Basic Monopoly Theory

E. Glen Weyl

University of Chicago

Lecture 9
Regular Section
Elements of Economic Analysis II
Fall 2011

Introduction

Competitive model so far assumes *price-taking*:

1. If firm charged even little above "market price", *no demand*
2. If firm increases production *no fall in price*

Never literally satisfied and bad approximation in detail

$\Longrightarrow$ Today we'll begin to study incentives to move prices

1. What is monopoly and when to apply?
2. Incentive to reduce quantity
3. Marginal revenue: mathematical and graphical examples
4. The Lerner elasticity pricing rule
   - Basic principles of trade-off, alternative metrics
   - Data and tricky cases
5. Deadweight loss and measurement
   - Quantifying the inefficiency created by monopoly
   - Tax pass-through and size of deadweight loss
   - How big are the economic losses from monopoly in practice?

When does monopoly apply?

Monopoly sounds like "this is the only company"

- But basic mechanism applies to *any non-price-taker*
  - Includes when company *can affect purchase price*
- More or less severe depending on size of distortion
- So when do we use monopoly v. oligopoly?
  1. Monopoly focuses on *direct effects of interventions*
     - Effects through changes in other eq. behavior ignored
     - Monopoly takes these as fixed, changes small
  2. Monopoly ignores welfare effects on other firms
     - Value to them ignored or pecuniary
     - Cannot be used to think about cross-firm externalities
  3. Monopoly model cannot study changes in structure
     - Useless for topics like merger analysis, effect of competition

$\Longrightarrow$ Focus on incentives of one firm, input to other analysis

Monopoly and quantity reduction

Basic idea: monopolies reduce quantity to raise price

- To sell more, price must fall on all *infra-marginal* units
  - Would not arise if could charge different prices to each
  - We will talk more about this possibility on Thursday
- Thus monopoly will reduce quantity below $P = MC$
- Monopolies trying to reduce quantity omnipresent?
  1. Occupational licensure from first class
  2. Labor unions opposition to immigration, closed shops
  3. Farmer cooperative try to prevent "over-production
  4. Drug cartels actually greatly reduce drug quantities
     - When drug baron Escobar killed, cocaine price fell
  5. Drug companies invest massive amounts in reducing supply
     - No reimportation, strictly delineated territories, etc.
  6. Digital materials sharply restricted, lawsuits v. students

The marginal revenue curve

To represent, consider derivative of revenue $R(q) = P(q)q$

- Under perfect competition, set $P = MC$
- Now set $MR = R' = MC$
- By product rule?

$$MR(q) = \underbrace{P(q)}_{\text{good, competitive}} + \underbrace{P'(q)q}_{\text{market power/Cournot distortion}}$$

- Two terms:
  1. Standard price, just as in competitive market
  2. Second term: change in price times quantity currently sold
     - Always negative, as long as demand downward sloping
     - Incentive to reduce quantity, to raise price on infra-marginal
- Distortion proportional to quantity, impact

