

# Engineering Economic Analysis

2019 SPRING

Prof. D. J. LEE, SNU



## INTRODUCTION

# MOTIVATION

## ■ Engineering

- Engineering: the science or profession of engineer who plans and understands the making of machines, roads, bridges, etc.  
- Longman Dictionary

- A discipline which is related to '*making something*'
- Making: designing, producing, manufacturing
- Something: goods, services

## ■ By whom?

- Producer, Firm

## ■ For whom?

- User, Consumer

## ■ In what place is something delivered?

- Market

# OBJECTIVES

- Engineers must understand economic mechanism, in particular micro-economics, to apply economic analysis in their (engineering) job for better (engineering) results!
  
- **Engineering Economic Analysis**
  - Provide a guide to making good engineering and managerial decisions.
  - Use formal models to analyze the effects of engineering and managerial decisions on measures of a firm's success.
  - Differs from microeconomics
    - Microeconomics focuses on description and prediction.
    - Engineering economic analysis is prescriptive.

# Engineering Economic Analysis

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THE MARKET

# Economic Modeling

- Simplified representation of a reality
  - Diagram, Graph
  - Mathematical formulation
- Variables: elements of an economic model
  - Exogenous: not determined by forces (mechanisms) in the model, but just given outside the model
  - Endogenous: determined by forces (mechanisms) in the model
- Functions: relationship among variables

# Economic Modeling

- Solutions: results of the analysis on an economic model
  - *Optimization principle*: rational agents pursue the best result given some constraints
  - *Equilibrium principle*: the results where rational agents do not have incentive to deviate from

# Modeling the Apartment Market

- How are apartment rents determined?
- Suppose
  - apartments are close or distant, but otherwise identical
  - distant apartments rents are exogenous and known
  - many potential renters and landlords

# Modeling the Apartment Market

- Who will rent close apartments?
- At what price?
- Will the allocation of apartments be desirable in any sense?
  
- How can we construct an insightful model to answer these questions?



# Modeling Apartment Demand

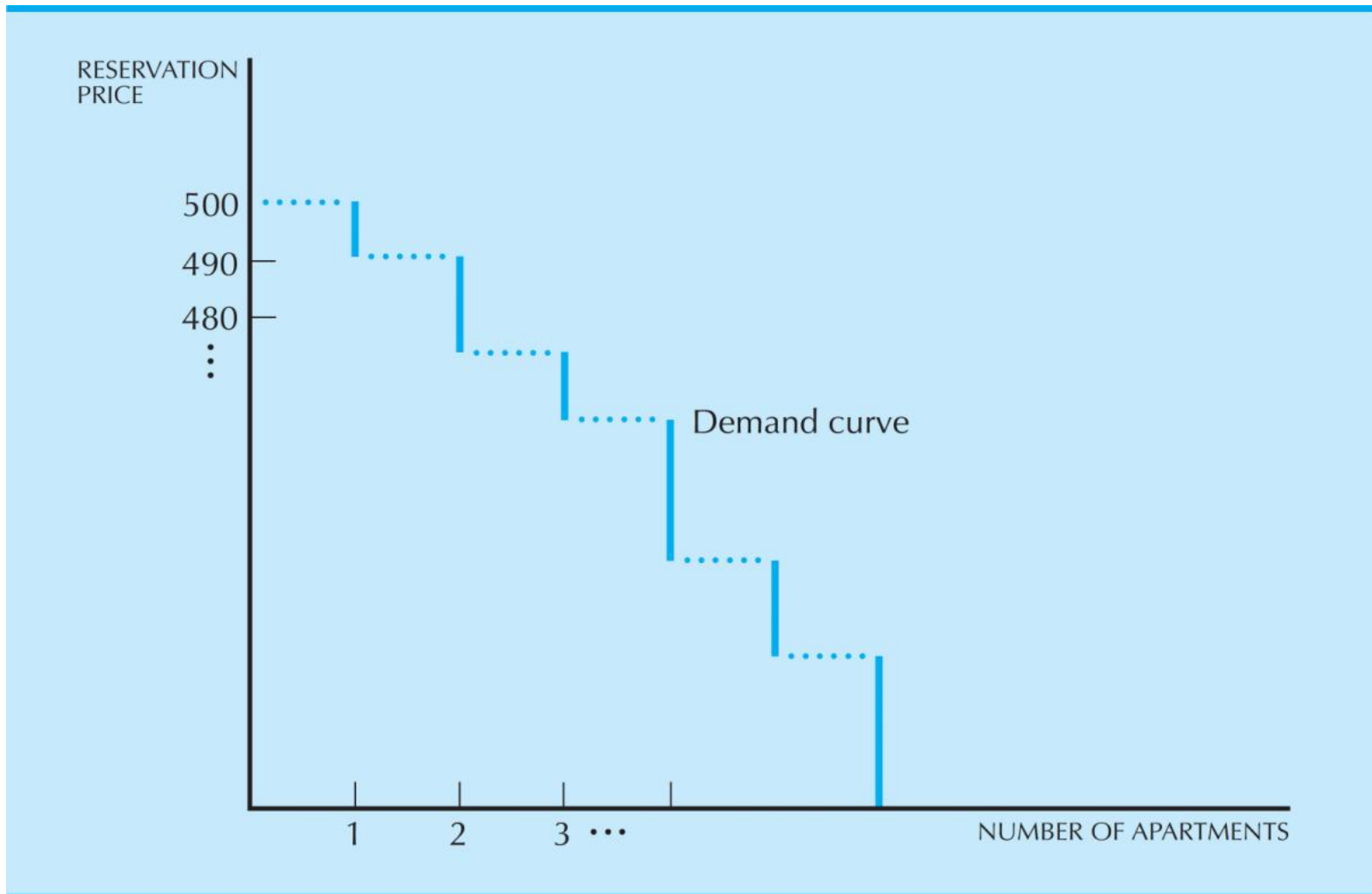
- Reservation price: the highest price that a given person will accept and still purchase the good
- How much is your (maximum) willingness to pay to rent a close apartment?



