decisions
Labour demand and labour supply

**Figure 15.1** Clearing of the Labor Market

The diagram illustrates the relationship between the demand for labor and the supply of labor in a market. The demand curve for labor, $L^d$, and the supply curve for labor, $L^s$, intersect at a point that determines the equilibrium wage, $(w/P)^*$, and the equilibrium quantity of labor, $L^*$.

- **Demand curve for labor** ($L^d$): Represents the quantity of labor demanded at various wage rates.
- **Supply curve for labor** ($L^s$): Represents the quantity of labor supplied at various wage rates.
- **Equilibrium**: The point where $L^d = L^s$ is marked by $(w/P)^*$ and $L^*$.

This equilibrium signifies a market clearing condition where the quantity of labor demanded equals the quantity of labor supplied at the prevailing wage rate.
Expected prices and actual prices I.

- the labour demand, $L^d$, is decided by the firm
- the firm’s problem is:

$$\max_{L^d,(\kappa K)^d} \pi = P \cdot F((\kappa K)^d, L^d) - w \cdot L^d - R \cdot (\kappa K)^d$$

in the optimum:

$$MPL = \frac{w}{P}$$

- the comparison is between the nominal price of the goods it produces and the nominal wage rate
- the relevant information is the real wage rate, $\frac{w}{P}$, which is known by the firm
Expected prices and actual prices II.

- the labour supply, $L^s$, is decided by the households
- the households decision is between work-leisure and consumption
- the relevant price level is the market price of a basket of goods these goods are purchased from many locations at various times
  $\Rightarrow$ the worker will typically lack good current information about some of these prices
- let $P^e$ denote the price that the household expects to pay for the basket of goods
- if $P^e \neq P$, then the perceived real wage rate is different from the actual real wage rate: $\frac{w}{P^e} \neq \frac{w}{P}$
- the household’s decisions are based on $\frac{w}{P^e}$
Unobserved monetary expansion

- assume that there is an increase in the nominal quantity of money
- what happens when households do not understand that the increase in the nominal wage rate, $w$, stems from a monetary expansion that inflates all nominal values, including the price level, $P$?
- each hh observes the rise in $w$
- they also increase the expected price level, $P^e$, but by less
- $\Rightarrow$ the perceived real wage rate, $\frac{w}{P_e}$, increases
- $\Rightarrow$ the worker increases the quantity of labour supplied: $L^s \uparrow$
Actual and perceived real wages

\[ \frac{w}{P^e} = \frac{w}{P} \cdot \frac{P}{P^e} \]

- for a given actual real wage rate, \( \frac{w}{P} \)
- an increase in \( \frac{P}{P^e} \), i.e. an increase in the underestimation of the price
- raises the perceived real wage rate, \( \frac{w}{P^e} \)
- if hhs underestimate prices, they overestimate their real wages: \( P^e < P \Rightarrow \frac{w}{P^e} > \frac{w}{P} \)
 Labour demand and labour supply - again

Figure 15.2 Effect of Unperceived Inflation on the Labor Market

Graph showing the effect of unperceived inflation on the labor market. The diagram illustrates the demand curve for labor and the supply curves for labor. Unperceived inflation shifts labor supply rightward.
Non-neutral monetary expansion I.

- due to **price misperceptions**
  the increase in $P$ and $w$ is followed by a smaller increase in $P^e$
- for the same $\frac{w}{P}$ the quantity of labour supplied increases, as
  the perceived real wage, $w^{\frac{w}{P^e}}$ is higher
- through this mechanism, an increase in $M$ leads to an increase
  in the quantity of labour input, $L^*$
- the increase in labour input leads to an increase in the GDP: $Y = A \cdot F(\kappa K, L)$
- the change in $M$ affects the real economy and is therefore
  **non-neutral**
Non-neutral monetary expansion II.

