

Basic Welfare Economics and Optimal Tax Theory

June 24, 2013

Outline

- The fundamental theorems of welfare analysis and the role of government
- Measurement of deadweight loss
- Optimal tax theory and applications

The Basic Criteria of Welfare Analysis

- *Efficiency*: how well resources are allocated, e.g., the size of the pie
- *Equity*: how resources are distributed among individuals
- While efficiency can be measured in terms of economic performance alone, measuring equity requires the specification of social norms and value judgments.

Another Important Distinction to Keep in Mind

- *Positive* versus *normative* analysis: how existing policies perform based on the criteria of efficiency and equity versus what policies would be optimal based on these criteria
- Normative analysis underlies discussions of the appropriate role of government in the economy.

A Starting Place: Two Fundamental Theorems of Welfare Economics

Some definitions:

1. An outcome is *Pareto efficient* if it is not possible to make someone better off without making someone else worse off.
 - Sometimes referred to as *Pareto optimality*, but is optimal only in the sense of being efficient; nothing to say about equity

A Starting Place: Two Fundamental Theorems of Welfare Economics

Some definitions:

2. A *competitive market* is one in which participants have full information and cannot influence prices.
3. Taxes and transfers are *lump-sum* in nature if they are unrelated to any actions by the individuals involved.

A Starting Place: Two Fundamental Theorems of Welfare Economics

Theorem 1:

A competitive equilibrium is Pareto efficient.

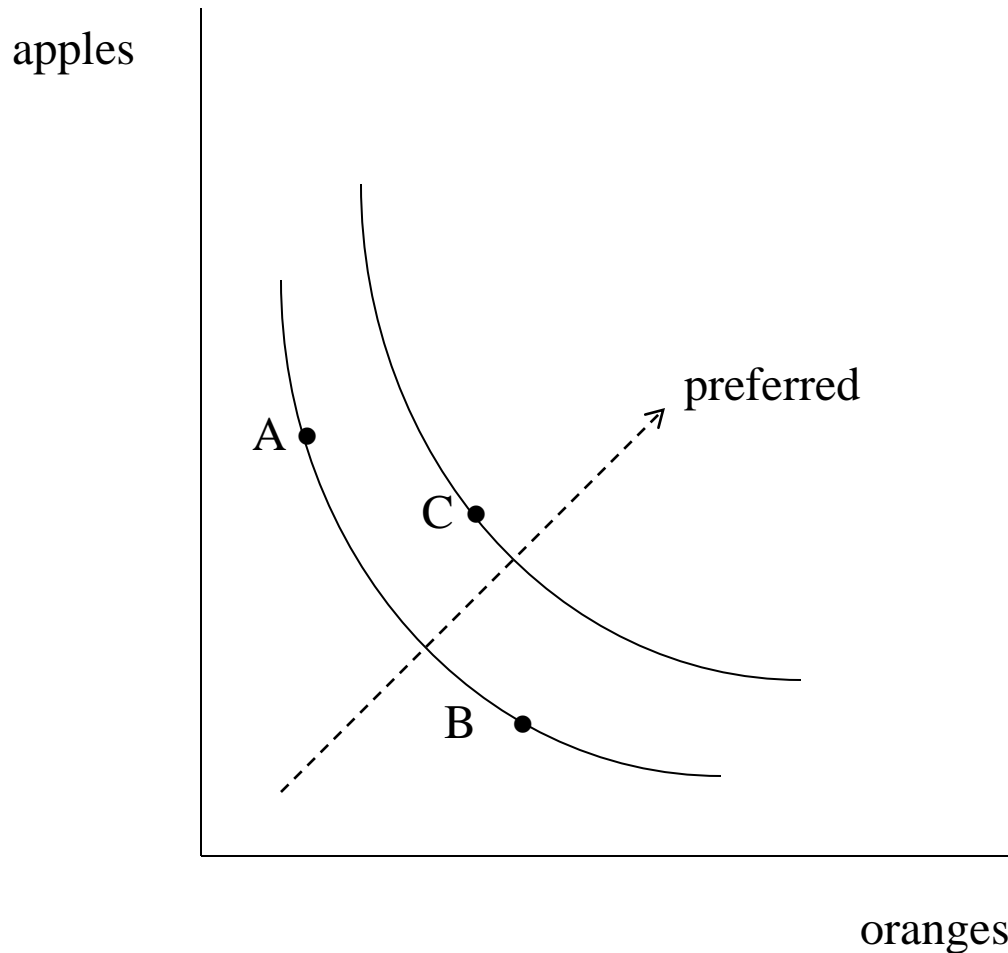
Theorem 2:

Any Pareto efficient outcome can be achieved via a competitive equilibrium through the use by government of a balanced-budget system of lump-sum taxes and transfers.

A Starting Place: Two Fundamental Theorems of Welfare Economics

- We demonstrate the fundamental theorems using tools to explain the behavior of individuals/households and firms.
- For households, the basic tools are the *indifference curve* and the *budget constraint*.

Indifference Curves

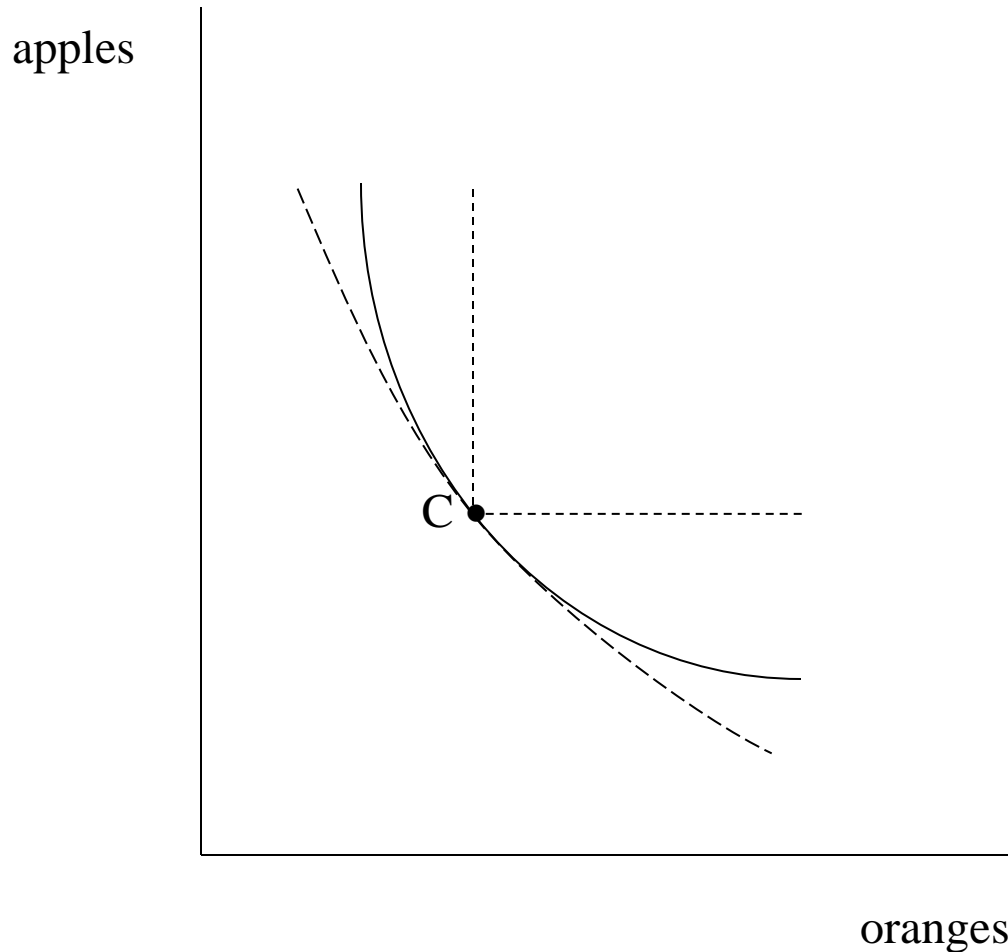


Each indifference curve collects bundles among which the individual is indifferent

Slope = - MRS (marginal rate of substitution)

Convexity indicates diminishing returns – more and more required as we get more of either good to make up for giving up a unit of the other