## Modeling Apartment Demand

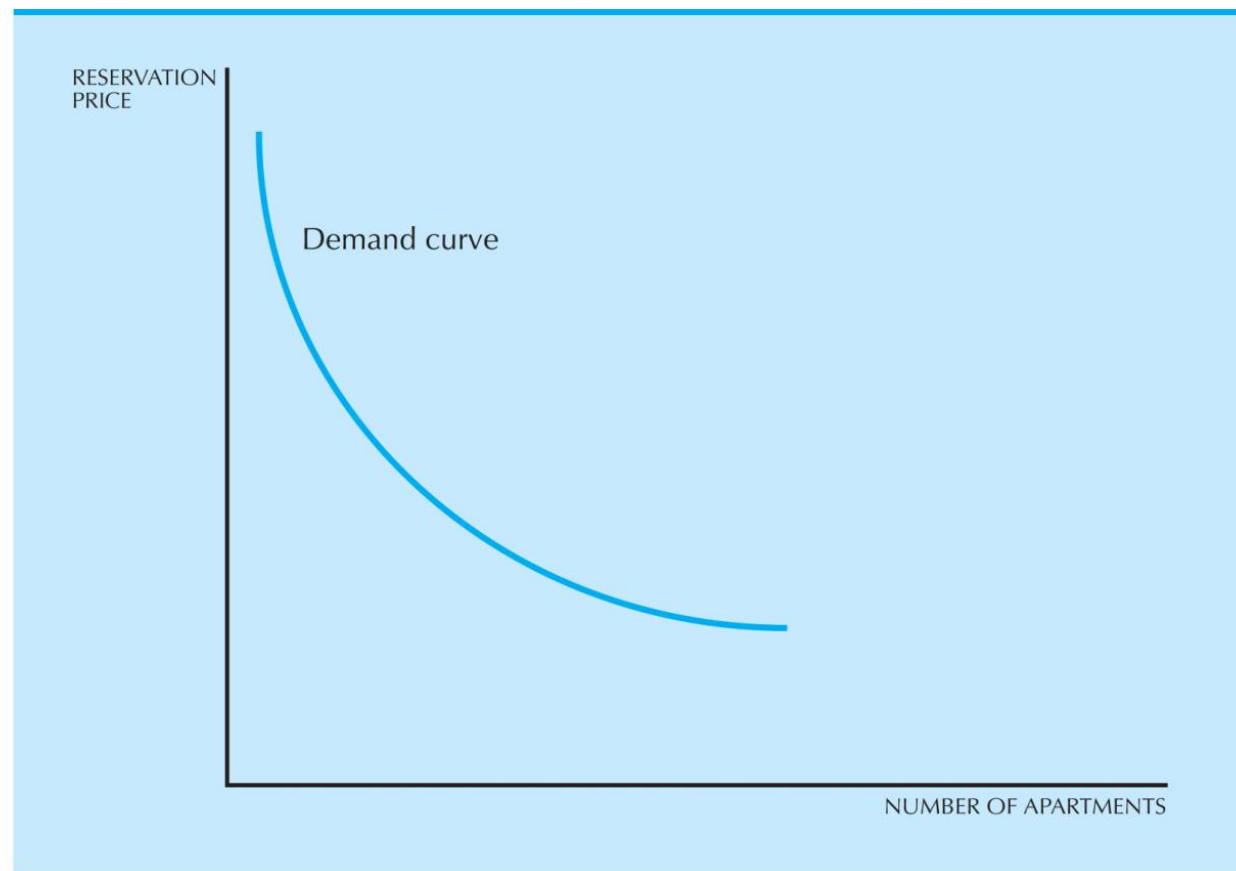
- Demand: Suppose the most any one person is willing to pay to rent a close apartment is \$500/month. Then  $p = \$500 \Rightarrow Q^D = 1$ .
- Suppose the price has to drop to \$490 before a 2nd person would rent. Then  $p = \$490 \Rightarrow Q^D = 2$ .
- The lower is the rental rate  $p$ , the larger is the quantity of close apartments demanded  
$$p \downarrow \Rightarrow Q^D \uparrow.$$

# Demand Curve for Apartments



# Market Demand Curve for Apartments

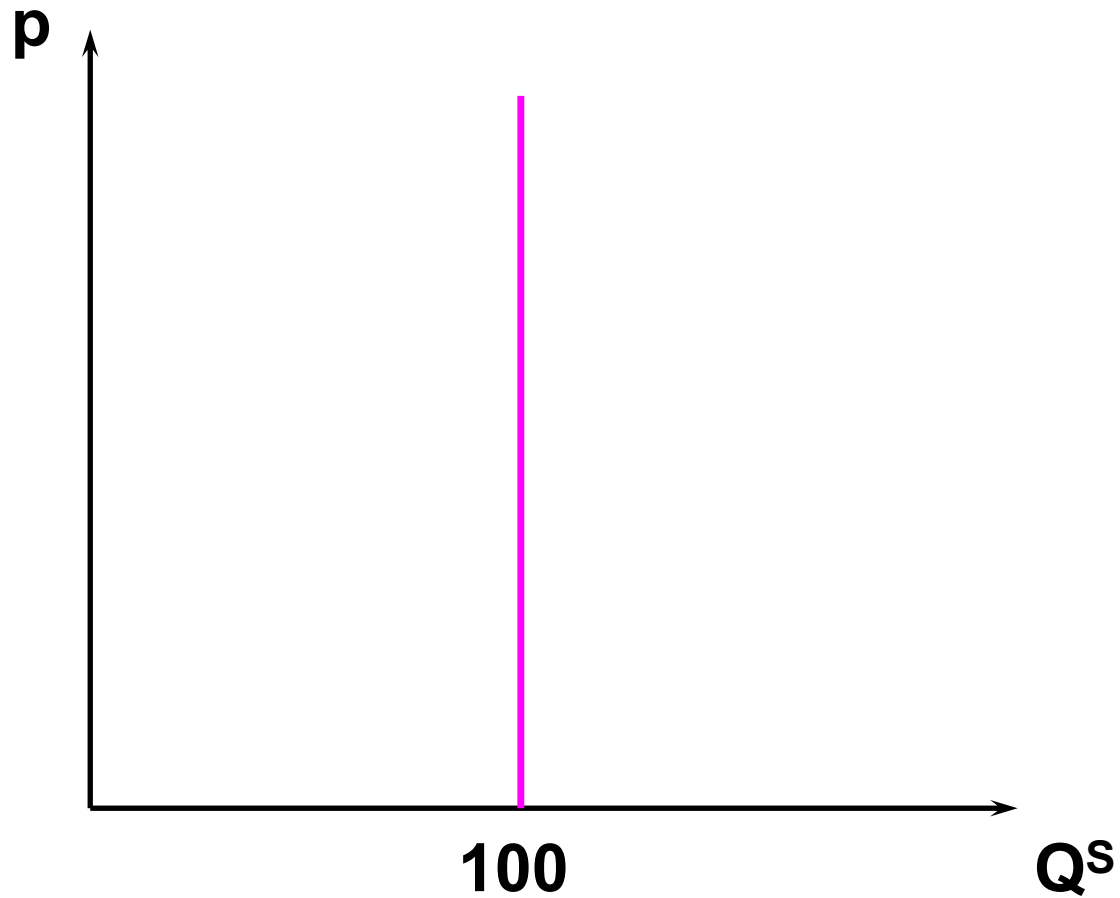
- The quantity demanded vs. reservation price with many demanders