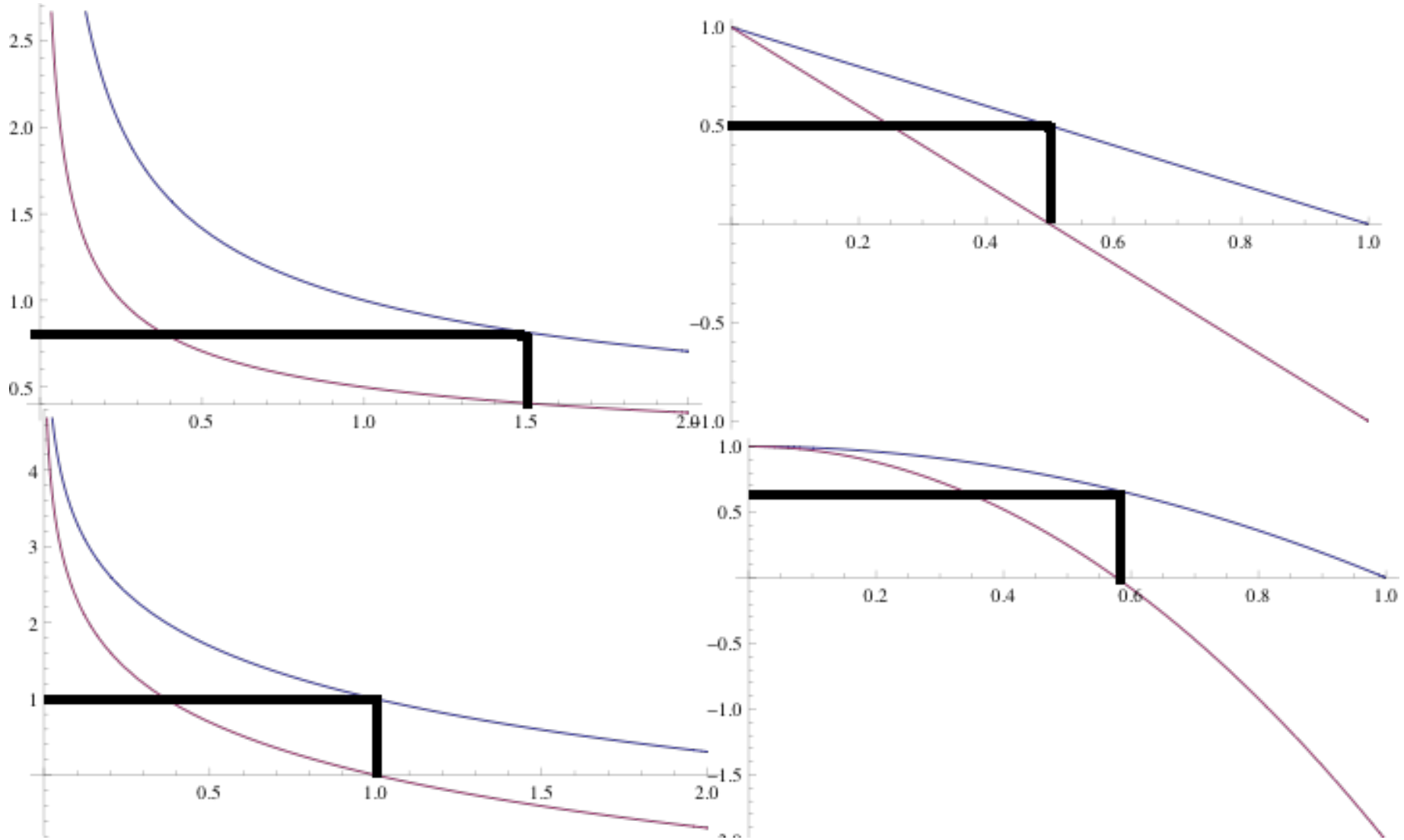
$\Longrightarrow$ Important to extent you are a large player

Examples of marginal revenue curve

Let's derive for some simple examples (most common curves):

1. Concave demand $P(q) = 1 - q^2$; derive MR?
   - $P'(q) = -2q$, $MR(q) = 1 - q^2 - 2q^2 = 1 - 3q^2$
   - Diverges from demand increasingly rapidly with q
2. Linear demand $P(q) = 1 - q$?
   - $P'(q) = -1$, $MR(q) = 1 - q - q = 1 - 2q$
   - Steeper than demand, but starts together
3. Exponential: $P(q) = 1 - \log(q)$?
   - $P'(q) = -\frac{1}{q}$, $MR(q) = 1 - \log(q) - 1 = -\log(q)$
   - Below P by a constant (1), same slope
4. Constant elasticity: $P(q) = \frac{1}{q^{\frac{1}{2}}}$?
   - $P'(q) = -\frac{1}{2q^{\frac{3}{2}}}$, $MR(q) = \frac{1}{q^{\frac{1}{2}}} - \frac{1}{2q^{\frac{1}{2}}} = \frac{1}{2q^{\frac{1}{2}}}$
   - Constant *fraction of demand*, less steep, *closer* higher q

Graphical representation of marginal revenue



Elasticity and marginal revenue

Another way to write MR is $P(q)\left(1-\frac{1}{\epsilon}\right)$; why?

- $\epsilon = -\frac{dQ}{dp}\frac{p}{q}$ so $-\frac{1}{\epsilon} = \frac{dP}{dq}\frac{q}{p}$
- So $-\frac{P}{\epsilon} = P'q = MR - P$

$\Longrightarrow$ Marginal revenue is negative if $\epsilon < 1$

- Monopolist *will never produce where demand inelastic*
- There, revenue falls w quantity, always reduce quantity!