Indifference Curves

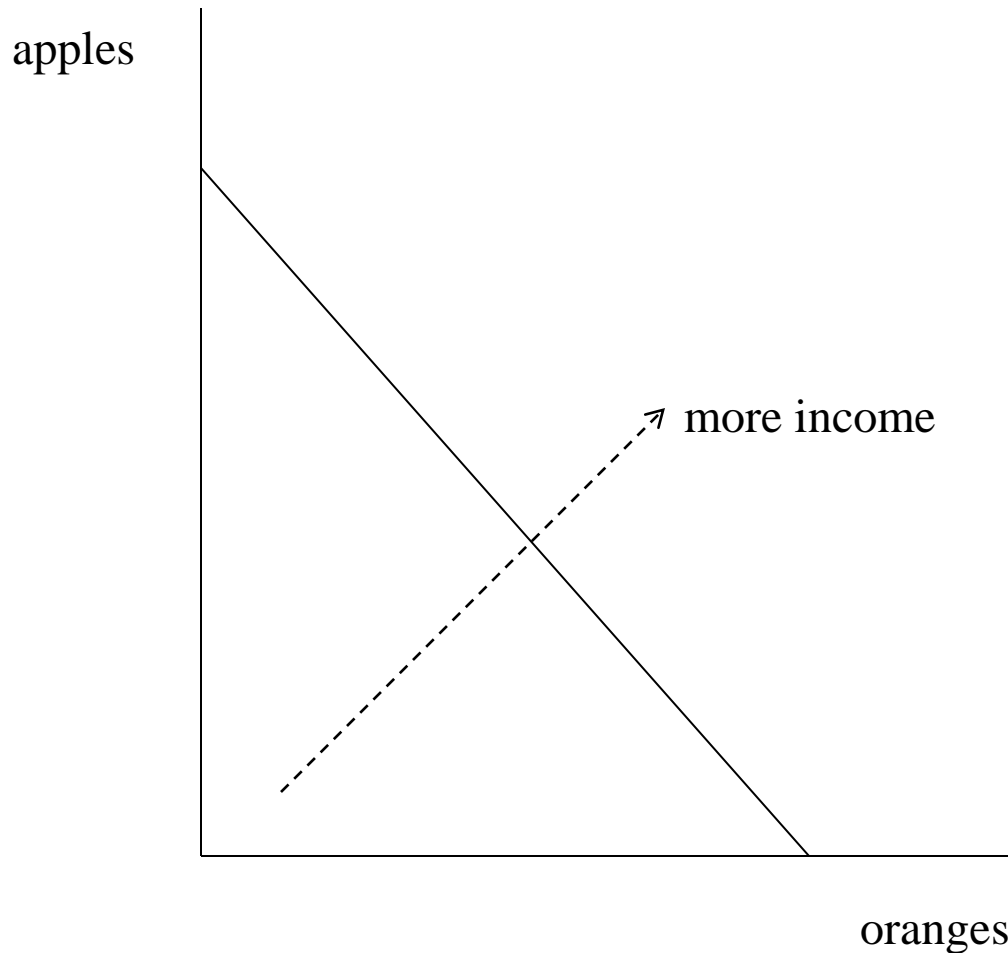


Each indifference curve collects bundles among which the individual is indifferent

Slope = - *MRS* (Marginal Rate of Substitution)

Degree of curvature indicates degree of substitutability (flatter = easier substitution)

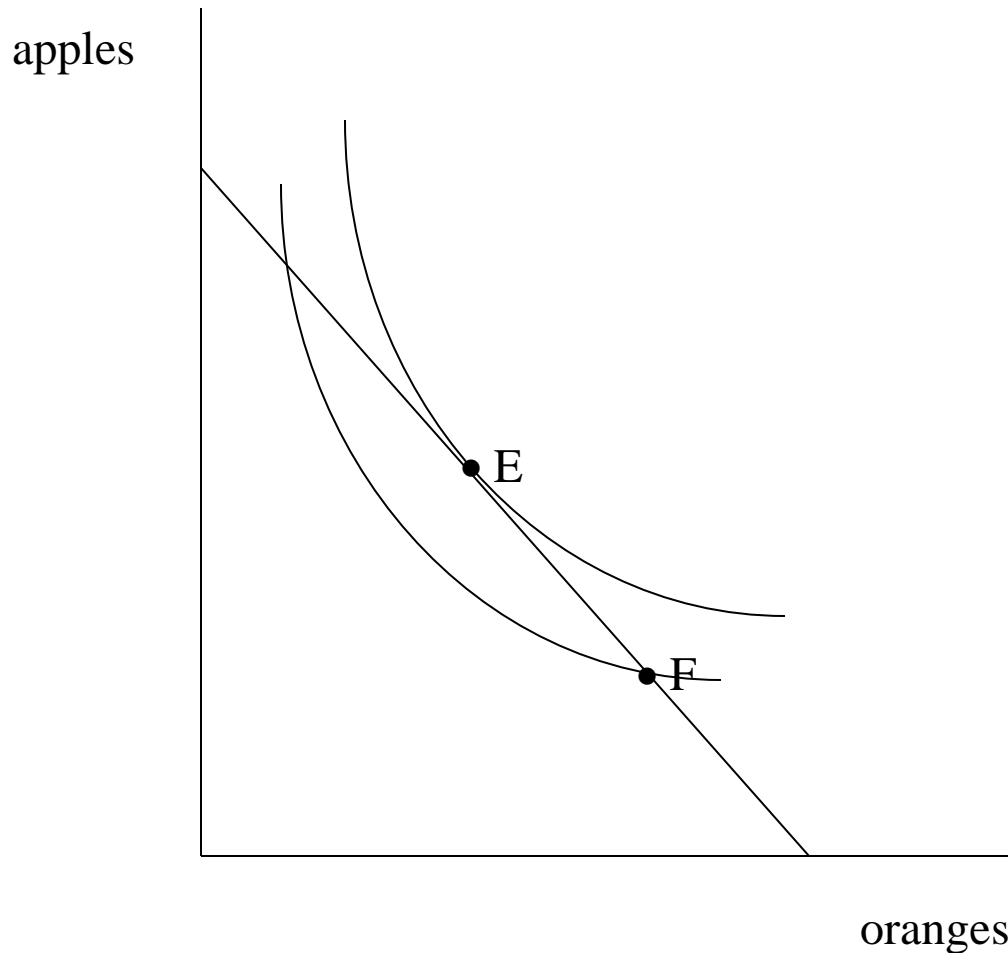
Budget Constraint



Indicates highest feasible combinations of goods, given their prices

$$\text{Slope} = - p_{orange}/p_{apple}$$

Consumer Choice

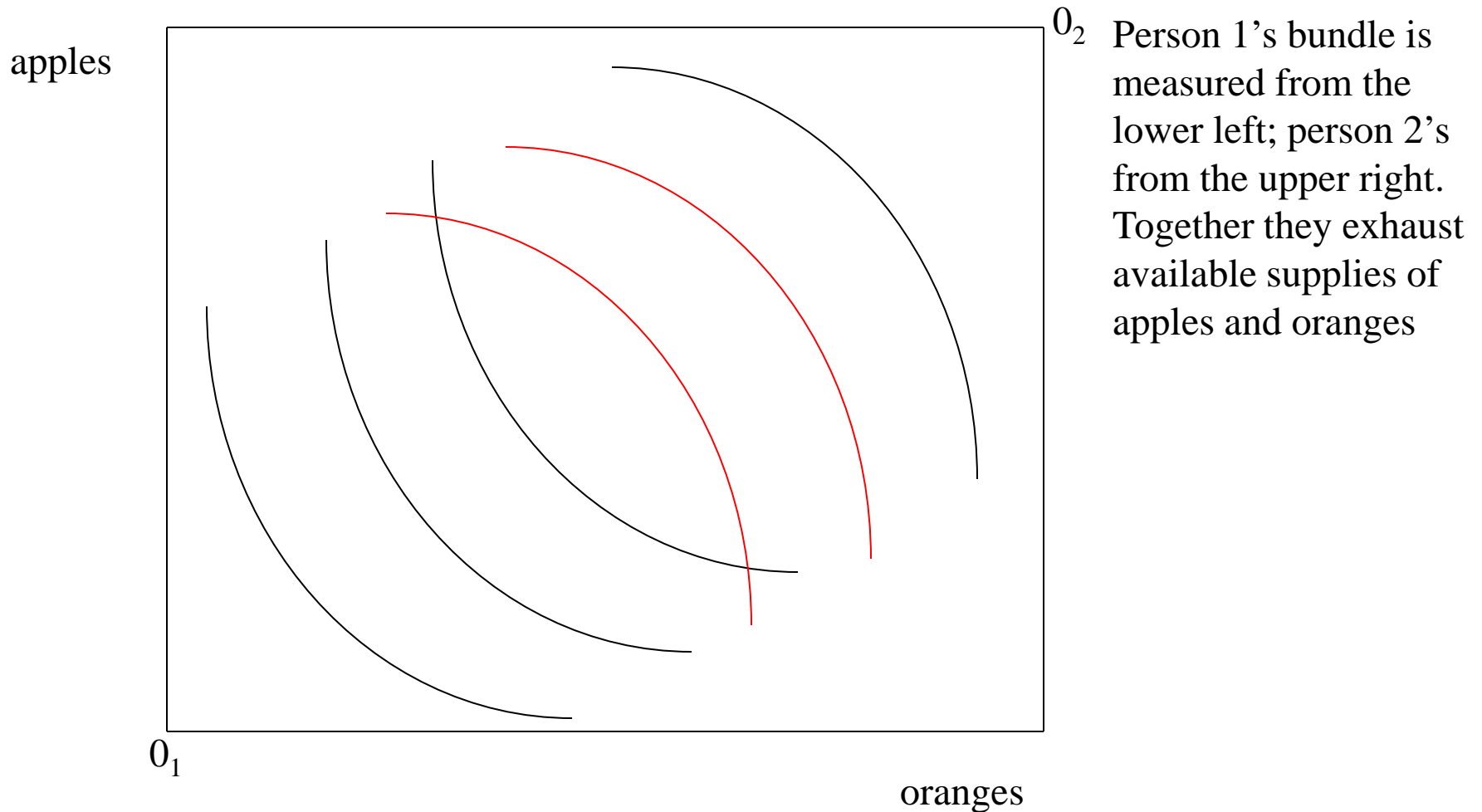


Most preferred outcome occurs, as at point E, when budget line is tangent to indifference curve, i.e., when