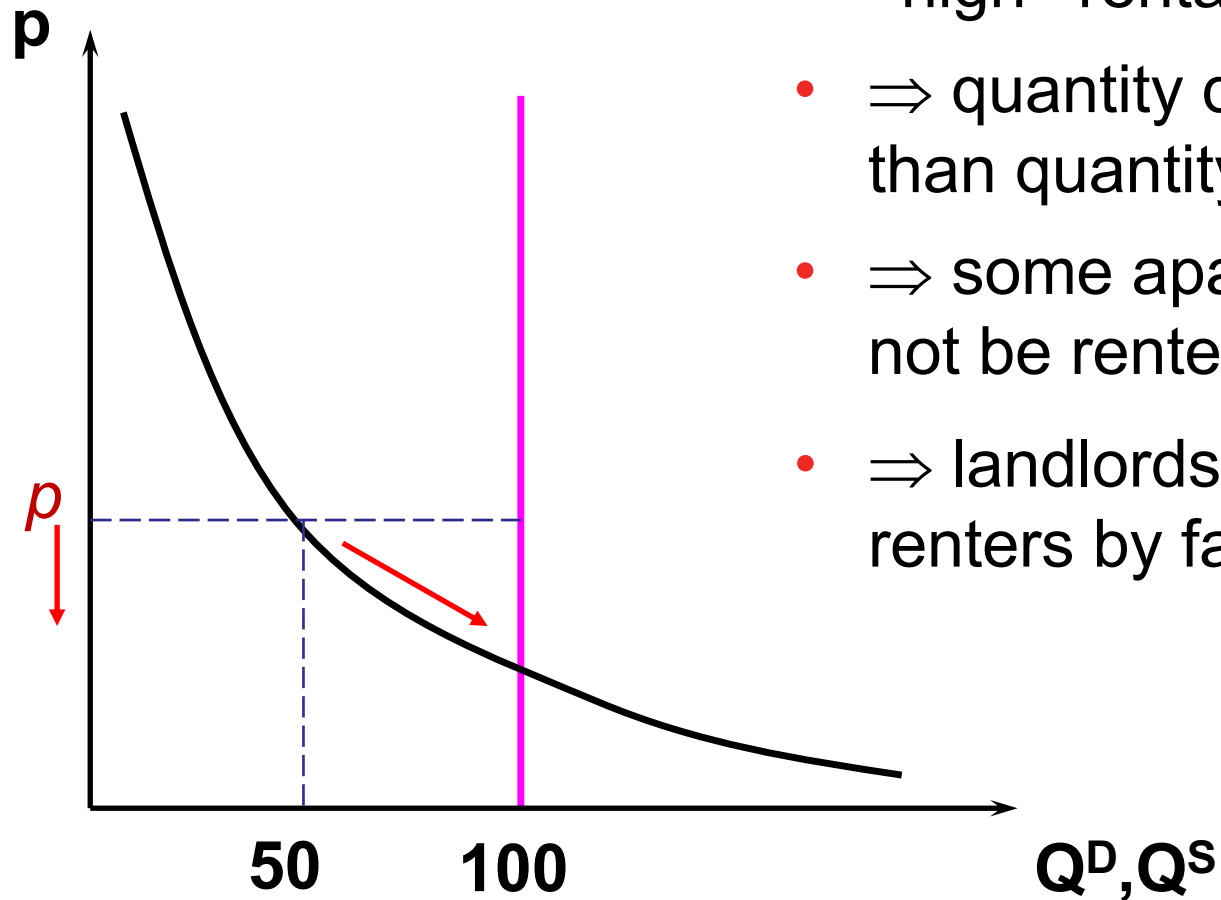
# Modeling Apartment Supply

- Supply: It takes time to build more close apartments so in this short-run the quantity available is fixed (at say 100).
  - Many independent landlords who are each want to rent their apartments for the highest: competitive market
  - No costs after rental: To give rental at any rental fee is always better than idling the apartment