$\Longrightarrow$ Elasticity of demand determines monopoly power

- If elasticity small, relative importance of market power small
- If elasticity large, relative importance very great
- Summarizes notion of being "big player" in the market

- Rearranging yields canonical formula:

Lerner's elasticity pricing rule

$$\frac{p-MC}{p} = \frac{1}{\epsilon}$$

Alternative measurements of monopoly power

$\frac{p-MC}{p}$ often called "mark-up": relative to price

- But could also do mark-up relative to cost $\frac{p-MC}{MC} = \frac{1}{\epsilon-1}$
- Or could do price-cost ratio $\frac{p}{MC} = \frac{\epsilon}{\epsilon-1}$
- Or absolute mark-up $p - MC = \frac{p}{\epsilon}$
- Alternative, very similar ways to measure market power
- Sometimes one can be more useful than others
  1. Standard Lerner nice because directly elasticity

     $\Longrightarrow$ Use when elasticity particularly salient
  2. Price-cost ratio useful for profits, especially w constant MC
  3. Similarly with mark-up to cost, profitability
  4. Absolute mark-up useful when costs not positive
     - What is mark-up in credit card market?
     - Make money off merchants, subsidies to consumers
     - There relative rules, elasticity are a mess

Experimenting and learning about demand

Of course, to set prices, firm needs sense of demand

- Otherwise quantity produces, demanded don't match
- To make optimal price, need to draw out marginal revenue
- In past, firms had to just guess, gradually learn at this
- But internet has created revolution: real time experiments
- Many companies now do this all the time: Amazon, etc.
- Particularly common on Ebay:
  - Sellers experiment with with reserve price
    - Identical objects, different days, same days, etc.
  - Auction, but a lot like a demand curve; why?
    - Raising reserve price raises average price
    - If reserve price higher than second highest bid...
    - Also reduces probability of sale: may be above highest bid
    - Induces average price, probability of sale trade-off