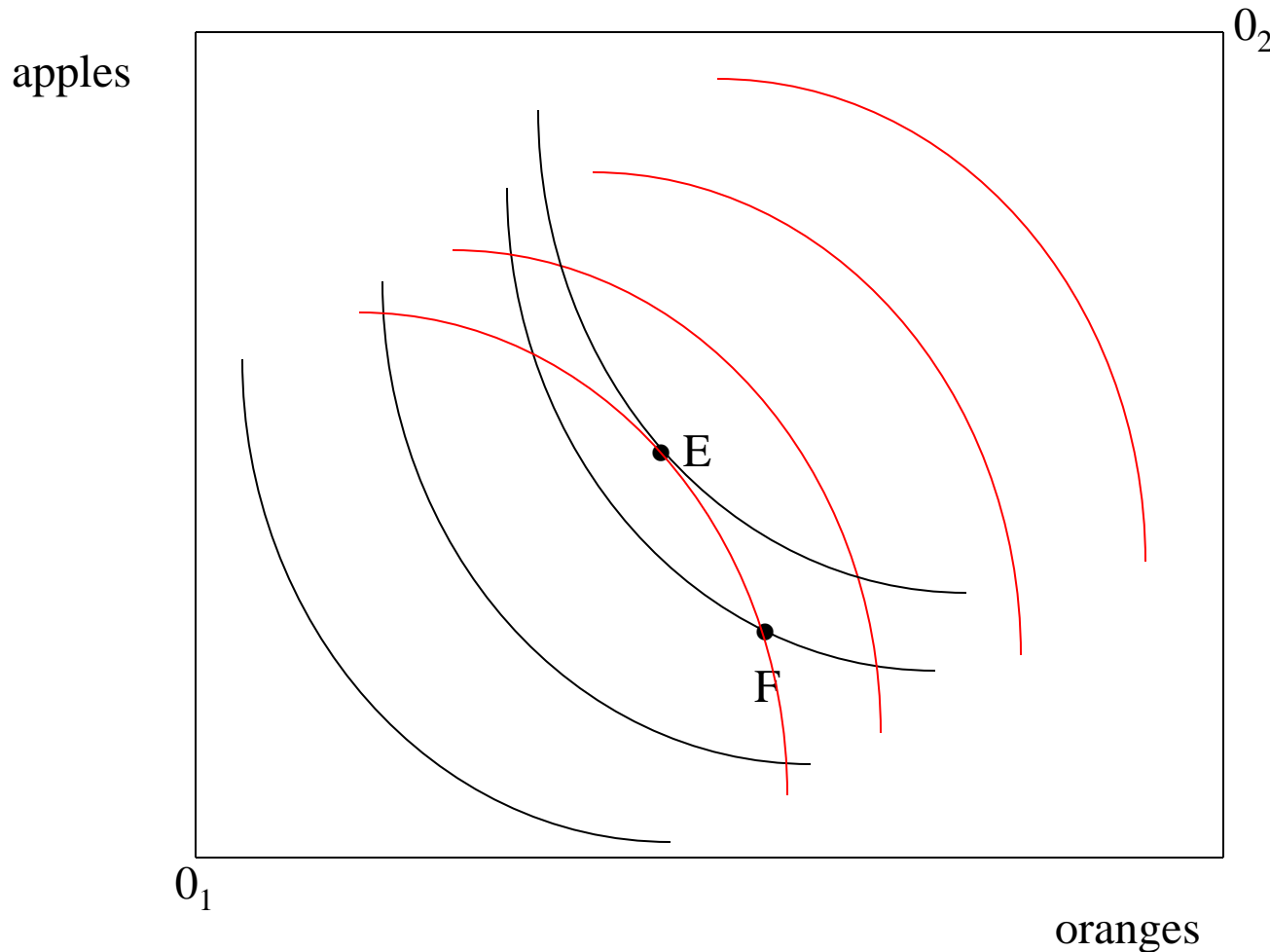
$$MRS = p_{orange}/p_{apple}$$

If this condition does not hold (e.g., as at point F), the individual can do better with the same income