# Short-run Supply Curve for Apartments

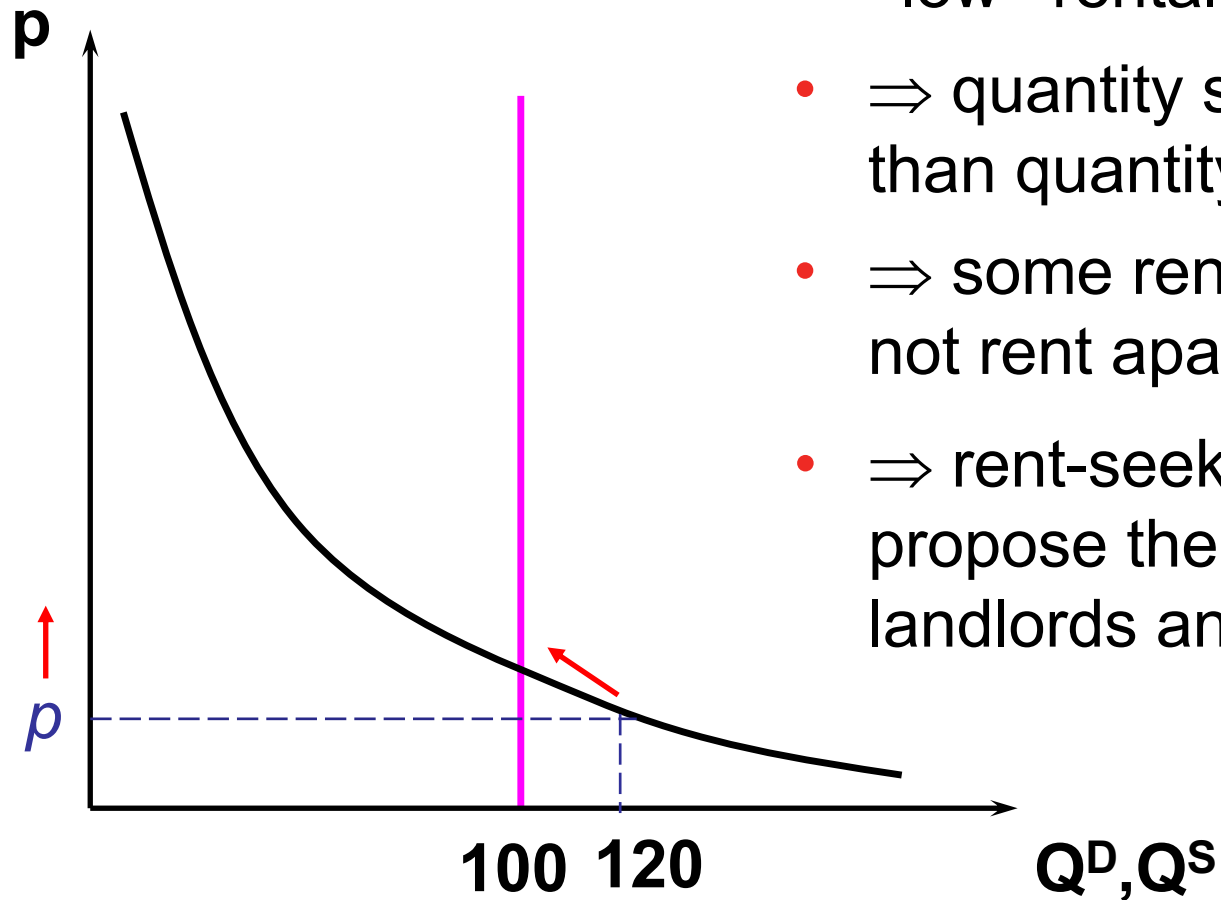


# Market Equilibrium



- “high” rental price
- $\Rightarrow$  quantity demanded less than quantity supplied
- $\Rightarrow$  some apartments can not be rented
- $\Rightarrow$  landlords will seduce renters by falling the price

# Market Equilibrium

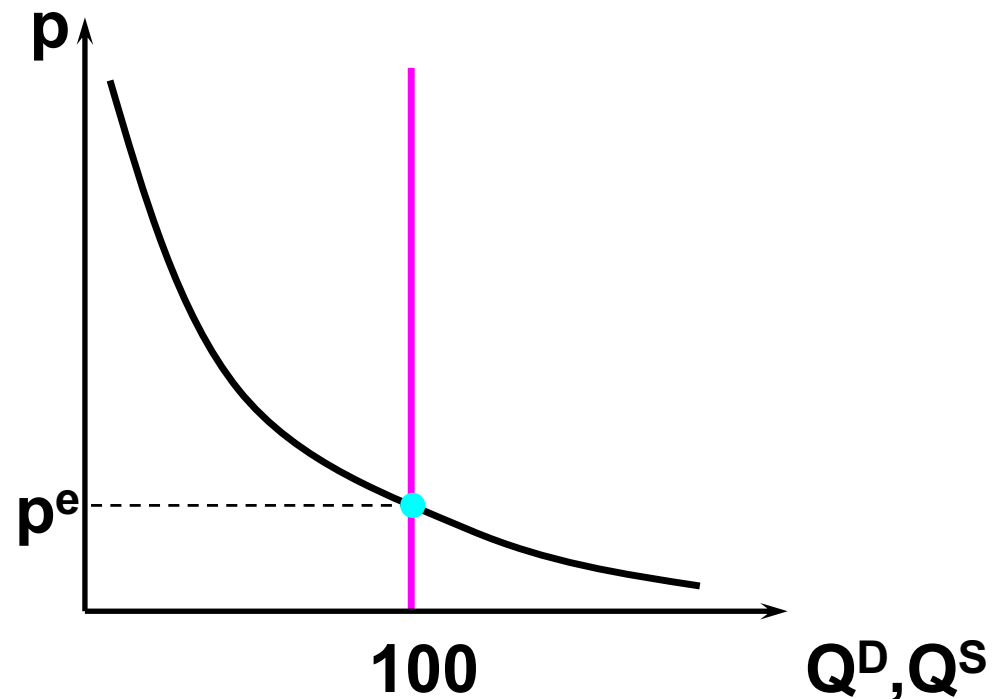


- “low” rental price
- $\Rightarrow$  quantity supplied less than quantity demanded
- $\Rightarrow$  some rent-seekers can not rent apartments
- $\Rightarrow$  rent-seekers will propose the higher price to landlords and vice versa



# Market Equilibrium

- Quantity demanded = Quantity supplied  
⇒ price will neither rise nor fall



- so the market is at an equilibrium.