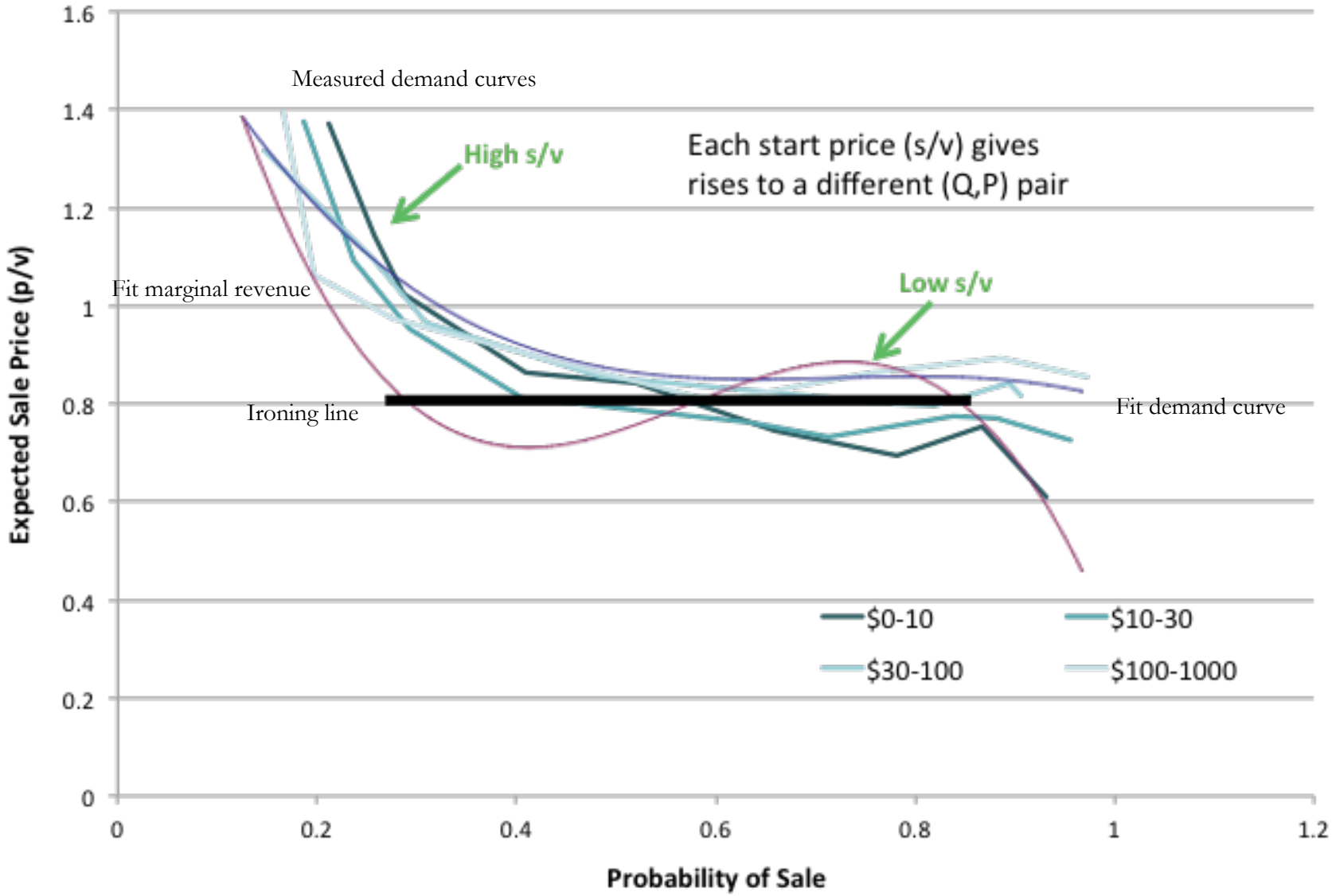
Einav et al. (2011) exercise

Einav et al. (2011) got all of eBays data, found all experiments

- Use to draw out many auction "demand" curves
- Find that all demand curves have similar shape
- Shape very interesting though:
  - Marginal revenue is *increasing* in some parts
  - Here marginal cost constant: probability of sale
  - This means may be multiple intersections
  - Above some cost, quantity falls discontinuously

  $\Longrightarrow$ Price rises discontinuously with cost
- We can represent with "ironing line"
  - Line above which choose low quantity, below high quantity
- To construct, I fit a 3rd degree polynomial to data
- Used this to build MR curve, drew in ironing line
  - Same area between line and curve on both sides

Einav et al. (2011) data



Why monopoly is inefficient

Monopoly has two basic effects, relative to competition:

1. Raises prices, *transferring* resources to monopolist
2. Reduces quantities, *inefficiently reducing output*
   - How do we know this reduction is inefficient?
   - At $p = MC$ everyone who values above cost consumes
   - When $p > MC$, some who value *more than cost* don't
   - This is an efficiency loss: could consume, compensate firm
   - Again, because firm cannot distinguish among consumers

Inefficiency of monopoly apparent in real life:

1. Why aren't information goods (music, etc.) available freely?
   - Completely non-rival, so cost obviously zero
2. Empty parking lots in busy cities charge high rates
   - People waste time looking on street, even though no cost
   - Clearly a waste of time and energy

The monopoly wedge

Effectively, monopoly means consumers have externality

- The more they purchase, the more profits firm makes
- Marginal externality equal to mark-up $p - MC$
- Extra profits created; not mediated through price system
- This naturally suggests standard Pigouvian solutions:
  1. Subsidize consumers for purchasing the good
  2. Regulate firm's price down to cost
  3. Mandate efficient quantity produced (floor+trade)
- Some of these used in practice (Lecture 12)
- But far less common than you'd think
- In lecture 13 we'll talk about why, but keep in mind
- Other solutions common (prestigious products, advertising)
- For now, we treat as if it cannot be internalized easily
- Like any tax/externality, value of production $(p - MC)dq$

The deadweight loss triangle

As a result, we can measure with standard tool

- *Deadweight loss* "triangle"
- Only difference is size determined by monopoly's optimum