- in the long run the expected price level, $P^e$, adjusts towards the actual price level, $P$
- $\Rightarrow$ the effects of an increase in the nominal quantity of money, $M$, on these real variables are only temporary
- in the long run, an increase in $M$ leaves the real variables unchanged
- in the long run, the price level, $P$, and the nominal wage rate, $w$, rise by the same proportion as the increase in $M$
- **in the long run money is neutral**
Only unperceived inflation affects real variables

- unperceived inflation, as we have just seen, affects real variables like the GDP and labour input
- in the inflation is perceived, then a change in $M$ raises perceived and actual prices by the same amount, $P = P_e$
- $\Rightarrow$ the monetary expansion will be neutral: households understand that the increase in their nominal wage rate, $w$, is due to a general increase in the nominal quantity of money, $M$, and the price level, $P$ and NOT to a rise in their real wage rate, $\frac{w}{P}$

**Lucas hypothesis:** the more stable the underlying monetary environment, the larger is the real effect of a given size monetary shock
Predictions for economic fluctuations

Table 15.1 | Cyclical Patterns of Macroeconomic Variables in Two Models

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<tr>
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<td>procyclical (weak)</td>
</tr>
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Note: The cells show the cyclical pattern of five macroeconomic variables in three settings. First is the equilibrium business-cycle model with economic fluctuations driven by shocks to the technology level, $A$ (described in Chapters 8–10). Second is the price-misperceptions model from this chapter, with economic fluctuations driven by shocks to the nominal quantity of money, $M$. Third is the empirical pattern from U.S. data.
Empirical evidence on the real effects of monetary shocks I.

Friedman and Schwartz (1963): *Monetary History*

- changes in the behaviour of the money stock have been closely associated with changes in economic activity, money income, and prices
- the interrelation between monetary and economic change has been highly stable
- monetary changes have often had an independent origin; they have not been simply a reflection of changes in economic activity
- an increase in unanticipated money growth raised real GDP over periods of a year or more
Empirical evidence on the real effects of monetary shocks

II.

Romer and Romer on Federal Reserve (US central bank) policy

- attempt to isolate exogenous monetary shocks
- measurement of shocks: changes in the target for the Federal Funds rate during meetings of the Federal Reserve’s Federal Open Market Committee (FOMC)
  - this rate is the overnight nominal interest rate, that the Fed monitors closely
  - an increase in $i \iff$ monetary contraction in the short run
  - $\implies$ reduced growth rate of monetary aggregates
- they find that an unanticipated increase in the Federal Funds rate tended to reduce real GDP while an unanticipated reduction in the Federal Funds rate tended to increase real GDP
Empirical evidence on the real effects of monetary shocks

III.

Romer and Romer on Federal Reserve (US central bank) policy

- one specific example: Paul Volcker became Fed chairman in 1979
- in 1980 Q4 and 1981 Q1 the inflation rate rose to over 10%
- Volcker committed to using monetary contraction to end inflation: FFR went from the already high 15% to 20%
- the growth rates on monetary aggregates fell sharply (from 10% to zero, or from 6-8% to 3-4%)
- inflation fell to 3% by 1983 Q1 & recession in 1982-1983
- whether this fits with the price misperceptions model depends on how credible the commitment was, and how well people understood it (if credible & people understood it → no recession)
Empirical evidence on the real effects of monetary shocks

IV.

Overview

▶ the empirical evidence suggests that positive monetary shocks tend to expand the real economy, whereas negative monetary shocks tend to contract the real economy

▶ the evidence is not 100% conclusive, and we surely lack reliable estimates of the strength of this relationship

▶ for example: R&R’s estimate does not account for the monetary policy’s reaction to anticipated future variations in real economic variables
increase in $A$ leads to an increase in $Y$

increased demand for money: $L(Y, i) \uparrow$

if $M$ does not increase, then the price level, $P$, must decrease

assume, as in the price misperceptions model, that the expected price level, $P^e$, lags behind the actual price level, $P$

$P^e$ decreases less than $P$, hence hhs overestimate $P$ and thus underestimate $\frac{w}{P}$:
the perceived real wage rate, $\frac{w}{P^e}$, falls below $\frac{w}{P}$

it follows that the quantity of labor supplied, $L^s$, decreases for a given $\frac{w}{P}$
Price misperceptions and real shocks II.