# Market Equilibrium

- In more general mathematical form

$Q^D(p; a_1, \dots, a_n)$ : Demand function

$Q^S(p; a_1, \dots, a_n)$ : Supply function

- Equilibrium condition

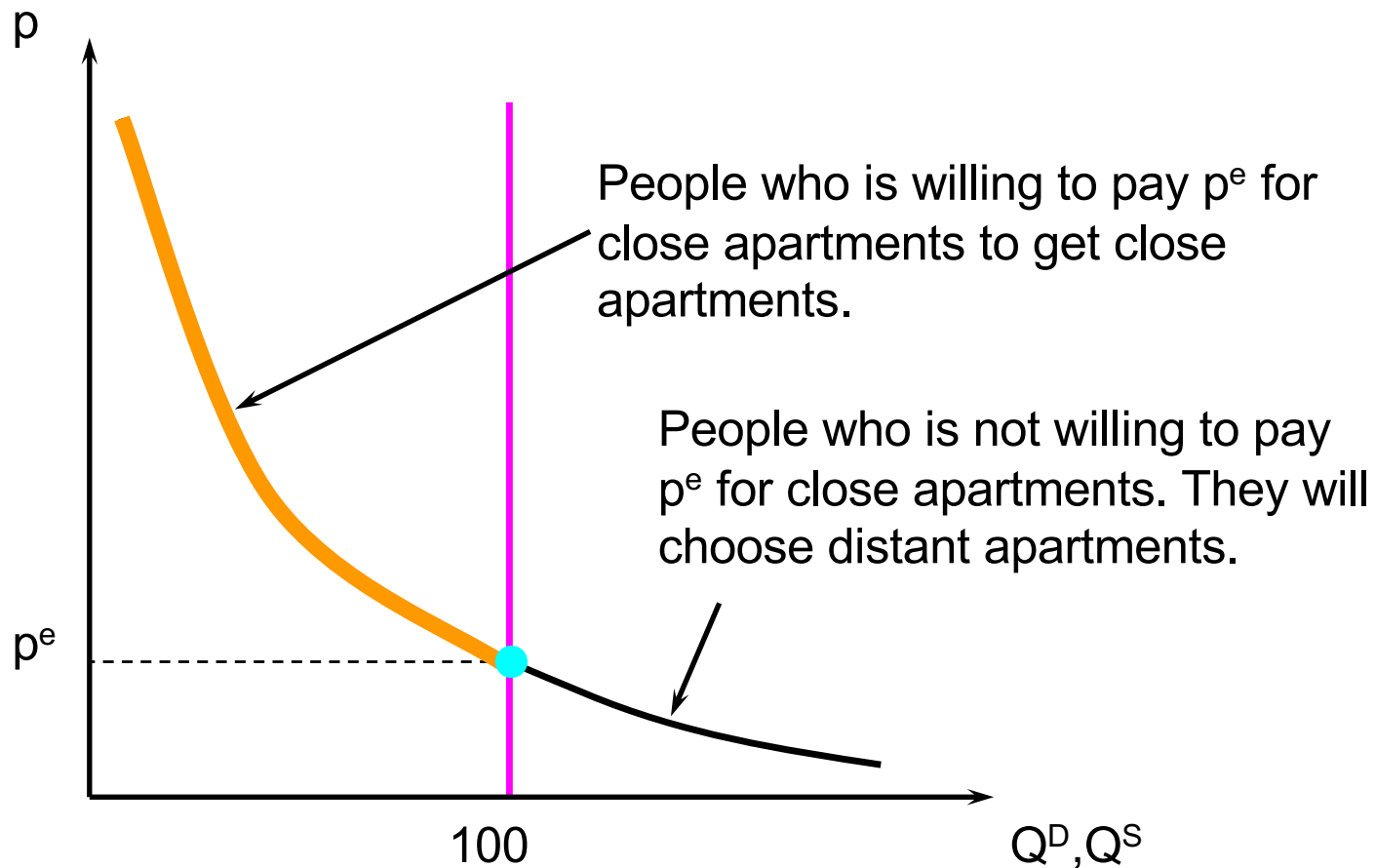
$$Q^D(p; a_1, \dots, a_n) = Q^S(p; a_1, \dots, a_n)$$

- Equilibrium price

$$p^e = f(a_1, \dots, a_n)$$

# Market Equilibrium

Q: Who rents the close apartments?



# Market Equilibrium

Q: Who rents the close apartments?

A: Those most willing to pay.

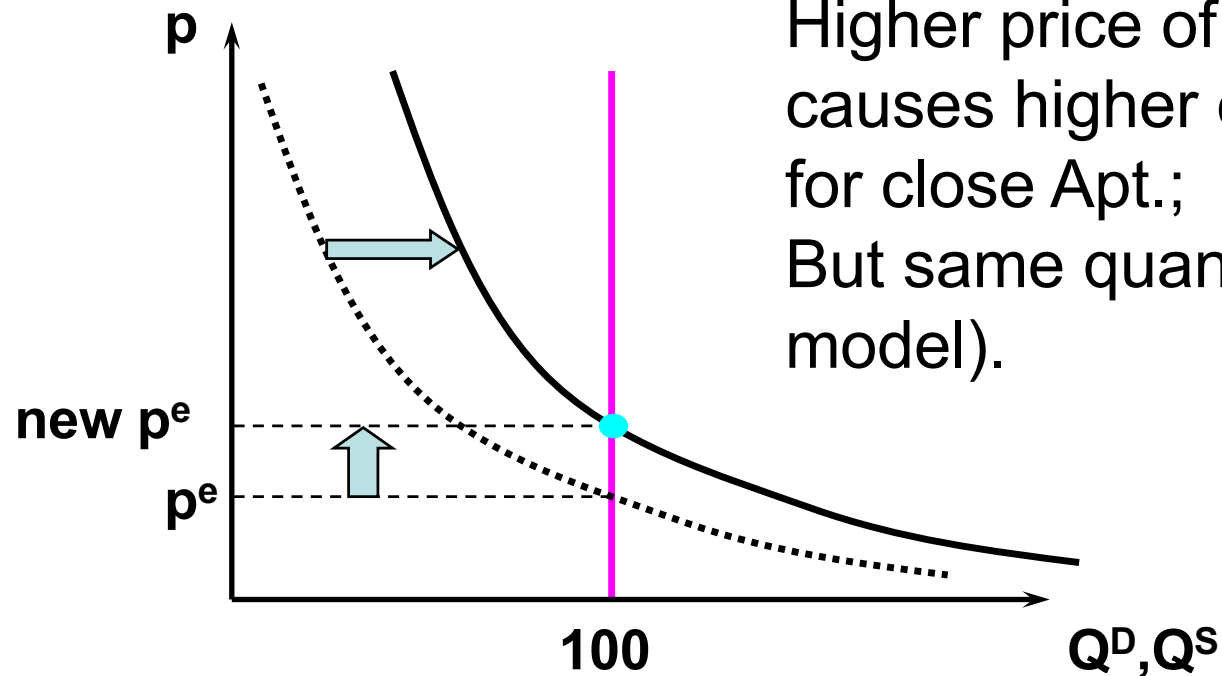
- The assignment of apartments to renters is determined by how much they are willing to pay and the level of market equilibrium price
  - Invisible hand

# Comparative Statics

- Method to analyze the behavior of *the equilibrium price* (the solution of model) when *various aspects* (exogenous variables) of the market change
- What is exogenous in our model?
  - price of distant apartments
  - quantity of close apartments
  - incomes of potential renters
  - Etc.

# Comparative Statics

- Suppose the price of distant apartment rises.
- $\Rightarrow$  Demand for close apartments increases (rightward shift), causing



Higher price of distant Apt.  
causes higher equilibrium price  
for close Apt.;  
But same quantity traded (in this  
model).