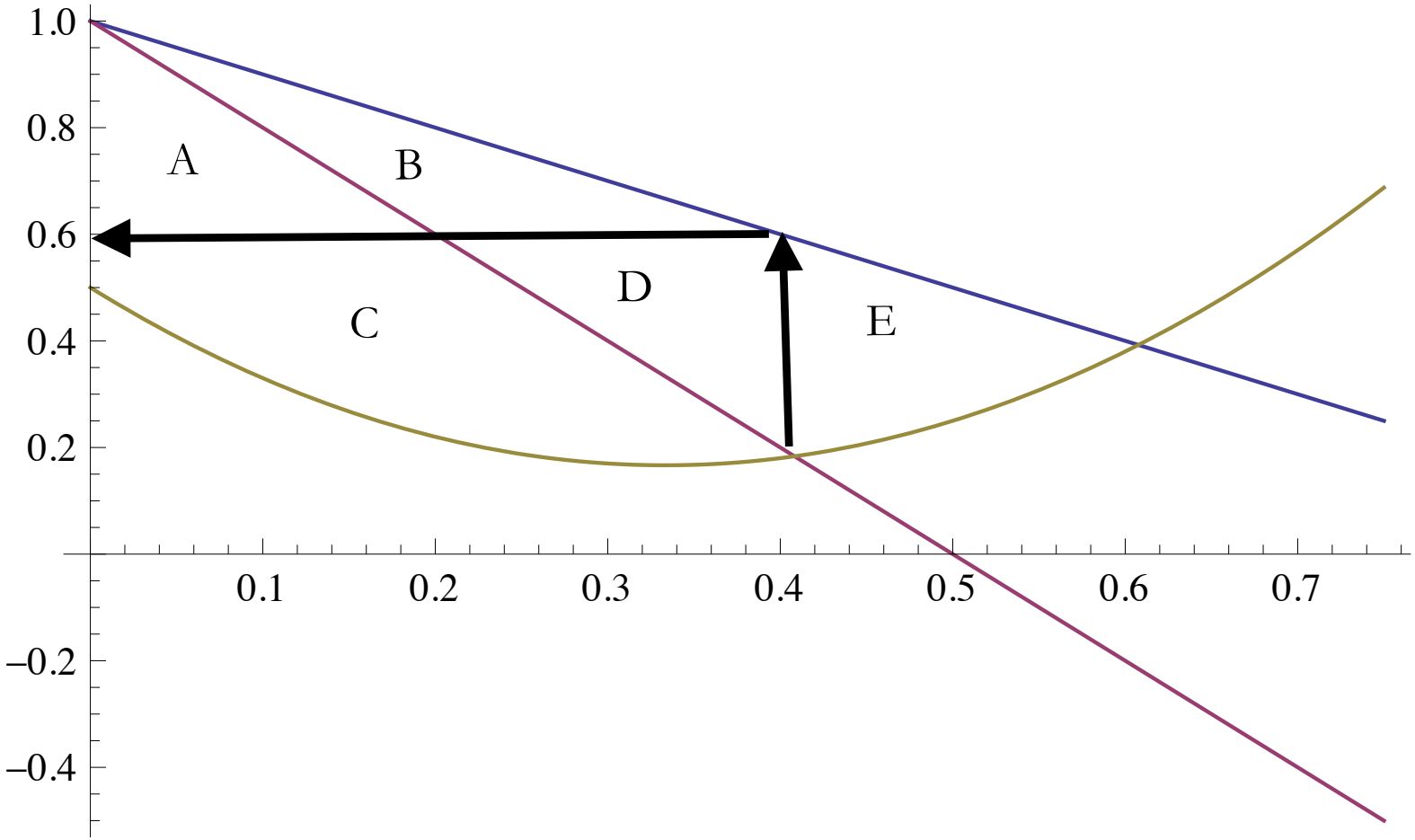
$\Longrightarrow$ Particular size, relationship to monopoly profits

  - We'll explore this in a bit

- Triangle bounded by supply, demand, equilibrium quantity
- Monopoly profits can be measured graphically in two ways:
  1. Area between equilibrium price and MC
  2. Or area between *MR* and *MC*
- Also *CS* (losses from no discrimination) is either:
  1. Area between demand and price
  2. Or area between demand and marginal revenue
- Monopoly gains = $(p - MC)q$ square...