Exchange Efficiency: Edgeworth Box



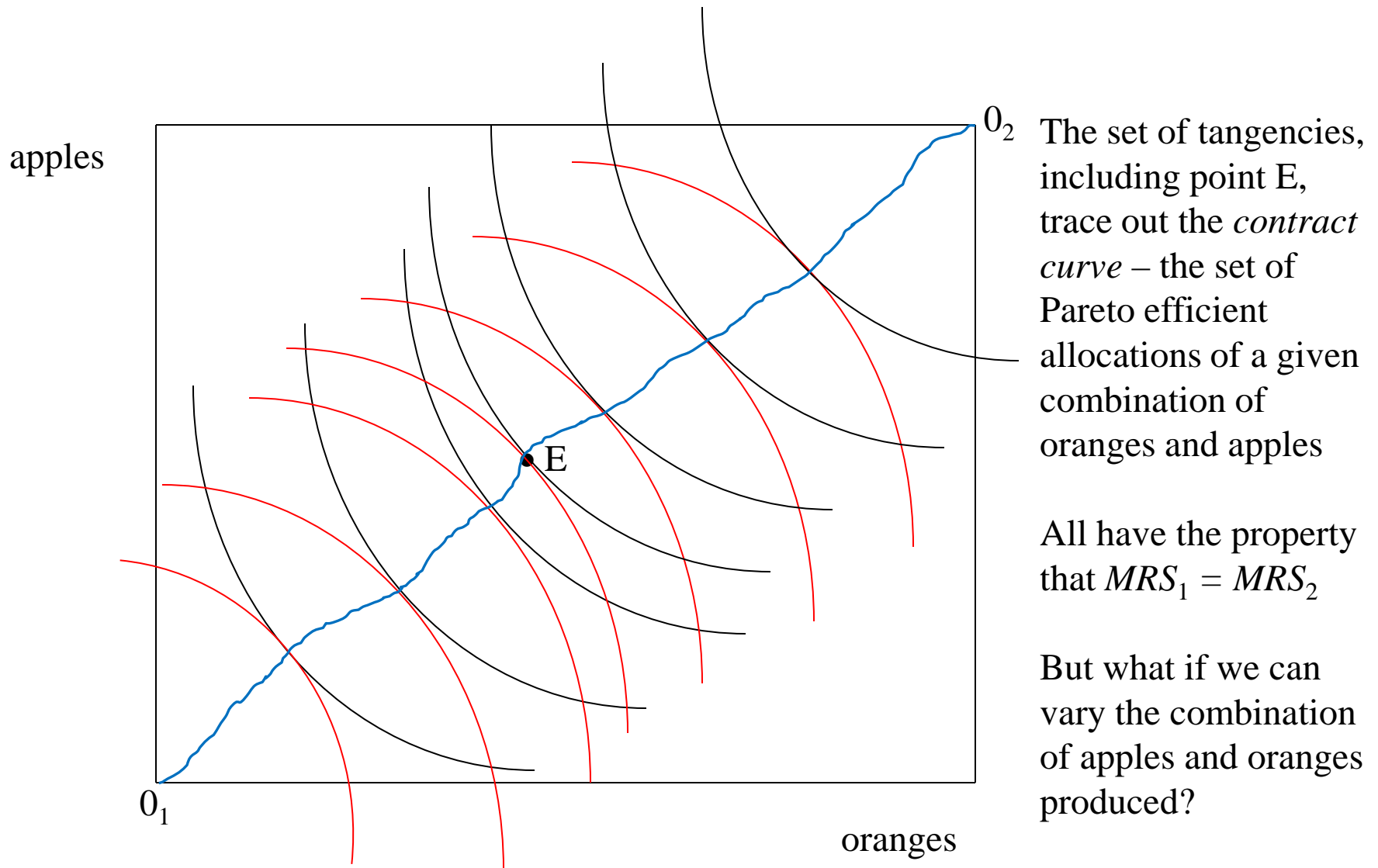
Exchange Efficiency: Edgeworth Box



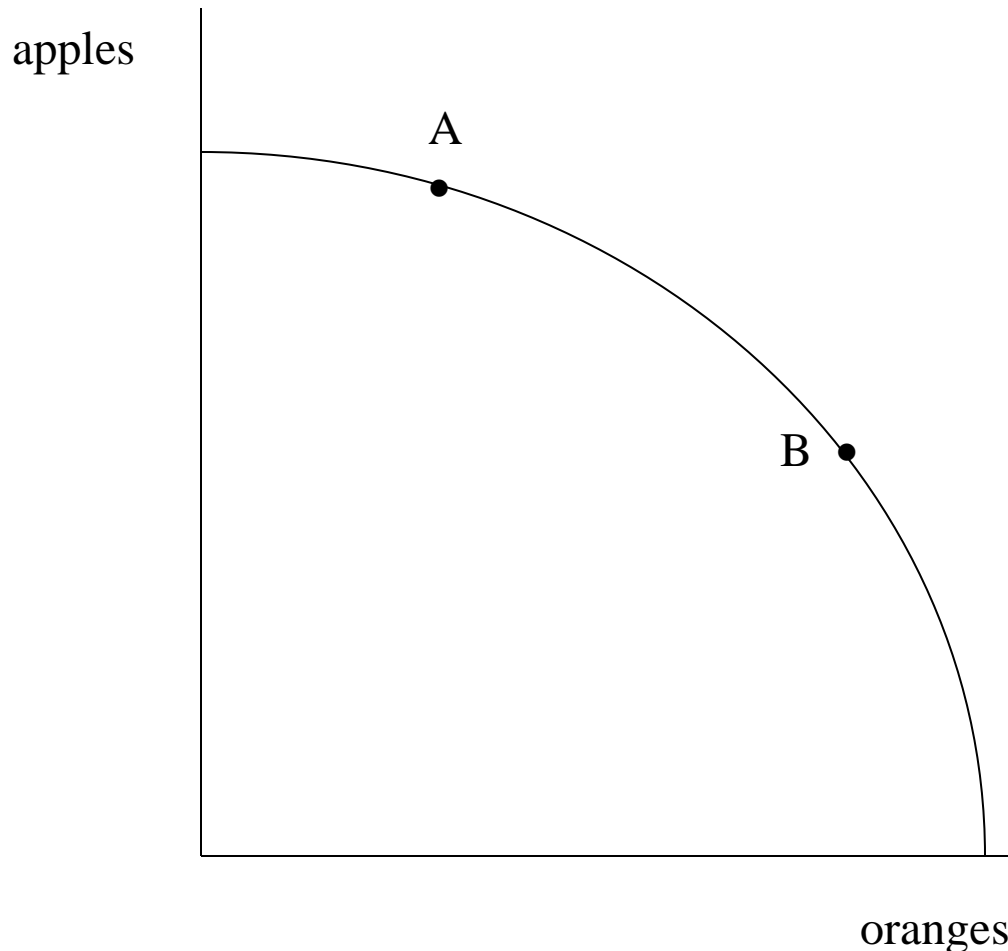
To achieve Pareto efficiency, we need the respective bundles to be at a point where the indifference curves are tangent, as at point E

Otherwise, as at point F, we can clearly make individual 1 better off (and leave individual 2 as well off) by moving to E

Exchange Efficiency: Edgeworth Box



Adding Production

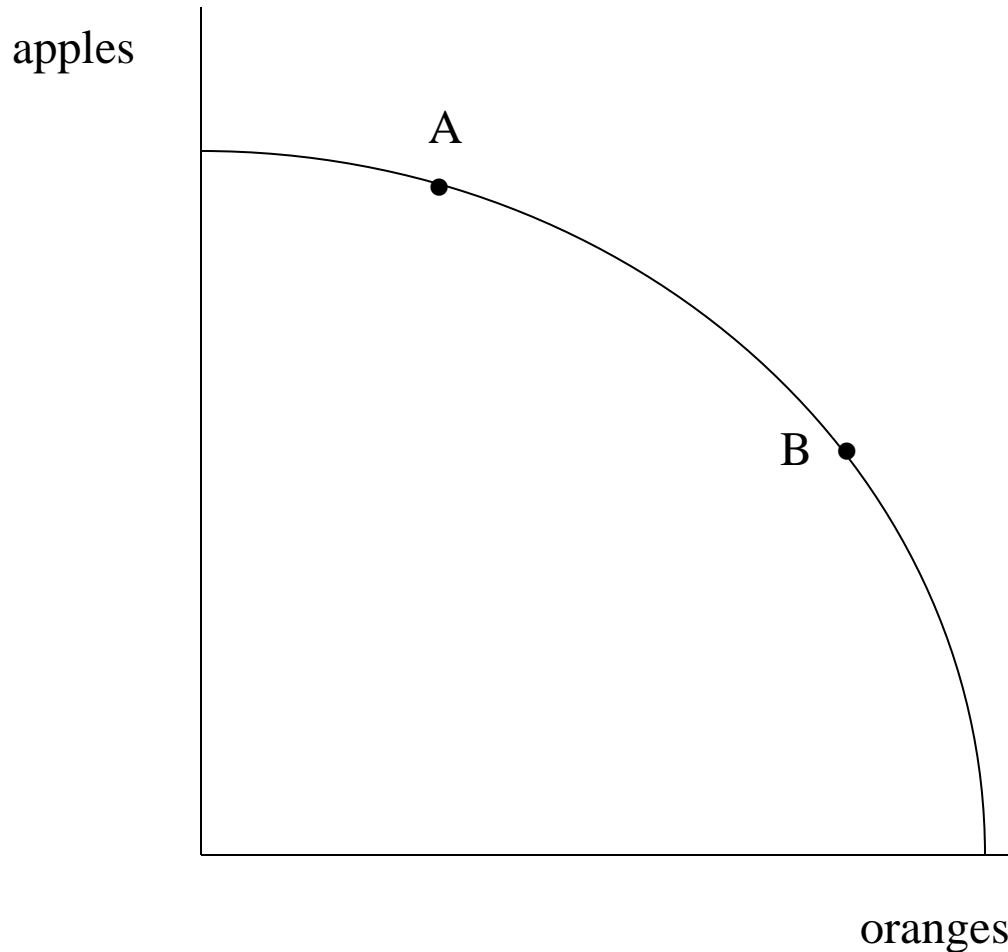


The *production possibilities frontier* (*PPF*) defines the limits of how much we can produce

The slope of the *PPF*, the *Marginal Rate of Transformation* (*MRT*), indicates the trade-off – how many additional apples we can produce for giving up 1 orange

The *PPF* is convex, indicating diminishing returns in the trade-off – fewer apples at A than at B

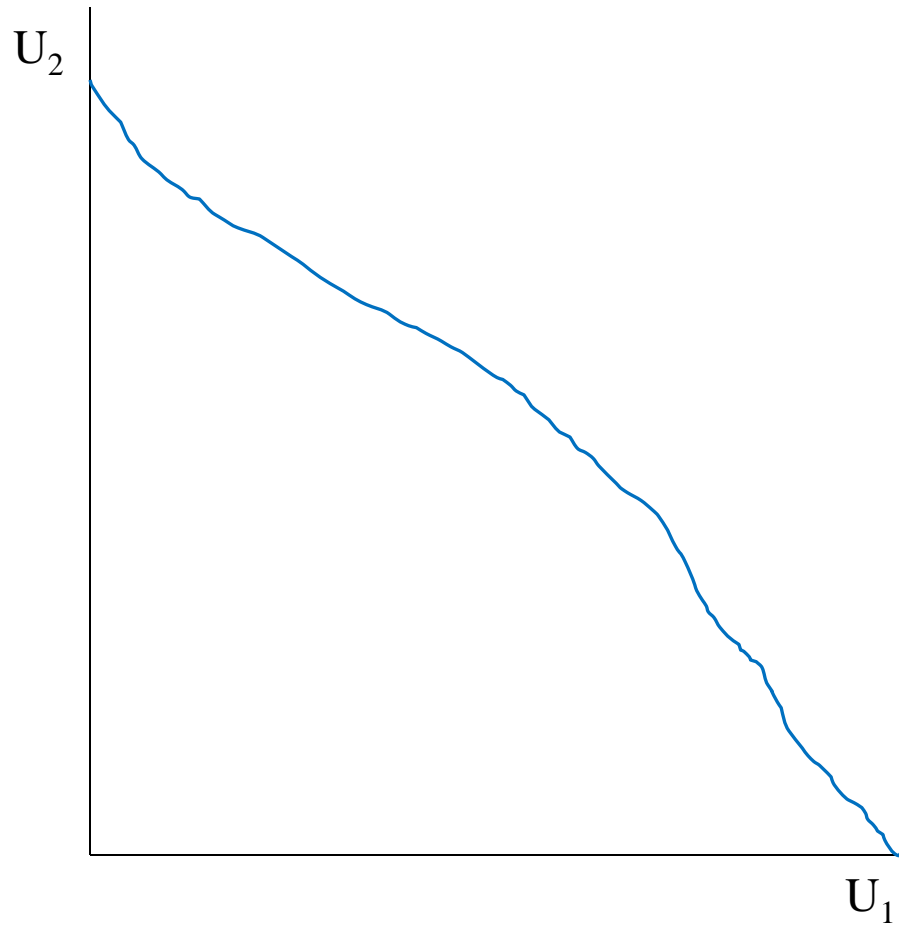
Adding Production



To achieve full Pareto efficiency with production, it must be true that the $MRT =$ every individual's MRS

Otherwise, we could shift production toward more apples (if $MRT > MRS$) or toward more oranges (if $MRT < MRS$) and make everyone better off