# Comparative Statics

- In mathematical methods, *partial differentiation* can be used for comparative statics
- To analyze the changes of equilibrium price with respect to the changes of certain exogenous variable, i.e.  $a_i$ , it is enough to calculate

$$\frac{\partial p^e}{\partial a_i} = \frac{\partial f(a_1, \dots, a_n)}{\partial a_i}$$

## Other Ways to Allocate Apartments

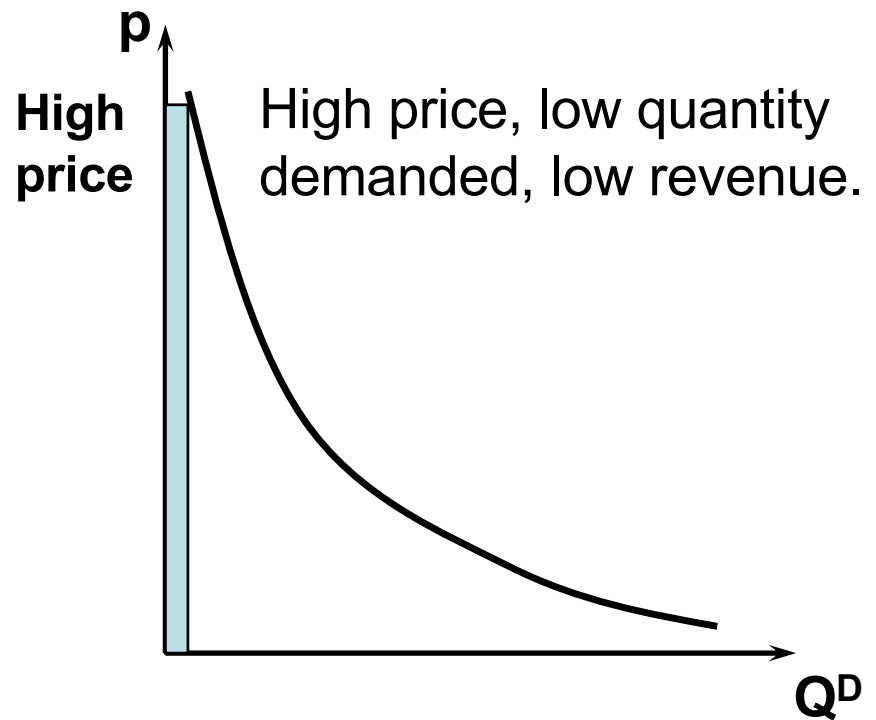
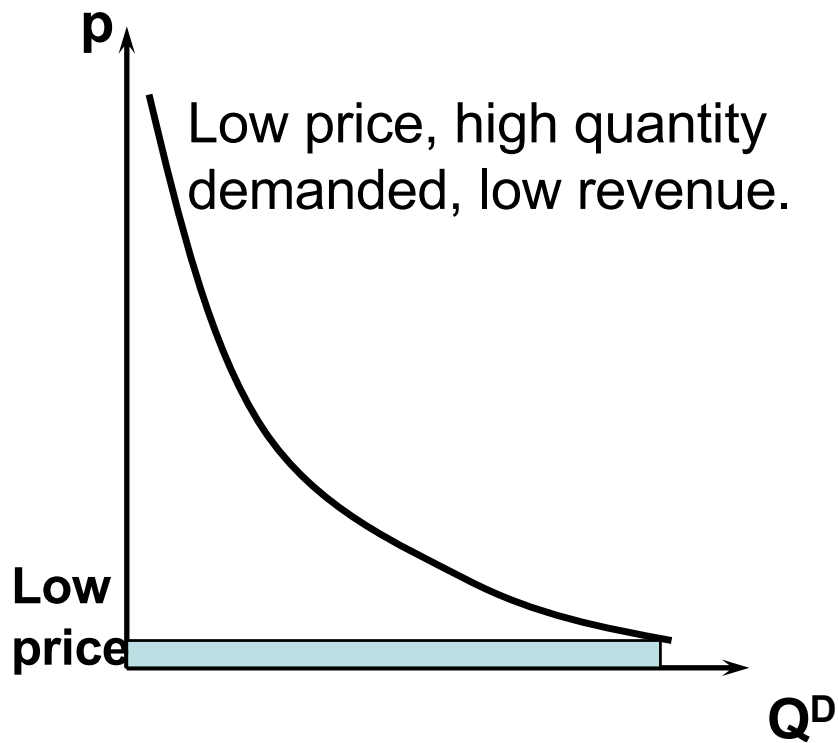
- Amongst many possibilities are:
  - a **monopolistic** landlord (for example Prof. DJ) who can set the uniform price
  - a perfectly **discriminatory monopolistic** landlord who can sell the identical apartment to each rent seeker with different prices
  - a competitive market subject to **rent control**.