Figure 15.3

Response of the Labor Market to a Technology Shock: Effects of Price Misperceptions

Price misperceptions dampen the short-run effects of real shocks.
Rules versus discretion

- under a **monetary rule**, the central bank commits itself to a designated mode of conducting policy
- under **discretion**, the authority leaves open the possibility for surprises, that is, for monetary shocks
- the real economy reacts to a change in the nominal quantity of money, $M$, only when the change is unanticipated
- the monetary authority may be motivated to **create price surprises** as a way to affect real economic activity
- for given inflationary expectations, $\pi^e$, the monetary authority faces a trade-off when considering to raise the inflation rate, $\pi$
  - **benefit**: $\pi - \pi^e \uparrow \Rightarrow Y$ and $L \uparrow$
  - **cost**: will return to this
- $\Rightarrow$ this trade-off determines the inflation rate $\hat{\pi}$ that the monetary authority selects, which depends on $\pi^e$
Equilibrium inflation in a discretionary regime

under rational expectations, $\hat{\pi} = \pi^e$
Why do people dislike inflation?

- typically, people answer "because it reduces my purchasing power"
- they believe that increases in their nominal wages are due to their hard work
- but big mean inflation monster takes it all away!
- economists helpfully point out that their big raises are also due to inflation
- worker’s real wage depends on MPL (marginal product of labor), not π
Costs of (expected) inflation

- **shoeleather costs**: if money demand depends on $i$ then people are forced to economize on real balances $\frac{M}{P}$ when $\pi$ rises

- **menu costs**: physical costs of changing prices

- **variability in relative prices**: if prices for different goods change at different times, then inflation distorts relative prices

- **imperfect indexation in the tax code**: capital gains taxes are levied on nominal increases in asset values, not real increases

- **inconvenience**: ("changing yardstick") planning for retirement would be a lot easier if $P$ were constant for moderate $\pi$ these costs are typically not too high, but the (marginal) costs of $\pi$ rise with $\pi$
Costs of (unexpected) inflation

- **Redistribution of resources**: Borrowers win and lenders lose when $\pi > \pi^e$, if the nominal interest rate is fixed in advance. Example: fixed defined-benefit pensions are an example of this (worker makes "loans" to the firm while working).

- It's curious why indexed contracts are not more prevalent in the U.S. (outside of Social Security).
Benefits of ...

expected inflation

1. Inflation may ”grease the wheels of the labour market”
   ▶ people do not like *nominal* wage cuts, but sometimes the real
     wages of particular workers need to be reduced
   ▶ if $\pi > 0$, keeping the nominal wages constant erodes the real
     wages
   ▶ when this is not possible: people might get fired or they might
     quit rather than taking nominal wage cuts
   ▶ unemployment rises as a result

2. Some inflation may make monetary policy easier
   ▶ the CB can’t cut nominal interest rates below zero
   ▶ if $\pi \approx 0$, then $i$ is equal to $r$, which is typically small
     ($\approx 1 - 2\%$)
   ▶ so $i$ will be close to the ”zero lower bound” for nominal
     interest rates

unexpected inflation

+1: monetary policy has real effects
Rules - Inflation targeting

- the CB might commit to certain rules: use policy instruments to achieve a goal
- the CBs in most advanced economies have become committed to low and stable inflation
- the CB may be able to build up a reputation for low inflation, which can work better than formal rules in communicating commitment
- in many countries, the commitments are reinforced by formal provisions stipulating that the central bank’s objective is price stability
- inflation targeting
Inflation targeting II.