– Firm profit side of the DWL triangle

Graphical example of welfare quantities



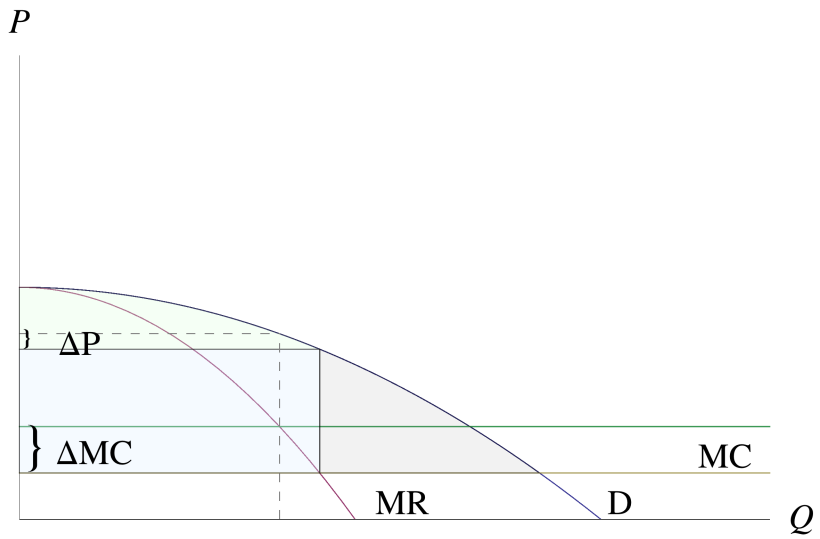
Demand and pass-through

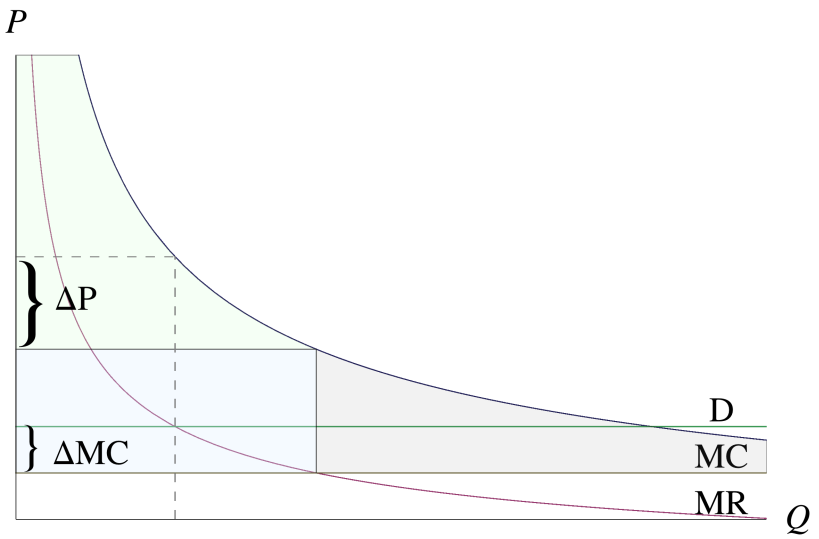
When tax imposed in competitive market, shared burden

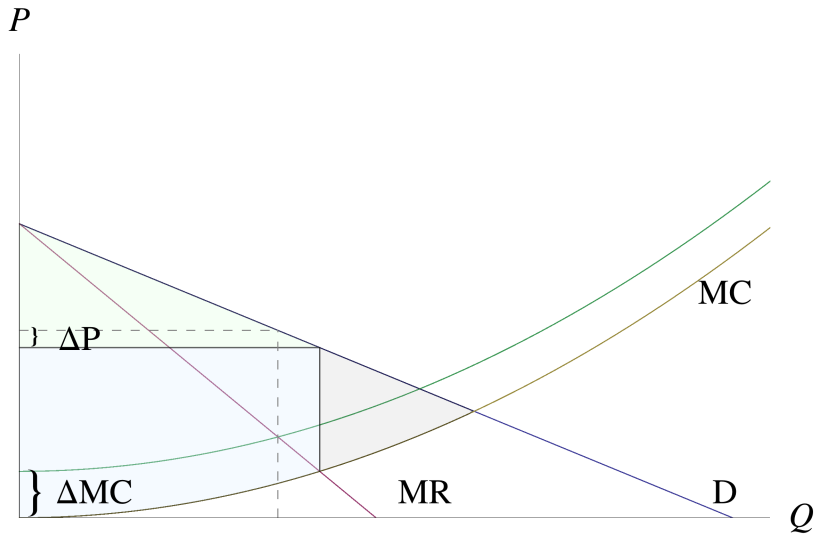
- Price rises less than 1-for-1 unless supply perfectly elastic
- Depends *only on elasticities*: $\rho_C = \frac{dp}{dt} = \frac{1}{1+\frac{\epsilon_D}{\epsilon_S}}$
- Under monopoly, slope of marginal revenue also crucial

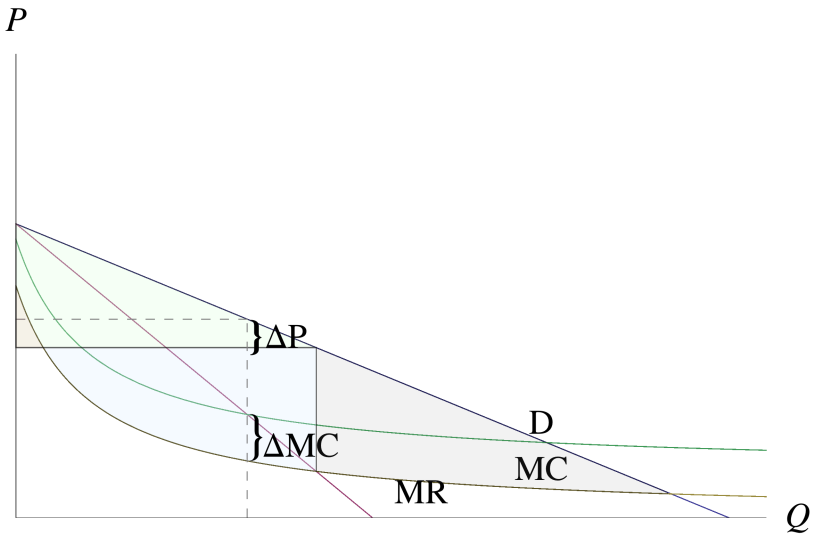
  $\Longrightarrow$ Curvature of demand, not just elasticity, important
- Close to competitive (elasticity high) $\Longrightarrow$ close to ρ_C
- Highly monopolized (ϵ_D low) $\Longrightarrow$ curvature crucial
- Curvature determines how sharply defined optimum is
  - If demand very concave then "price the market will bear"
    - Firms dare not go above this even if costs high
    - No value in going below it, just give up profits
  - If demand highly convex, then indifferent over range
    - Changes in cost can break this indifference, jump up
    - Einav et al. example an extreme case (upward sloping MR)