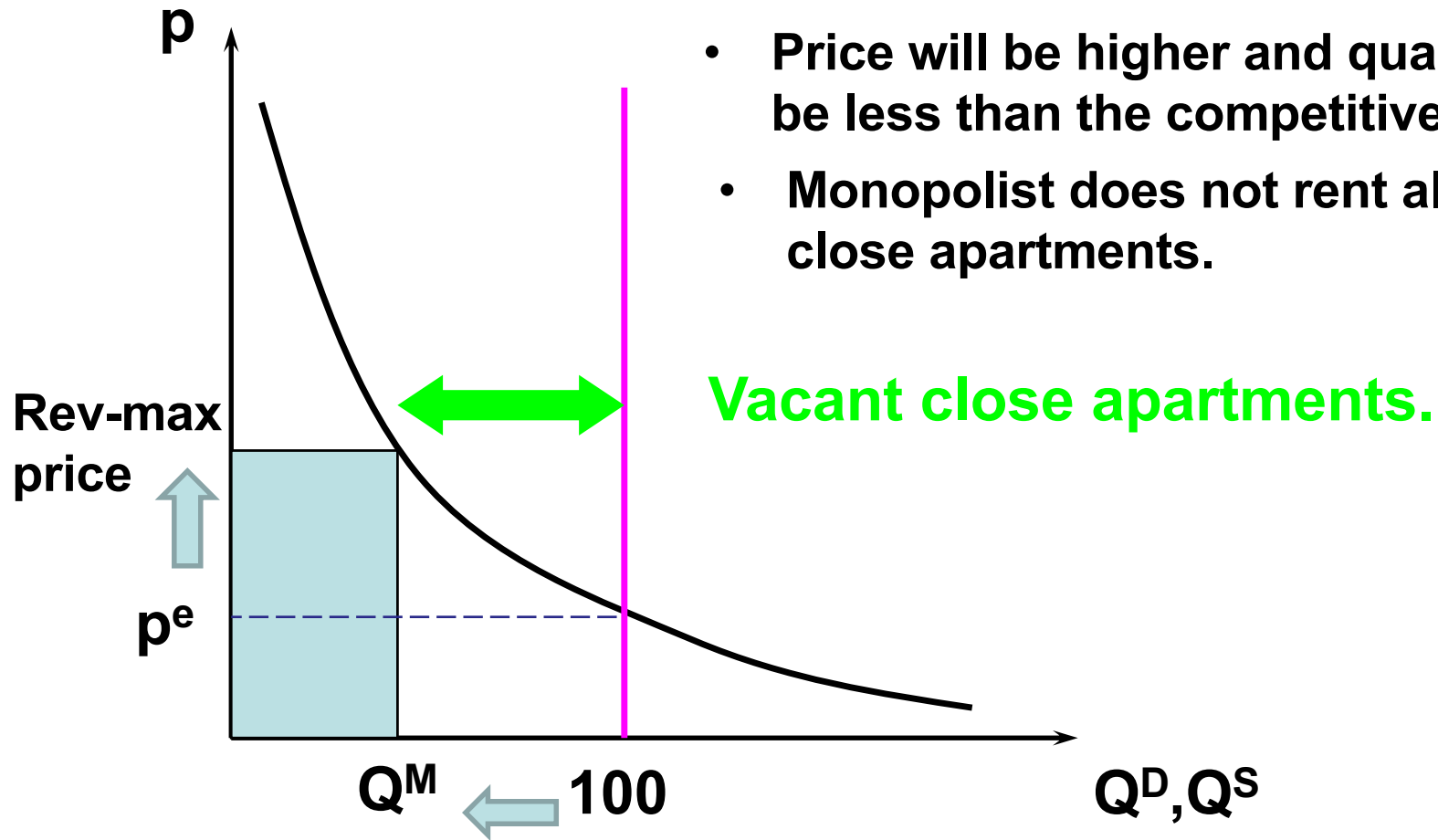
## A Monopolistic Landlord

- When the landlord sets a rental price  $p$ , the monopolist can rent  $Q^D(p)$  amount of apartments.
- Revenue =  $p * Q^D(p)$
- The monopolist wants to maximize this revenue

# Monopolistic Market Equilibrium



# Monopolistic Market Equilibrium



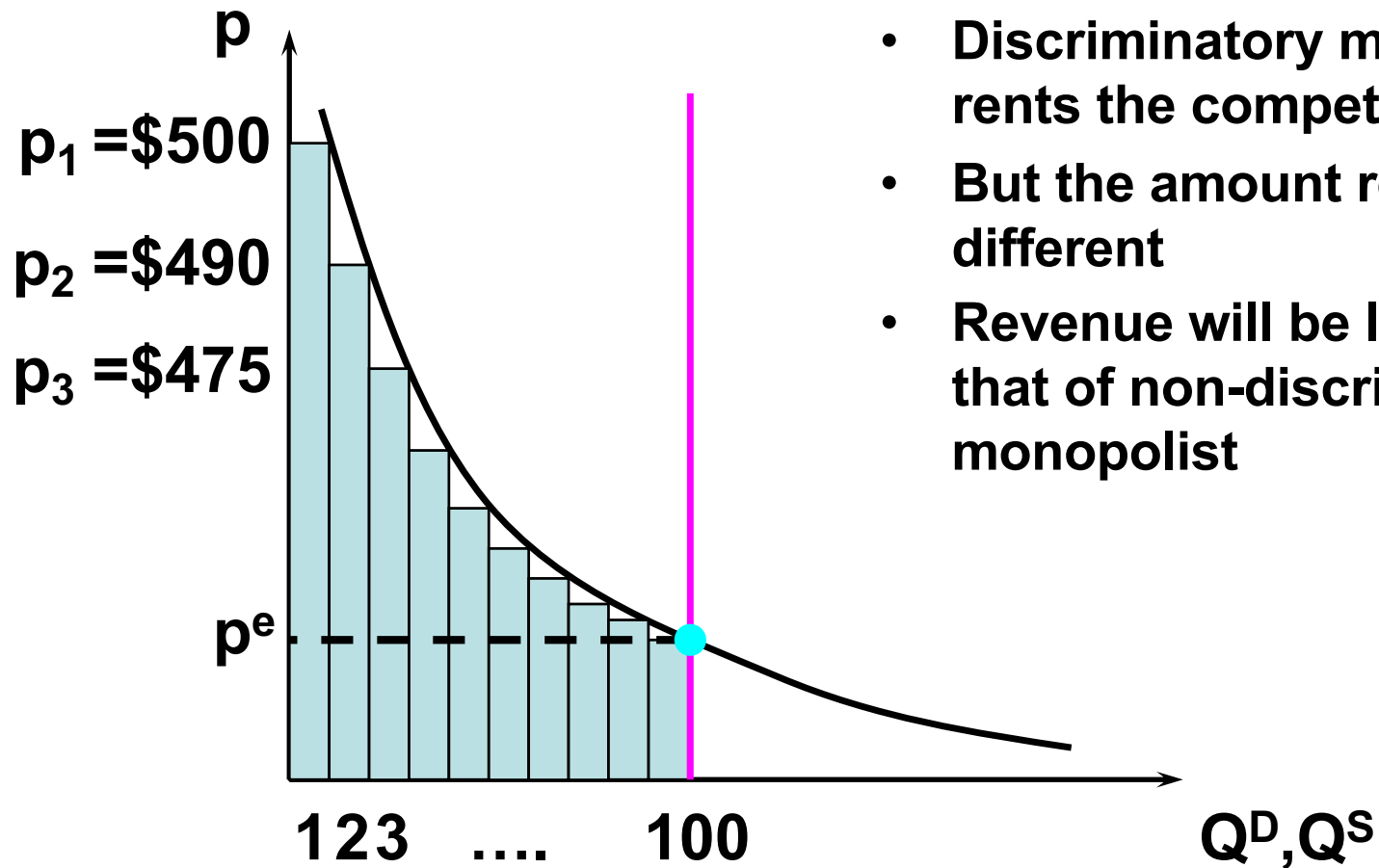
- Price will be higher and quantity will be less than the competitive market
- Monopolist does not rent all the close apartments.