The Pareto Frontier



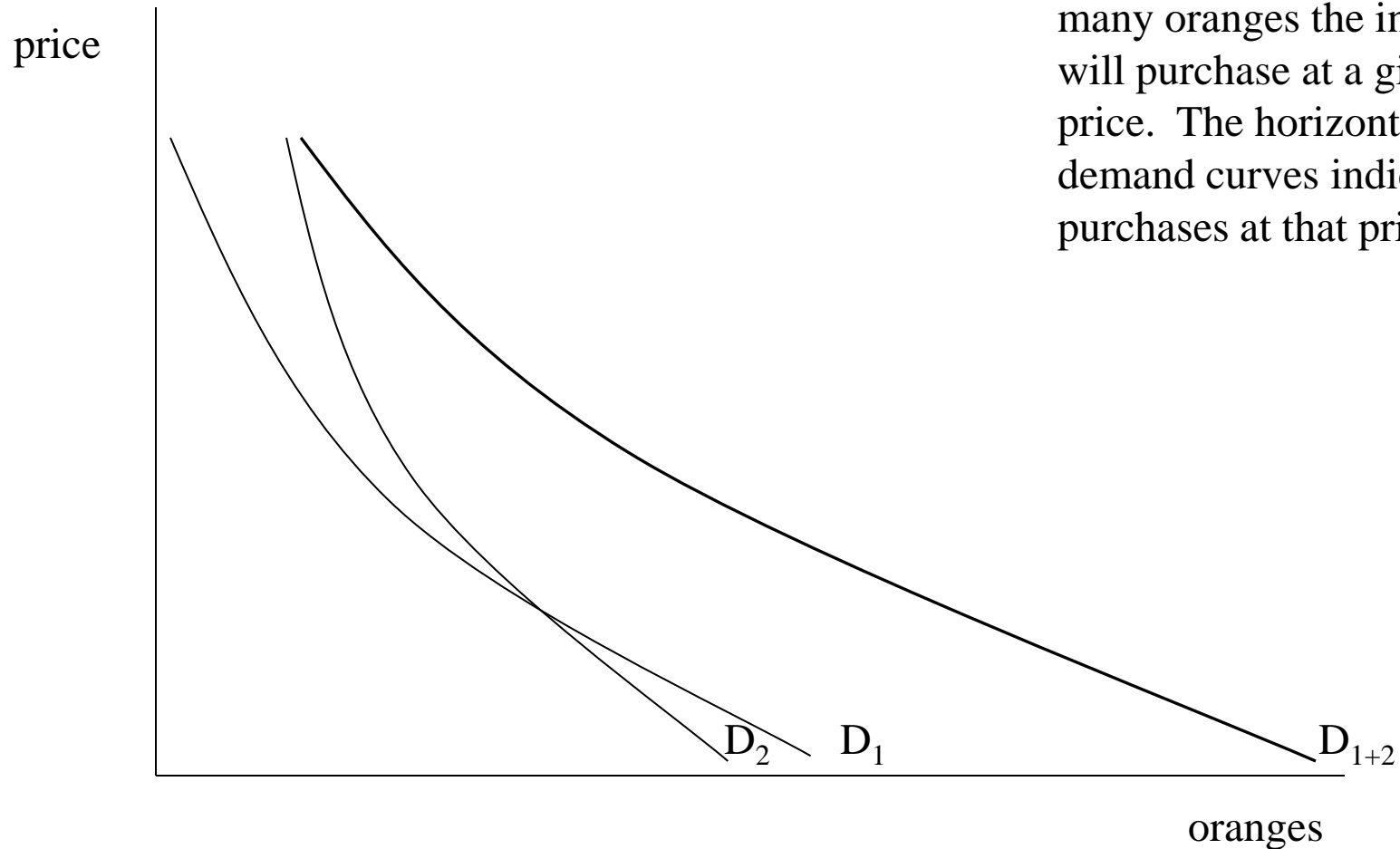
All combinations of production and allocation of goods that achieve Pareto efficiency define a frontier of feasible utility combinations. Inside this frontier, we can make some individuals better off without hurting others, so it is preferable to be on the frontier, *assuming that our measure of social welfare respects the Pareto criterion*

The First Fundamental Theorem

- How do competitive markets lead to a point on the Pareto frontier?
- Recall that consumers will choose a point of tangency between indifference curve and budget line, where $MRS = p_{orange}/p_{apple}$.
- We can also represent this in terms of the demand for oranges (letting $p_{apple} = 1$), as then MRS represents the willingness to pay for oranges:

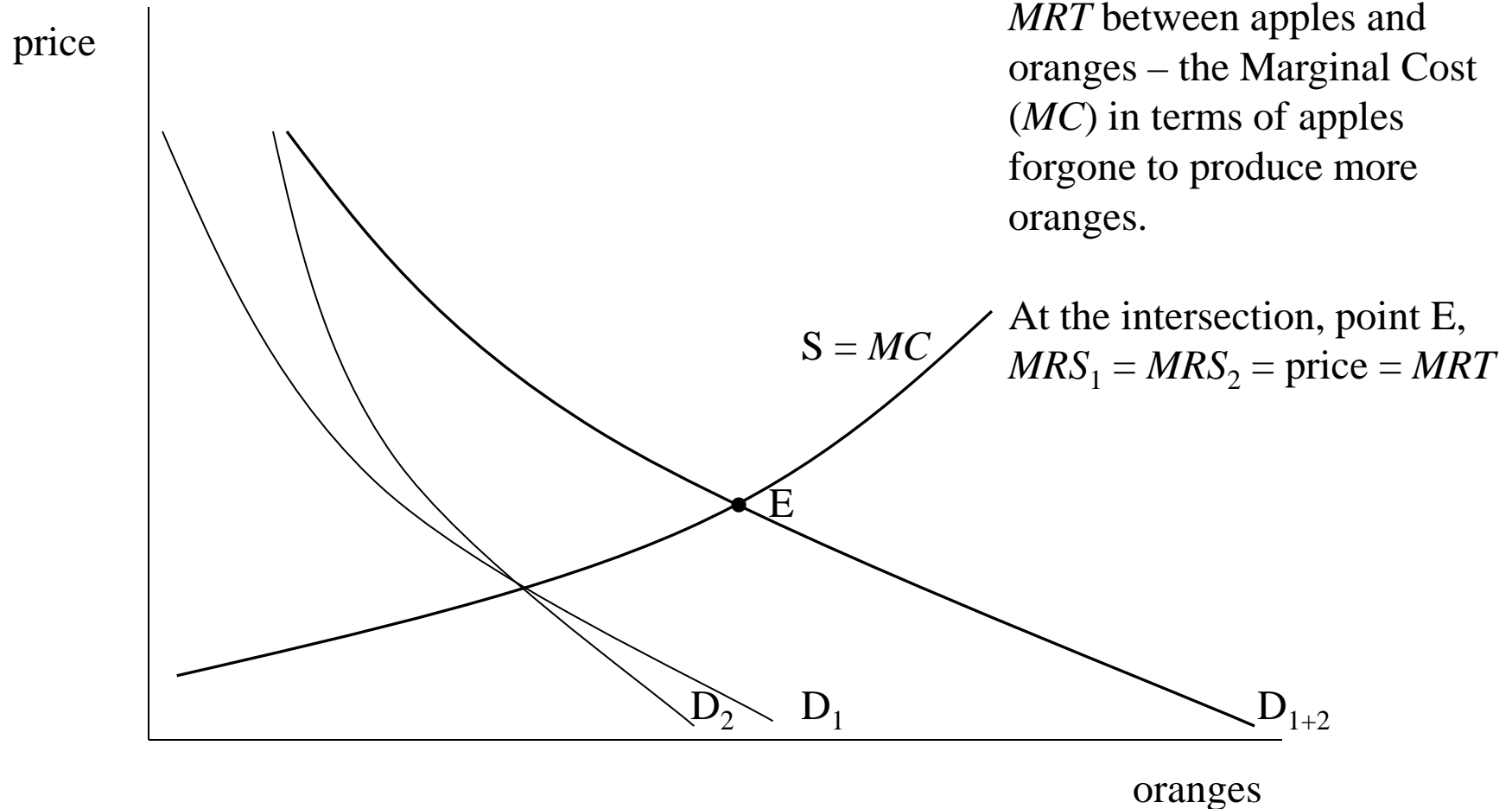
Demand and Supply

For each individual, the demand curve indicates how many oranges the individual will purchase at a given price. The horizontal sum of demand curves indicates total purchases at that price.