Graphical representation of pass-through









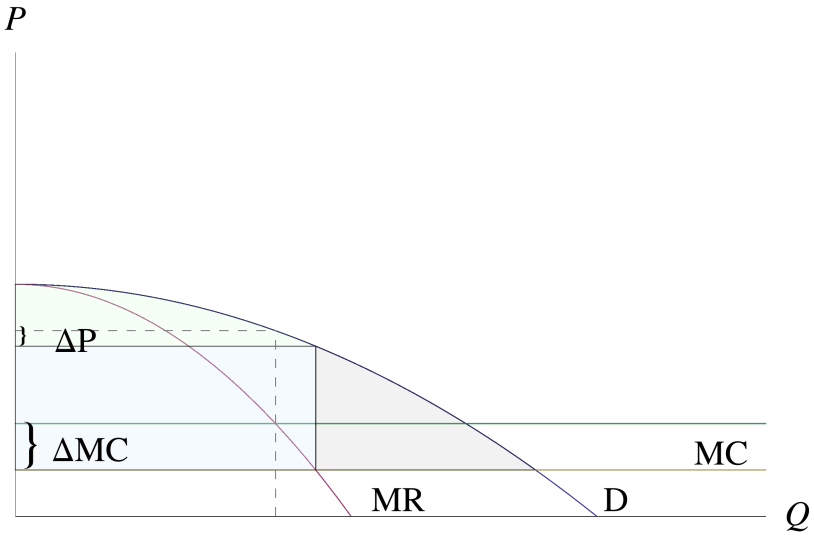
Division of surplus and demand

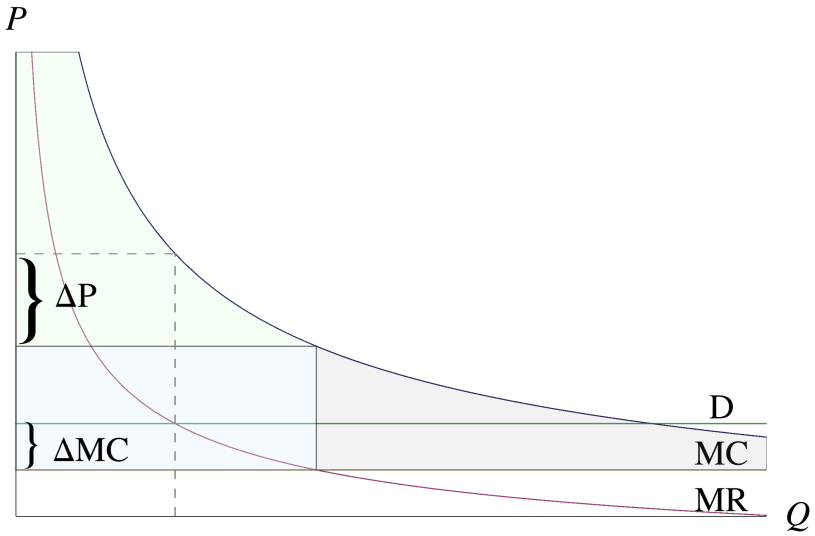
Same properties determine division of surplus

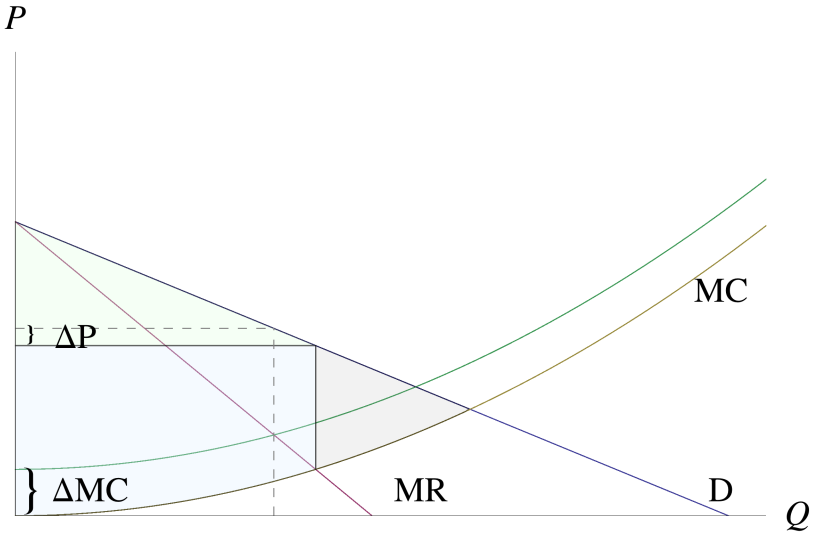
- What makes monopolist have "single right price"?
  - Little consumer surplus or deadweight loss
  - Capturing everything "there is to get" with current price
  - Concave: dies off quickly above, but don't gain below
- What makes monopolist indifferent over range of prices?
  - Lots of consumer surplus, deadweight loss
  - Getting only small part of pie, tempted in both directions
  - Convex: dies off slowly above, but high price below
- Cost properties for high pass-through raise CS, DWL too:
  - If MC increasing, then lots of profits, small pass-through
  - If MC flat, smaller profits, larger pass-through
  - Also increasing MC reduces DWL triangle directly