**Vacant close apartments.**

# Perfectly Discriminatory Monopolistic Landlord

- Imagine the monopolist knew everyone's willingness-to-pay.
- Force to charge \$500 to the most willing-to-pay,
- Force to charge \$490 to the 2nd most willing-to-pay, etc.
- Auction

# Discriminatory Monopolistic Market Equilibrium

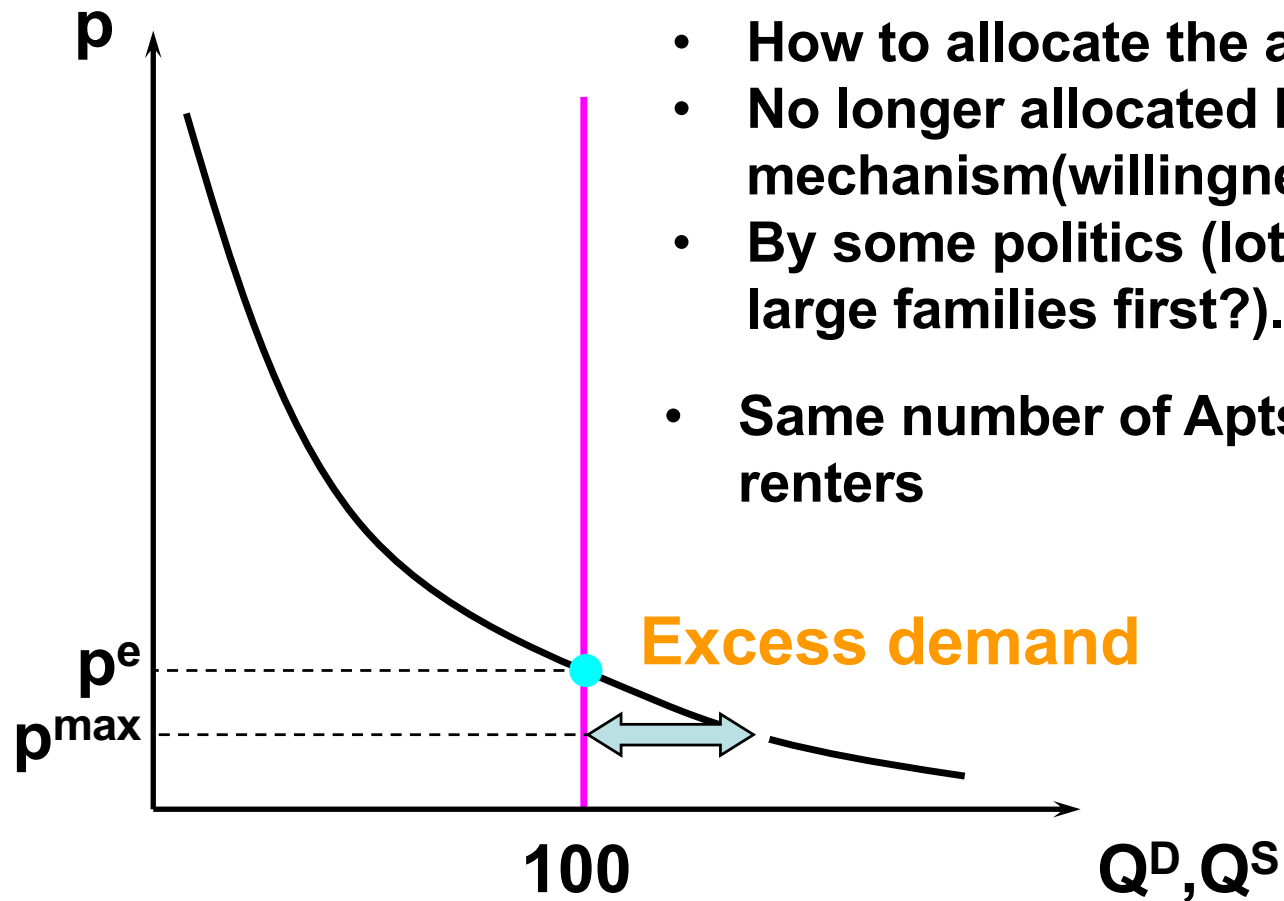


- **Discriminatory monopolist rents the competitive quantity**
- **But the amount renters pay is different**
- **Revenue will be larger than that of non-discriminatory monopolist**

# Rent Control

- Local government imposes a maximum legal price which is less than the competitive price,  $p^{\max} < p^e$ ,

# Market Equilibrium



- How to allocate the apartments?
- No longer allocated by economic mechanism(willingness-to-pay)
- By some politics (lottery, lines, large families first?).
- Same number of Apts. but other renters

# Which Way is Best?

- Which is better?
  - Rent control
  - Perfect competition
  - Monopoly
  - Discriminatory monopoly
- How to define “best”?
- Pareto efficiency: Bottom line



# Pareto Efficiency

- **Pareto improvement:** Be able to find a way to make some economic agents (whatever individual or firm) better off without making anybody else worse off
- **Pareto efficient:** a state where if an allocation is such that no Pareto improvements are possible

# Pareto Efficiency

- Jill has an apartment; Jack does not.
  - Jill values the apartment at \$200; Jack would pay \$400 for it.
  - Jill could sublet the apartment to Jack for \$300.
  - Both gain with nobody hurts, so it was **Pareto inefficient** for Jill to have the apartment.
- Now Jack has an apartment; Jill does not.
  - Jack values the apartment at \$400; Jill would pay at most \$200 for it.
  - No ways of gains-to-trade
  - This is **Pareto efficient (optimal)**

# Pareto Efficiency

- How to check whether one way of apartment allocation is Pareto efficient or not?
- Enough to check that (i) anyone who has a close apartment must have a higher reservation price than anyone who has a distant apartment – otherwise, they could make a trade and make both people better off, and (ii) the number of allocated apartment is an equilibrium (Demand = Supply).

# Pareto Efficiency

- **Competitive equilibrium:**
  - all close apartment renters value them at the market price  $p^e$  or more
  - all others value close apartments at less than  $p^e$
  - so no mutually beneficial trades remain
  - so the outcome is Pareto efficient.

# Pareto Efficiency

- **Discriminatory Monopoly:**
  - assignment of apartments is the same as with the perfectly competitive market
  - so the discriminatory monopoly outcome is also Pareto efficient.

# Pareto Efficiency

- Monopoly:
  - not all apartments are occupied
  - so the monopolist can increase his revenue by renting an apartment to someone who doesn't have one at positive price
  - Both the monopolist and the renter must be better off without lowering anybody else's welfare.
  - so the monopoly outcome is Pareto inefficient.

# Pareto Efficiency

- Rent Control:
  - some close apartments are assigned to renters valuing them at below the competitive price  $p^e$
  - some renters valuing a close apartment above  $p^e$  don't get close apartments
  - Pareto inefficient outcome.

# LONG-RUN EQUILIBRIUM

- The supply can change in the long run
- Problem: How many apartments will be provided by various types of market institution?
  - the supply of close apartments increase?
  - rent control decrease the supply of apartments?
  - a monopolist supply more apartments than a competitive rental market?