4. Calculating Costs and Benefits

Outline

4.1 Introduction

- Key CBA question: does a policy lead to an increase in social surplus?
- Outputs are valued in terms of their social benefit (as measured by WTP).
- Inputs are valued in terms of opportunity cost (as measured by WTA).
- We begin by characterizing the costs and benefits of a market-produced good and the relationship to social surplus.
- We will develop two key concepts:
  - consumer surplus
  - producer surplus

4.2 Consumer Surplus

- The *demand curve* for an individual measures her WTP for the good; it reflects her *MPB* from consumption of the good.
- The negative slope of the demand curve reflects diminishing *MPB* from consumption.
- See Figure 4.1
- Suppose price = 10. Then the consumer will buy 25 units.
- The total private benefit from consumption of the 25 units is measured by the area under the demand curve up to that level.
- See Figure 4.2
- Consumer surplus (CS) measures the difference between the total private benefit received from consumption and the amount actually paid.
- Thus, CS measures the net private benefit to consumer.
- See Figure 4.3

Aggregation

- An aggregate demand curve can be constructed by summing individual demands.
- The consumer surplus measure under an aggregate demand curve reflects the aggregate net benefit to all the consumers.
- See Figure 4.4

- See Supplementary Module S4.1

4.3 Producer Surplus

- The *supply curve* for the supplier of a good reflects her WTA to part with the good; her private opportunity cost.
- In competitive markets, the supply curve reflects the marginal cost of production.
- See Figure 4.5
- Suppose price = 10. Then the supplier is willing to supply 25 units.
- The total payment needed to just compensate the supplier (the total private opportunity cost) is the area under the supply curve up to that level.
- See Figure 4.6
- *Producer surplus* (PS) measures the difference between the payment actually received by the supplier and the minimum payment she would be willing to accept.
- Thus, PS measures the private net benefit to the supplier (the difference between revenue and opportunity cost).
- See Figure 4.7
- Producer surplus is often called *economic rent.*
- Note that the area under the supply curve represents total variable cost; thus, PS is equal to profit plus fixed costs.

Aggregation

- An aggregate supply curve can be constructed by summing individual supply curves.
- The producer surplus measure from an aggregate supply curve reflects the aggregate net benefit to all the suppliers.
- See Figure 4.8
- See Supplementary Module S4.2

4.4 Market Equilibrium and Social Surplus

- Equilibrium in a perfectly competitive market occurs where the price equates supply and demand.
- Social surplus in the market
  = consumer surplus + producers surplus
- See Figure 4.9
- Recall the first welfare theorem: perfectly competitive market allocations are Pareto efficient.
- That is, social surplus is maximized at the competitive market equilibrium; the value of the marginal unit is just equal to its opportunity cost.
- See Figures 4.10 and 4.11

4.5 Using Market Prices in CBA

- The equilibrium market price in the perfectly competitive market measures:
  - the social benefit of the marginal unit
  - the opportunity cost of the marginal unit
- Thus, for CBA we can generally use market prices to value benefits and costs if
  - the relevant markets are perfectly competitive; and
  - the policy does not cause prices to change.
- Under these conditions:
  - the social cost of an input is equal to its market price;
  - the social benefit of an output is equal to its market price.
- It is generally not appropriate to use market prices when:
  - the policy has price effects; or
  - markets are distorted (or non-existent)

4.6 Calculating Costs When There Are Prices Effects

- Suppose a project draws a very large amount of input from a market with a steeply sloped supply curve.
- Then the market price of the input is likely to rise.
- See Figure 4.12 and Table 4.1
- An alternative way of thinking about it:
  - the project usage of the input is drawn partly from an increase in supply and partly from displaced consumption by existing buyers.
- See Figures 4.13 and 4.14
- Thus, the opportunity cost of the input is slightly less than the financial outlay by the agency.
- A reasonable approximation to the true social opportunity cost can be obtained by using an average of the pre- and (estimated) post-project prices to calculate cost.

4.7 Calculating Costs When Input Markets Are Distorted

- If markets are distorted then the equilibrium market price will generally not reflect the true marginal social cost or benefit of the resource.
- Main sources of distortion:
  - market failure
  - government intervention (eg. taxes, price controls)
- An input drawn from a distorted market should be valued at its true opportunity social cost or *shadow price*.