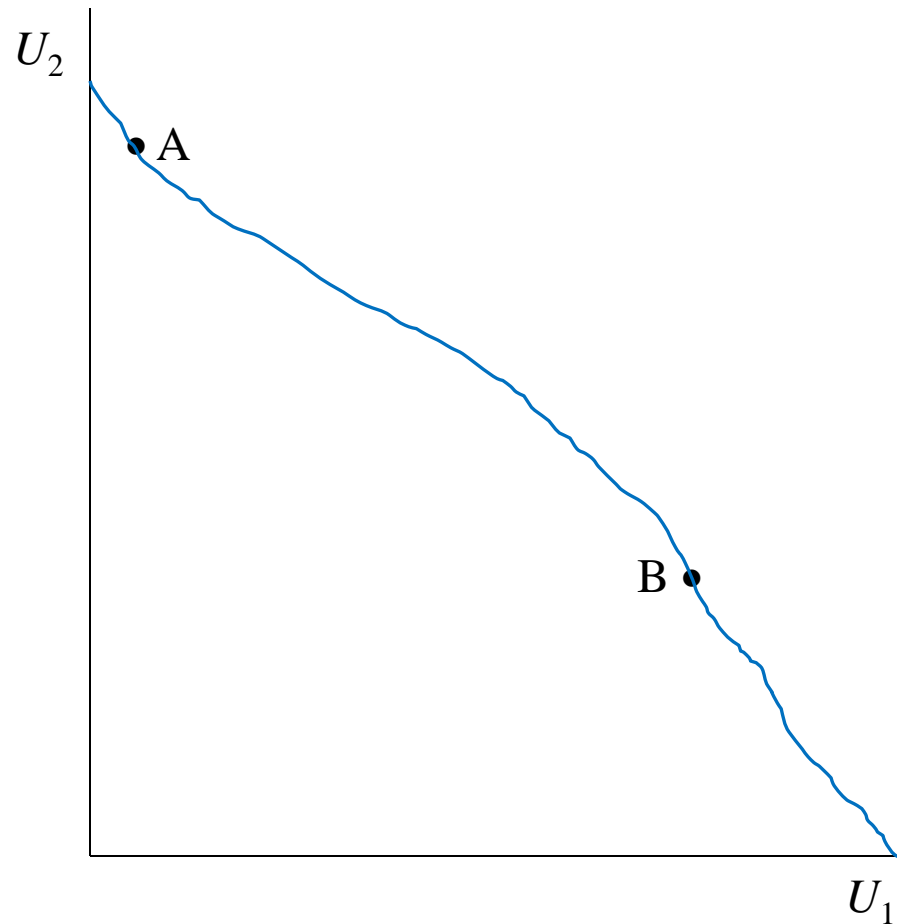


Demand and Supply

For producers, there is a supply curve, indicating the *MRT* between apples and oranges – the Marginal Cost (*MC*) in terms of apples forgone to produce more oranges.



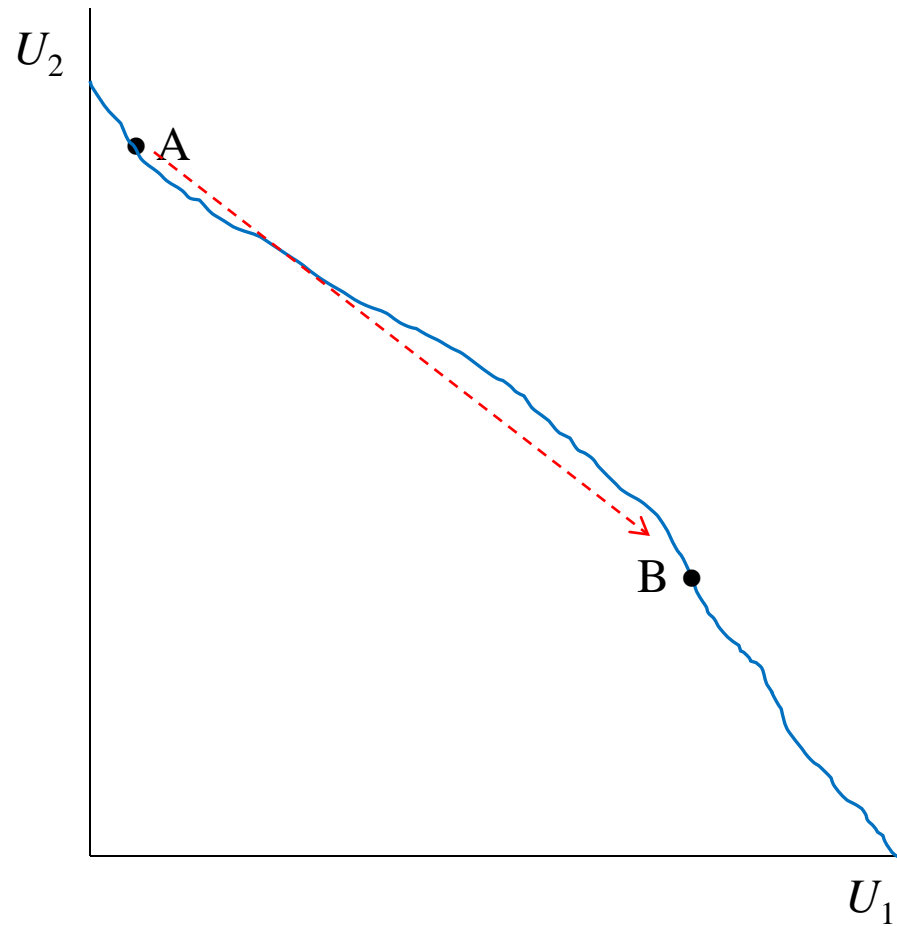
The Second Fundamental Theorem



The first fundamental theorem says that competitive markets put society on the Pareto frontier. But what if this is at point A, where person 2 gets virtually everything?

The second fundamental theorem says we can move elsewhere on the Pareto frontier, say to point B, by imposing a lump-sum tax on individual 2 and giving the same amount as a lump-sum transfer to individual 1.

The Second Fundamental Theorem



Intuition: we have not disrupted the condition that $MRS_1 = MRS_2 = MRT$; we've just adjusted each individual's initial resources.

The Scope of Government, So Far

- To achieve a social optimum, use lump-sum taxes and transfers
 - No more complicated taxes and transfers
 - No government purchases of goods and services
 - No regulation of private activity
- Of course, we will want further intervention if there are *market failures*.

Examples of Market Failures

- Lack of price-taking behavior
 - May be associated with cost structure (e.g., decreasing costs)
- Lack of markets
 - Nonexcludable public goods
 - Externalities (e.g., no market for pollution)
- Lack of information
- Government intervention may be warranted, but government also faces information problems when markets don't work well.

Realistic Tax and Transfer Systems

- Market failures are only one reason why government goes beyond lump-sum taxation.
- For lump-sum taxes to be helpful in achieving redistribution, they must be individual-specific taxes on innate ability.
 - We don't observe ability.
 - If we did, would our problem be solved? Is it feasible/acceptable to impose ability taxation?

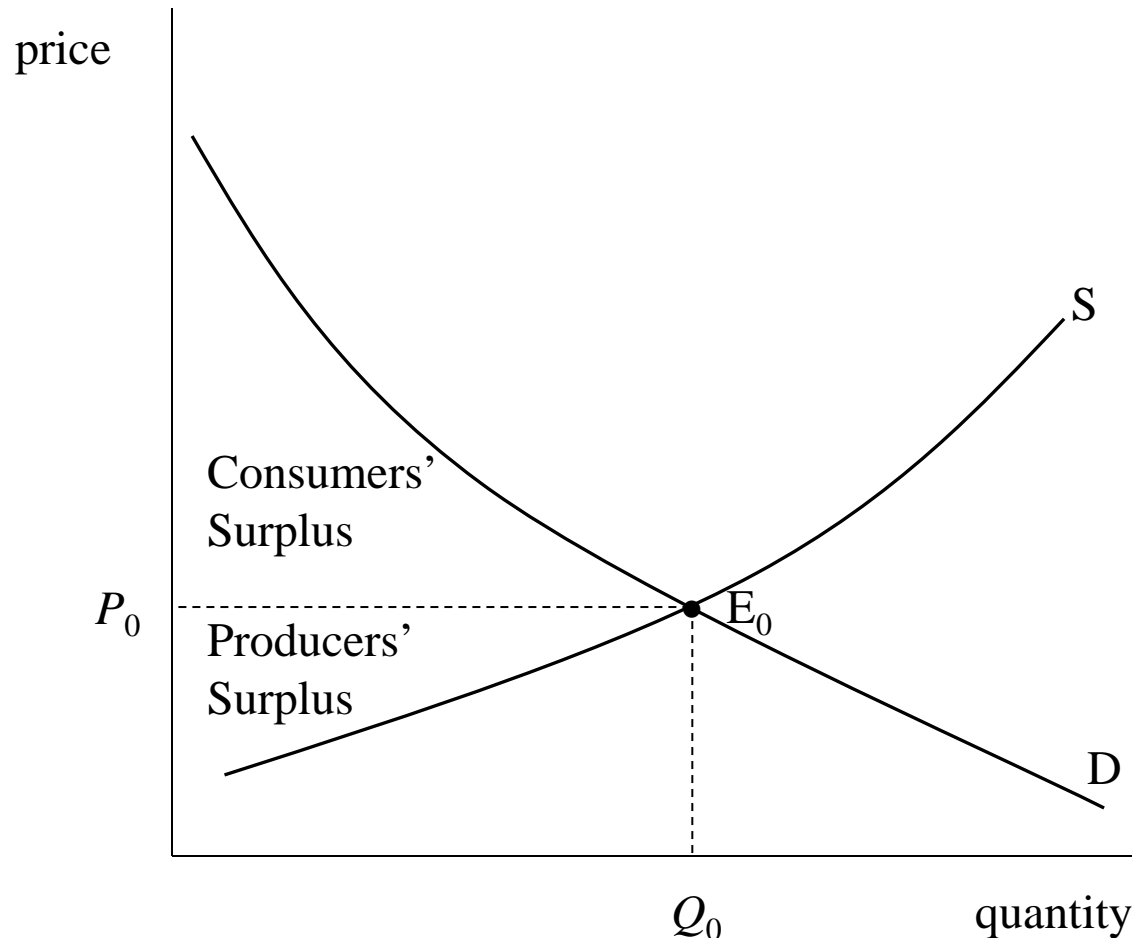
Realistic Tax and Transfer Systems

- Once we move away from lump-sum taxation, we also move away from the Pareto frontier.
- We measure the efficiency losses from doing so by estimating the *deadweight loss (DWL)* or *excess burden* of taxation.
- Minimizing deadweight loss for a given amount and use of revenue defines the objective of *optimal taxation*.