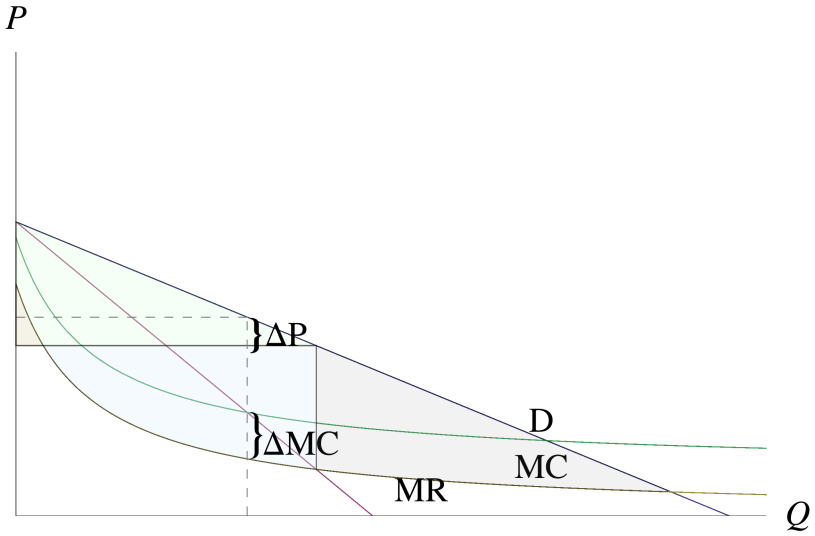
$\Longrightarrow$ Pass-through is same as division of surplus

Graphs of division of surplus









Harberger's economy-wide exercise

1950's: Chicago's Arnold Harberger tried to measure, how?

1. Identified "abnormal profits" with monopoly; assumptions?
   - Assumes constant marginal cost/constant returns
2. Assume all industries have constant elasticity of 1
   - This allows him to determine, based on profits, size of DWL
   - Use relationship of profits to size of DWL as in diagram
3. Assume resources allocated perfectly within industry
   - Firms in industry same monopoly power
4. Got data on profitability of industries, compared
   - "Average" degree of profitability is opportunity cost of capital
   - Profits above this identified with monopoly
5. Backed out degree of excess profits
   - Determined how much reallocation needed to cure

$\Longrightarrow$ Total cost of cost of monopoly to economy

Harberger's shocking numbers and problems

Found something very surprising; what?

- Total loss from monopoly very small!
- About $\frac{1}{10}$ of one percent of GDP!
- Basic reason: triangle proportional to square of distortion

  $\Longrightarrow$ Lots of small distortions make little difference
  - Requires a few big distortions to really matter

  $\Longrightarrow$ Not everything that matters in theory matters in practice
- Lots of things are wrong with Harberger's analysis?
  1. Monopoly arises particularly with increasing returns
     - This makes one firm more productive than many

     $\Longrightarrow$ Greatly understates degree of monopoly
  2. Most of heterogeneity is *within industry*, not across
     - Apple v. Motorolla, HTC, etc.
  3. Elasticity of demand uncertain, heterogeneous

Broader lessons from Harberger's work

Still, carries some important lessons:

1. Monopoly distortions exist, but not necessarily large
   - I love antitrust policy and we'll study a lot
   - But you should be skeptical about how important it really is
2. Takes large price change before DWL significant
   - Monopoly deadweight loss can be large relative to profits
   - But a bit of market power (not fully monopoly) not so bad
   - Starting from competitive, first mostly profits increase
   - If all prices elevated, cost from elevating one price smaller
     - Raising price has positive, real externality on other firms

   $\Longrightarrow$ Monopoly model (in symmetric industyr) overstates DWL
3. Primary impact of monopoly may be transfer, not DWL
   - We'll return to this in Lecture 13
4. Details (costs, heterogeneity) crucial for measurement