- Examples examined:
  - taxes
  - unemployed labour
  - pollution generated in supply
- Assume no price effects.

Taxes

- Consider an input drawn from a market in which there is a sales tax.
- Example:
  - price before tax: $20 per unit
  - price after tax: $25 per unit
- Which is the appropriate shadow price?
- Answer depends on whether or not the tax revenue collected stays within the referent group.
- If tax revenue stays within the referent group:
  - shadow price = before-tax price ($20)

  Note that this is the price actually received by the supplier.
- If tax revenue flows outside the referent group:
  - shadow price = after-tax price ($25)

Unemployed labour

- Unemployment (an excess supply of labour at the prevailing wage) occurs because of some market friction or government regulation that stops the wage from falling to equate supply and demand.
- Thus, the prevailing market wage overestimates the true opportunity cost of using unemployed labour.
- One possible approach: assume that opportunity cost of unemployed labour is zero; likely an underestimate.
- A reasonable approximation:
  - shadow price of unemployed labour

    = 1/2*market wage
- Treatment of income and payroll taxes:
  - calculate shadow price using the after-tax wage
  - include any tax payments that flow outside the referent group as an additional cost (tax payments that remain inside the referent group are just transfers).
- Treatment of unemployment insurance payments:
  - if referent government makes UI payments then UI payments saved are just transfers (because they are gained by the government but lost by the newly employed workers)

- if UI payments are made by a government outside the referent then UI payments given up by the newly employed workers are a cost of the project (because they no longer flow into the referent group).

- See Supplementary Module S4.3

Pollution generated in supply of an input

- Suppose the production of an input generates pollution, and that pollution is not properly regulated (eg. electricity).
- The market price of the input will not include the social cost of the pollution; it is external to the supplier of the input.
- Shadow price
  = market price of the input
  + marginal pollution cost
- Alternative approach:
  - use market price and include pollution costs in a separate "environmental costs" category in the CBA.

4.8 Calculating Benefits When There Are Price Effects

- We will consider two examples (both assuming undistorted markets):
  - a direct addition to supply
  - a cost reduction for private supply

Direct addition to supply

- Suppose the project produces an increase in the supply of a good that is already supplied in the market.
- Suppose the supply increase is large enough to cause a fall in the market price.
- This means the project will "crowd out" some existing private supply.

  See Figures 4.15 – 4.18
- Thus, the benefit from the project supply is somewhat greater than the financial value of that supply (at the new market price).
- A reasonable approximation to the true social benefit can be obtained by using an average of the pre- and (estimated) post-project prices to calculate value.

Cost reduction for private supply

- Example: public infrastructure investment can reduce the costs of private sector production.
- Cost reduction reflected in a downward shift of the market supply curve.
- See Figure 4.19
- Two equivalent ways to calculate the benefit:
  (a) benefit
  = gain in consumer surplus
  + net gain in producer surplus
  See Figures 4.20 – 4.22

  (b) benefit
  = cost reduction for existing supply
  + net surplus from new supply
  See Figure 4.23

4.9 Calculating Benefits When Output Markets Are Distorted

- Common rationale for intervention is to supply goods that are often not provided efficiently by the market.
- Important examples:
  - basic education
  - health services
  - transportation services
  - some public utilities
  - environmental services

Supply of a good with a positive externality

- Consider a government program to subsidize market provision (eg. vouchers for contagious disease immunization or early childhood nutrition)
- Subsidy effectively reduces the price paid by consumers.
- The case illustrated is an optimal subsidy (see Supplementary Module S4.4)
- See Figure 4.24

Important examples:

- the value of changes in risk of death
- morbidity costs
- time costs
- environmental impacts

- The legitimacy of using pre-existing estimates depends on the similarity between the particular application and the setting under which the estimates were derived.

The value of a "statistical life"

A *specific life* is the life of an identifiable individual.