Table 15.2 Countries with Central Banks that Adopted Formal Inflation Targeting

<table>
<thead>
<tr>
<th>Country</th>
<th>Date of Adoption of Inflation Targeting</th>
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<tbody>
<tr>
<td>New Zealand</td>
<td>1989</td>
</tr>
<tr>
<td>Canada</td>
<td>1991</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1992</td>
</tr>
<tr>
<td>Australia</td>
<td>1993</td>
</tr>
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<td>Finland</td>
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<td>Sweden</td>
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<tr>
<td>Spain</td>
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</tr>
<tr>
<td>Czech Republic</td>
<td>1997</td>
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<tr>
<td>Israel</td>
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<tr>
<td>Brazil</td>
<td>1999</td>
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<td>Chile</td>
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<tr>
<td>Poland</td>
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<tr>
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*Note:* The list shows countries in which the central banks have formal procedures in place for targeting the inflation rate. This list comes from Frederic Mishkin and Klaus Schmidt-Hebbel (2001) and Alina Carare and Mark Stone (2003).
The sticky prices model

- **sticky prices**: nominal prices that do not react rapidly to changed circumstances

- environment: imperfect competition: firm $j$ sets the price of its good, $P(j)$

- the demand for good $j$, $Y^d(j)$ depends on the price of good $j$ compared to other prices mostly goods supplied nearby, or prices of very similar goods

- simplifying assumption: customers of firm $j$ compare the price, $P(j)$, with the average of the prices charged by other firms, $P$
  - an increase in the price ratio, $\frac{P(j)}{P}$ lowers $Y^d(j)$
  - a decrease in $\frac{P(j)}{P}$ raises $Y^d(j)$

- $Y^d(j)$ depends on the income of customers of the firm, a higher real income in the whole economy increases the demand for each for $j$
Product pricing

\[ \pi(j) = F(\kappa(j)K(j), L(j)) \cdot P(j) - wL(j) - R\kappa(j)K(j) \]

In perfect competition

firms take \( P(j) = P \) as given \( \Rightarrow \) firms produce goods until

\[ P = \text{the marginal cost of production} \]

In imperfect competition

firms find it optimal to charge a mark-up, \( \eta > 1 \) over their marginal cost

\[ P(j) = \text{the marginal cost of production} \cdot \eta \]
What is the marginal cost of production?

There are several ways of increasing the production of $Y(j)$:

1. by increasing the labour input a tiny bit, the production of $Y(j)$ increases by:

   $$F_L(\kappa(j)K(j), L(j)) = MPL$$

   the nominal cost of increasing the production of $Y(j)$ is:

   $$\frac{w}{MPL}$$

2. by increasing the capital input a tiny bit, the production of $Y(j)$ increases by:

   $$F_K(\kappa(j)K(j), L(j)) = MPK$$

   the nominal cost of increasing the production of $Y(j)$ is:

   $$\frac{R}{MPK}$$

3. by increasing both capital and labour input
Equilibrium in this economy

- as before the profit-maximising decisions of firms determine the labour and capital demand
- the prices that the firms set for their products give a distribution of prices $P(j)$
- the real wage rate and real rental rate are determined by the clearing of the labour and capital markets where the real rate is the ratio to the average price, $P$
- money market clearing determines the average price level

If *prices were fully flexible* and this change would be anticipated
- a doubling of the money supply, $M$, to $2M$
- would lead to the doubling of all nominal quantities: $w$, $R$, $P(j)$, $P$
- none of the real variables would be affected (including the price ratios of specific firms, $\frac{P(j)}{P}$)

money would be neutral.
consider the extreme case in which all of the \( P(j) \) prices are rigid in the short run

- the average price, \( P \), would then also be fixed
- each hh would have twice as much real money, \( \frac{M}{P} \), as before
- nothing has changed to motivate households to hold more money in real terms →
- each hh would therefore try to spend its excess money, partly by buying the goods produced by the various firms →
- each firm \( j \) would then experience an increase in the quantity demanded of its goods, \( Y^d(j) \)
Due to the increased demand, if $P(j)$ is fixed, the firm would raise production, $Y(j)$, by