Deadweight Loss

We can measure the total value generated by activity in a market by the sum of *consumers' surplus* (how much more consumers would be willing to pay for what they get) and *producers' surplus* (how much more producers get than what they would need to break even on what they are producing – their *economic profits*).

Competitive markets maximize this value



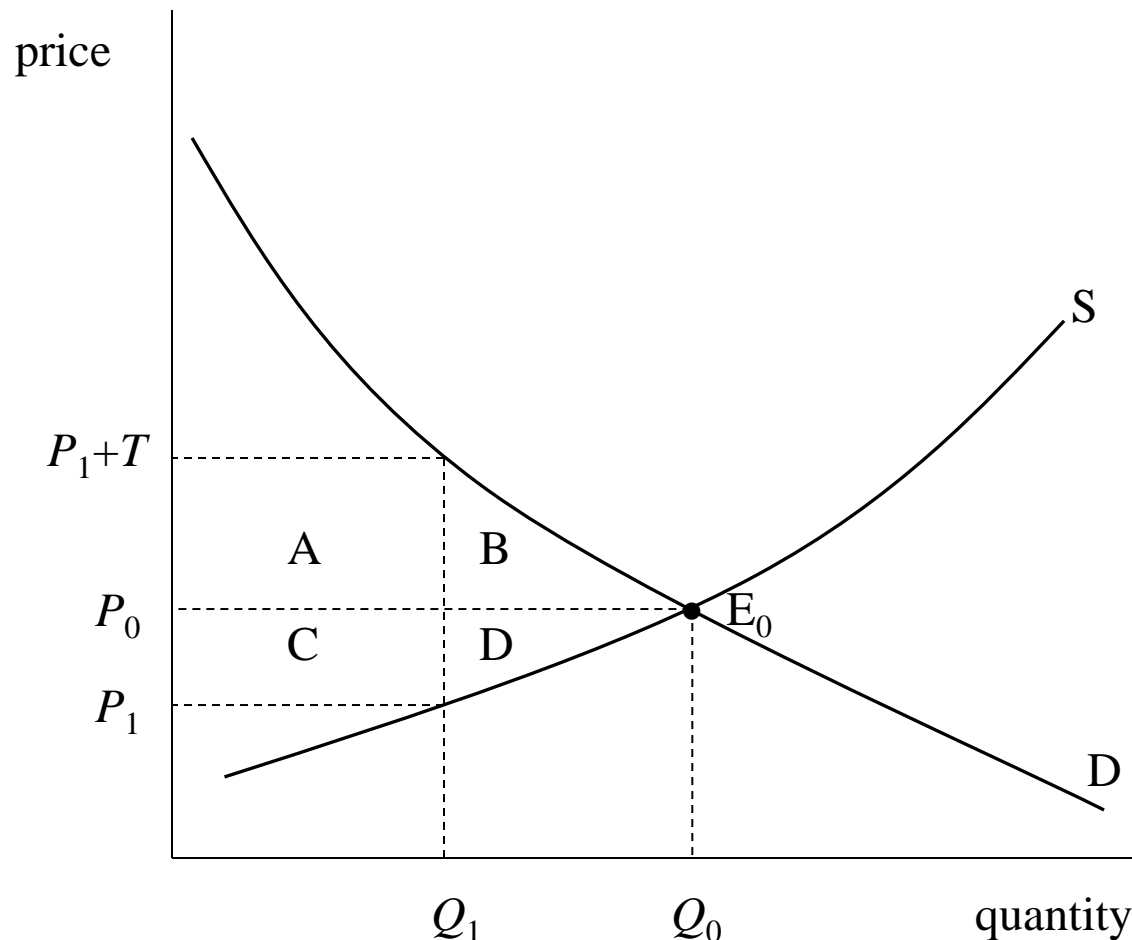
Deadweight Loss

Imposing a tax of size T reduces consumers' surplus by $A+B$ & producers' surplus by $C+D$; net of revenue $A+C$, the social loss (DWL) is $B+D$

This area is approximately a triangle, so its magnitude is roughly $-\frac{1}{2}T\Delta Q$

DWL arises here because transactions that would cost society less than their value to purchasers do not occur.

But a subsidy would cause DWL as well



Deadweight Loss

Most taxes are given as a percentage of the purchase price, so rewrite formula as:

$$DWL = -\frac{1}{2} \frac{T}{P} \Delta Q \cdot P$$

Now, multiply by $(T/P) \cdot (P/T) \cdot Q/Q$:

$$DWL = \frac{1}{2} \left(\frac{T}{P} \right)^2 \left(-\frac{\Delta Q}{T} \cdot \frac{P}{Q} \right) \cdot PQ = \frac{1}{2} t^2 \eta PQ$$

From this expression we see that DWL depends on three things:

Deadweight Loss

$$DWL = \frac{1}{2} t^2 \eta PQ$$

1. The size of the market, PQ
 - This makes sense, since we'd expect deadweight loss to double if the number of transactions doubles, other things being equal.

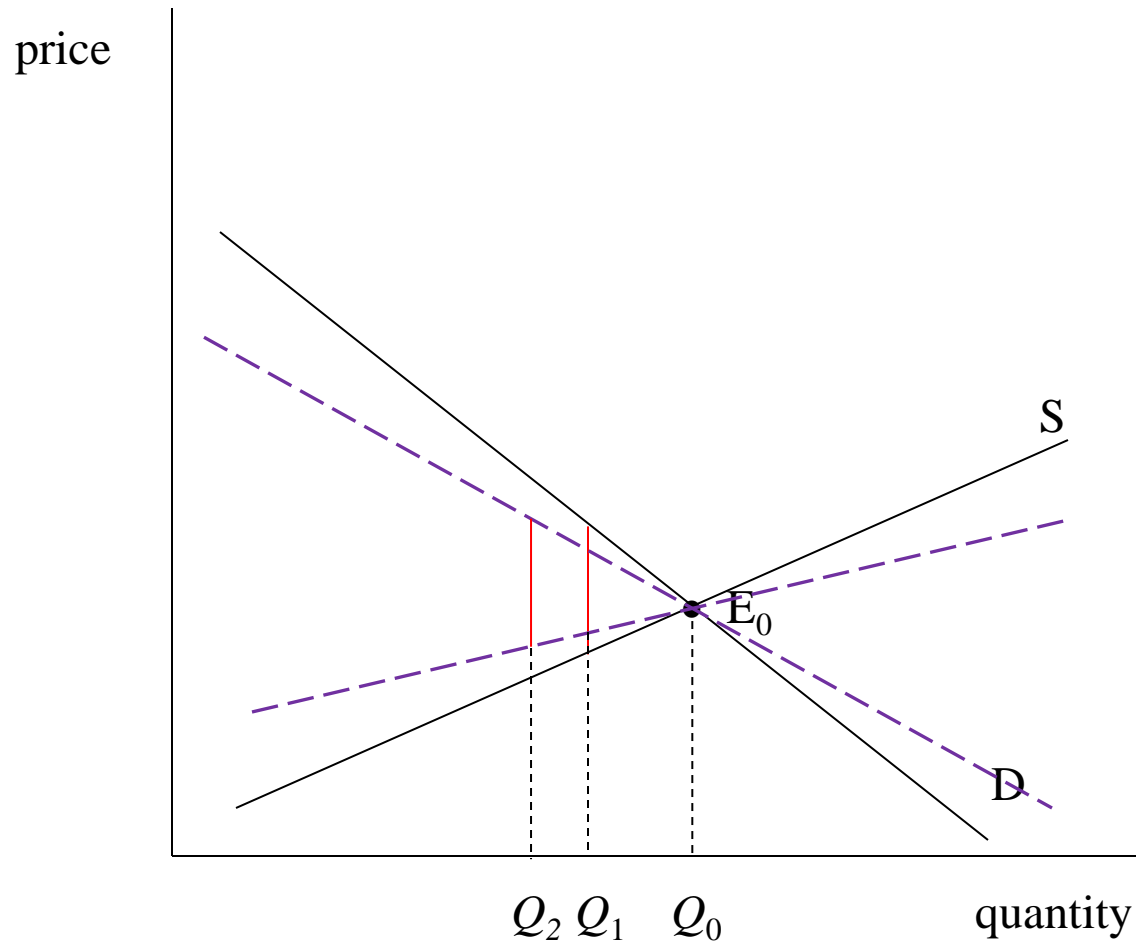
Deadweight Loss

$$DWL = \frac{1}{2} t^2 \eta PQ$$

1. The size of the market, PQ
2. The elasticity (e.g., flatness) of the demand and supply curves, η
 - For a given tax increase, more responsiveness on the demand or supply side will increase the change in behavior, and hence the number of “lost” transactions.