- increasing its labour demand, $L^d(j)$
- increasing its demand for capital services, $(\kappa(j)K(j))^d$
Short-run responses

- as $M$ increases, if prices are rigid
- the labour input increases
- and real GDP, $Y$ increases as well
- money is non-neutral and labour input, $L$ is pro-cyclical
- the real wages increase, as the demand for labour increases
- $\frac{Y}{L}$ decreases, as the marginal productivity of labour is declining, and $L$ increases
Comparison to price-misperceptions model

- both predict that labour input and GDP increase
- hence that $L$ is pro-cyclical, which is in line with the data
- the predictions for the real wage rate, $\frac{w}{P}$, are different
  - there: the labour supply increases, and hence the real wage, $\frac{w}{P}$, falls $\Rightarrow$ counter-cyclical wage rate
  - here: the market clearing wage rate increases, as the demand increases $\Rightarrow$ pro-cyclical wage rate

in the data wages are pro-cyclical
- both predict that $\frac{Y}{L}$ is counter-cyclical, this is pro-cyclical in the data

potential solution: labour hoarding: due to the costs of hiring and firing workers, employers are motivated to retain workers during temporary downturns - $L$ still falls in a recession, but not by so much $\rightarrow$ $\frac{Y}{L}$ would be low in recessions, this is why we observe that $\frac{Y}{L}$ is pro-cyclical
Long-run response

- in the longer run, the prices adjust
- these adjustments tend to undo the real effects from a change in the nominal quantity of money, $M$
- the real effect of a monetary shock in the new Keynesian model is a short-run result that applies only as long as prices fail to adjust to their equilibrium levels

Data:
- data do reveal stickiness of some prices; that is, prices for some types of products often do not change for several months
- a tentative conclusion from empirical research with these new data is that price stickiness is insufficient to explain a major part of economic fluctuations
Table 16.1 | Cyclical Patterns of Macroeconomic Variables in Three Models

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Note: This table extends Table 15.1 from Chapter 15. The cells show the cyclical patterns for five macroeconomic variables in four settings. First is the equilibrium business-cycle model, with economic fluctuations driven by shocks to the technology level, A (described in Chapters 8–10). Second is the price-misperceptions model from Chapter 15, with economic fluctuations driven by shocks to the nominal quantity of money, M. Third is the new Keynesian model from this chapter, with economic fluctuations driven by shocks to M. Fourth is the empirical pattern from U.S. data.
Aggregate demand shocks can have the same effect

- the monetary expansion had real effects through the expansion of demand, \( Y^d(j) \)
- the same results apply if \( Y^d(j) \) rises for each firm \( j \) for reasons having nothing to do with money, for example aggregate demand for goods increases
- for example: households shift exogenously away from current saving and toward current consumption, \( C \)
- or: the government could boost the aggregate demand for goods by increasing its real purchases, \( G \)
- an increase in the aggregate demand for goods may end up increasing real GDP, \( Y \), by even more than the initial expansion of demand
- there may be a multiplier in the model, the rise in \( Y \) may be a greater than the rise in demand
Monetary policy tools

- In practice, CBs tend to express monetary policy as targets for short-term nominal interest rates, rather than monetary aggregates.
- In the U.S., especially since the early 1980s, the Fed focuses on the Federal Funds rate, the overnight nominal interest rate in the Federal Funds market, which comprises financial institutions, such as commercial banks.
- The Federal Reserve’s Federal Open Market Committee (FOMC) meets eight or more times a year.
- At each meeting, the FOMC adopts a target for the Federal Funds rate.
- The central idea is that, in the short run with sticky prices, open-market operations affect nominal interest rates, the Federal Funds rate in the U.S., and the nominal interest rate, $i$, in our model.
Money and nominal interest rates

- $M^s = P \cdot L(Y, i)$ is the money market equilibrium
- in the new Keynesian model, $P$ is fixed in the short run
- in the short run, if $M$ increases, equilibrium requires some combination of higher $Y$ or lower $i$ to raise the nominal quantity of money demanded by the same amount
- until now, we thought of an expansionary monetary shock as an increase in the nominal quantity of money, $M$
- now, we can think of an expansionary monetary action as a decrease in the nominal interest rate, $i$
Monetary policy I.

- if \( L(Y, i) \) were a fixed relationship, i.e. the function \( L(\cdot, \cdot) \) was known and constant, then one policy tool would be sufficient
- but \( L(Y, i) \) fluctuates a lot, for example due to seasonal variations
- by adjusting \( M \), the CB can avoid seasonal variations in \( i \)
- \( \Rightarrow \) the CB cannot designate the precise time path for the monetary base needed to achieve a desired path for \( i \)
- **constant-growth-rate rules** for a designated monetary aggregate have been rejected (suggested by Milton Friedman)
- CBs tend to frame their policies in terms of targeted adjustments in nominal interest rates, \( i \)
- an important point is that the CB does not have to know the exact specification of \( L(Y, i) \)
Monetary policy II.

- **example 1**: imagine that the CB wants to decrease the interest rate, $i$

- for this, it has to increase $M$, by the amount that the nominal money demand would increase due to the desired fall in interest rate

- however, the CB does not have to know the exact specification for $L(Y, i)$, it can just keep raising $M$ until it sees the nominal interest rate that it wants

- **example 2**: imagine that the money demand increases, but the CB does not want the interest rate to increase

- if the CB would leave $M$ unchanged, $i$ would have to increase

- but the CB can increase $M$ to balance the increase in $L(Y, i)$, this is called the **accommodation** of money demand
Monetary policy in the Fed

the Fed has used the Federal Funds rate since the early 1980s to achieve a moderate and stable $\pi$
Sticky nominal wages - Keynesian model

- **sticky nominal wage rates**: a failure of nominal wage rates to react rapidly to changed circumstances
- return to perfect competition on the goods market, i.e. there is a single nominal price, $P$, that applies to all goods
- Keynes had a model where $w$ was higher than its market clearing level
- $\Rightarrow$ real wage rate also above its market clearing value
Involuntary unemployment

- labour input is the smaller of $L^s$ and $L^d$, in this case $L^d$
- this is because if $L > L^d$, then some employer would be forced to hire more people than desired at real wage rate $\frac{w}{P}$, it is not clear how this could be done
- $L^s - L^d$ is the **involuntary unemployment**
- this is involuntary as opposed to unemployment caused by search frictions, where people are unemployed because (mainly) they decided to reject a wage offer and wait for a better one to come along
The effects of a monetary expansion

- suppose that a monetary expansion raises the price level, $P$
- if the nominal wage rate stays the same, the real wage rate, $\frac{w}{P}$, falls
- at a lower real wage rate, employers demand more labour
- therefore labour input rises, and involuntary unemployment drops
- the output, $Y$ increases
- so the model predicts, similarly to the new Keynesian model, that $M$ and $L$ are pro-cyclical
- however, contrary to the data, the model predicts that real wages are counter-cyclical
Long-term contracts and sticky wages

- many workers have nominal wage rates that are set for one or more years in agreements made with employers
- this wage, $w$, is the best estimate for the market clearing nominal wage rate, $w^*$
- $\Rightarrow w$ is the rational expectation of $w^*$
- there is no reason to think that the deviation of $w$ from $w^*$ is systematically positive or negative, so $w > w^*$ & $w < w^*$ arise
- in the Keynesian model: $w > w^*$, and the employer chooses how many people to employ at this wage rate $\iff$
- in contracts, the employer and employee agree on a given wage rate and on employment at the same time
- with labour contracts the stickiness of nominal wages does not necessarily cause errors in the determination of labour input and production