Deadweight Loss

With flatter demand and supply curves, imposing a tax of size T induces a bigger reduction in quantity, to Q_2 rather than to Q_1 .



Deadweight Loss

$$DWL = \frac{1}{2} t^2 \eta PQ$$

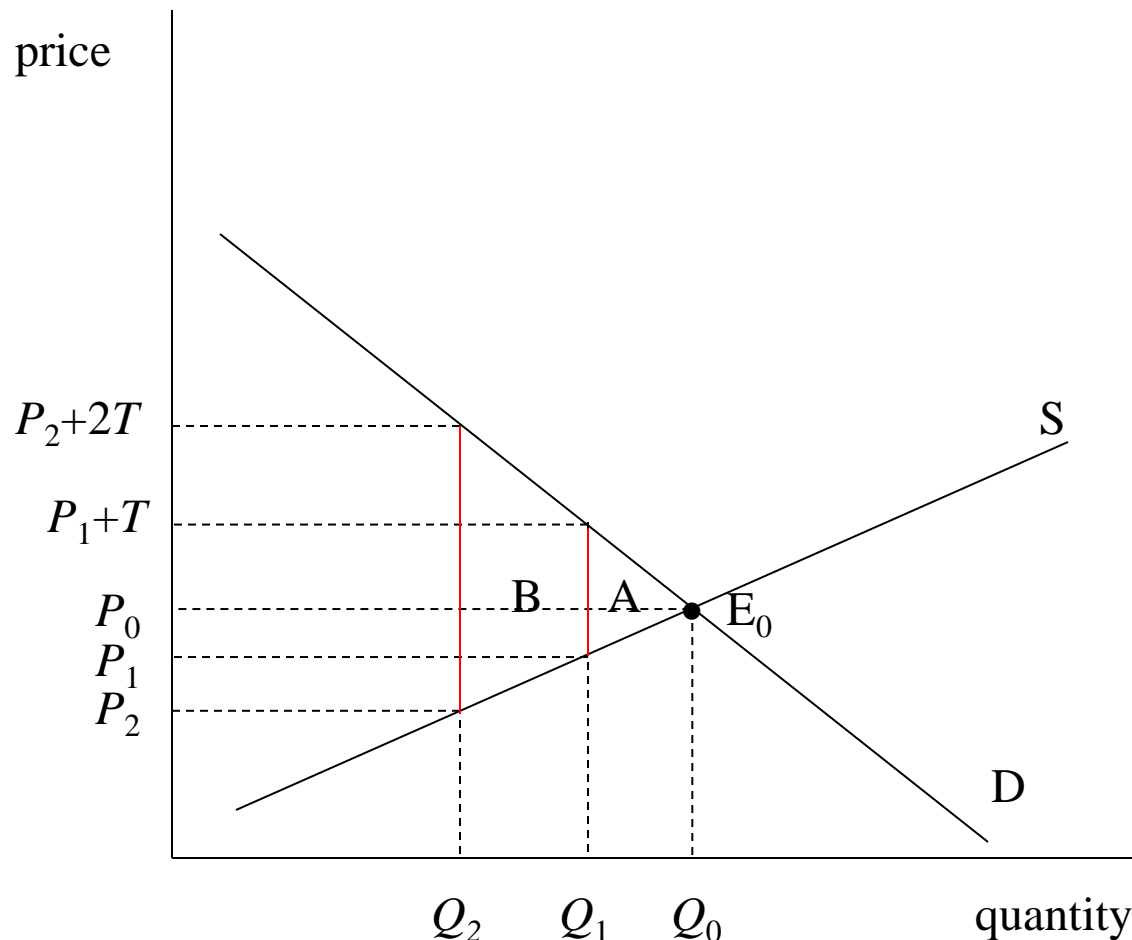
1. The size of the market, PQ
2. The elasticity (e.g., flatness) of the demand and supply curves, η
3. The square of the ad valorem tax rate, t
 - Because distortions are cumulative

Deadweight Loss

Imposing a tax of size T induces DWL of area A. Doubling the tax doubles the triangle's height *and* base, adding a trapezoidal area B, roughly three times the size of area A, to the total.

The additional quantity reduction costs society more because the gap between cost and valuation is increasing.

Another way of thinking about this higher cost is that the government is losing revenue on some previously taxed purchases.



Deadweight Loss

- We can also express DWL as:

$$DWL = \frac{1}{2} t \eta (tPQ)$$

- The last term in this expression is revenue, so DWL per dollar of revenue is $\frac{1}{2} t \eta$.
- The key question of optimal commodity taxation is how to minimize this DWL per dollar of revenue.

Optimal Taxation

Dividing through by revenue, we have:

$$\frac{DWL}{tPQ} = \frac{1}{2}t\eta$$

- To minimize overall DWL , we want each revenue source to have the same DWL per revenue dollar
 - This means we want to equalize $t\eta$ across taxes – to have $t \sim 1/\eta$. This is the basic intuition for the well-known “inverse elasticity rule.”

Optimal Taxation

- The formal derivation and applicable expression are more complicated. Still, the intuition of the inverse elasticity rule remains:
 - We want broad-based taxes to avoid cumulative effects of high tax rates on narrow bases.
 - But we should rely more on taxes where taxpayer responsiveness is lower.
- Keep in mind, though, that so far
 - We are considering only *DWL*, not equity
 - We are looking only at proportional taxes

An Example

- Suppose there are two commodities and one source of income, labor, so that the household faces the budget constraint:

$$p_1c_1 + p_2c_2 = wL$$

We can tax both goods and labor, but one instrument will be redundant, since a uniform consumption tax is equivalent to taxing labor:

$$(1+\tau)(p_1c_1 + p_2c_2) = wL \Rightarrow p_1c_1 + p_2c_2 = wL/(1+\tau)$$

So consider just consumption taxes, for now.

An Example

- Should we impose a uniform consumption tax, i.e., should the tax rates on the two goods be equal (i.e., raising the prices p_1 and p_2 proportionally)?
- In this setting, equal taxes on consumption will be most efficient only if the elasticities of c_1 and c_2 are the same; to be exact, only if they are equal complements to leisure.

Application: Capital Income Taxation

- We can think of the two consumption goods as being consumption at different dates; that is, if an individual works in the first period of life and saves for retirement consumption, c_2 , earning a rate of return, r , then the budget constraint is

$$c_2 = (1+r)(wL - c_1), \text{ or}$$

$$c_1 + 1/(1+r)c_2 = wL$$

Taxing capital income is equivalent to imposing a heavier tax on second period consumption.

Application: Capital Income Taxation

- Other issues:
 - With preexisting wealth, a consumption tax hits prior accumulation; a labor income tax does not.
 - Capital income taxes impose increasingly large distortions as saving horizon lengthens.
 - How to treat bequests

Application: Tax Treatment of the Family

- Consider three-good example again, now with one good & two types of labor (e.g., spouses):

$$pc = w_1L_1 + w_2L_2$$

Now, the two taxes on labor should be the same only if elasticities are the same.

- Other issues:
 - Nature of family decision making
 - Joint vs. single filing
 - Assortative mating (relevant for equity)

Application: Sales Taxes

- States rely heavily on sales taxes for revenue.
- Sales tax bases exclude a lot of purchases.
 - Services
 - Necessities
- Should services be exempt from tax?
 - Requires conditions on demand that are unlikely to be satisfied

Application: Sales Taxes

- States rely heavily on sales taxes for revenue.
- Sales tax bases exclude a lot of purchases.
 - Services
 - Necessities
- Should necessities be free of tax?
 - Justification: to make the tax more progressive
 - If sales tax were the only instrument, this *might* make sense – weigh equity vs. efficiency
- But, as we will see, it's likely we can do better.

Application: Sales Taxes

- States rely heavily on sales taxes for revenue.
- Sales tax bases *include* a lot of business purchases.
- In general, we'd like to avoid taxing inputs.
 - These taxes distort the production process, and so move us inside the *PPF*
 - Generally better to tax final sales (Diamond-Mirrlees): achieve same objective, but stay on *PPF*
 - But, if we don't tax final sales (e.g., services), maybe it's helpful to tax some inputs

Summary

- Role for government:
 - Correct market failures
 - Effect redistribution
- We calculate deadweight loss to measure departures from Pareto efficiency.
- Optimal taxes are those that minimize deadweight loss, given our objectives; their form depends on objectives (equity vs. efficiency) and available instruments.