- Placing a value on a specific life is beyond the realm of CBA; it is an issue of property rights with extreme outcomes (WTP vs. WTA).
- In most policy problems, lives saved (or not saved) are anonymous; these are *statistical lives*.
- Example:
  - highway upgrade project is expected to reduce traffic deaths from 4 in 100,000 trips to 3 per 1000,000 trips.
  - Based on 1 million trips per year, there are an average of 10 statistical lives saved per year.
- The value of a statistical life is measured in terms of the value of small changes in the risk of death.
- Example:
  - a person is WTP $20 to reduce the risk of death by 1 in 100,000.
  - the implied value of their statistical life is
    $20 * 100,000 = $2m
- A variety of *non-market valuation techniques* can be used to estimate WTP values for reduced risk of death.
- The same sort of techniques are used to calculate environmental values.

4.11 The Cost of Funds

- Public projects and policies are usually funded by taxes or debt (deferred taxation).
- Raising revenue via taxes is costly, for two reasons:
  - administrative cost; and much more importantly
  - loss of social surplus due to the distortion of incentives (“deadweight losses”).

  Each dollar of revenue raised through taxes takes more than one dollar of surplus out of the private economy.
- The amount of surplus removed when one dollar of revenue is raised is called the marginal cost of funds (MCF).
- Estimates of the MCF for the US: 1.3 - 1.5
- See Figure 4.25 and Table 4.2
- In principle, the cost of funds should be included as a cost of any public project or policy:
  - cost of funds = (MCF-1)*(net financial cost to the government).
- This is rarely done in practice, but it should be done.

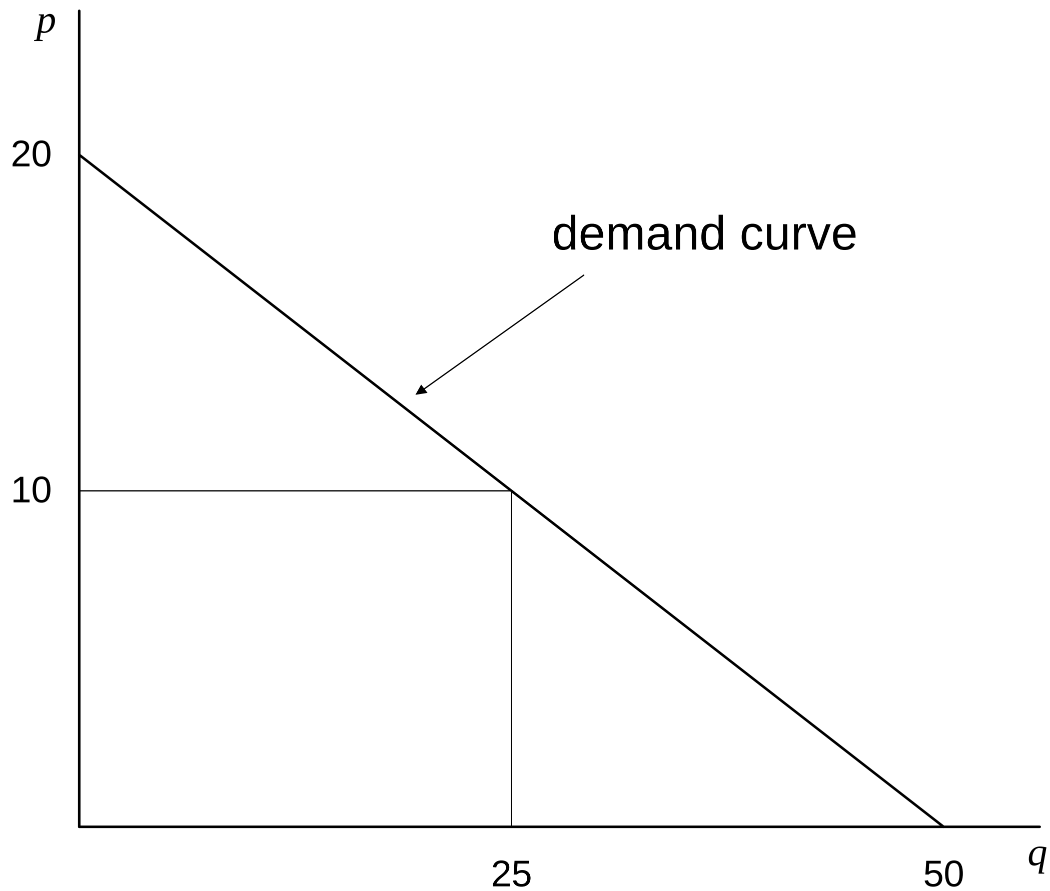


Figure 4.1

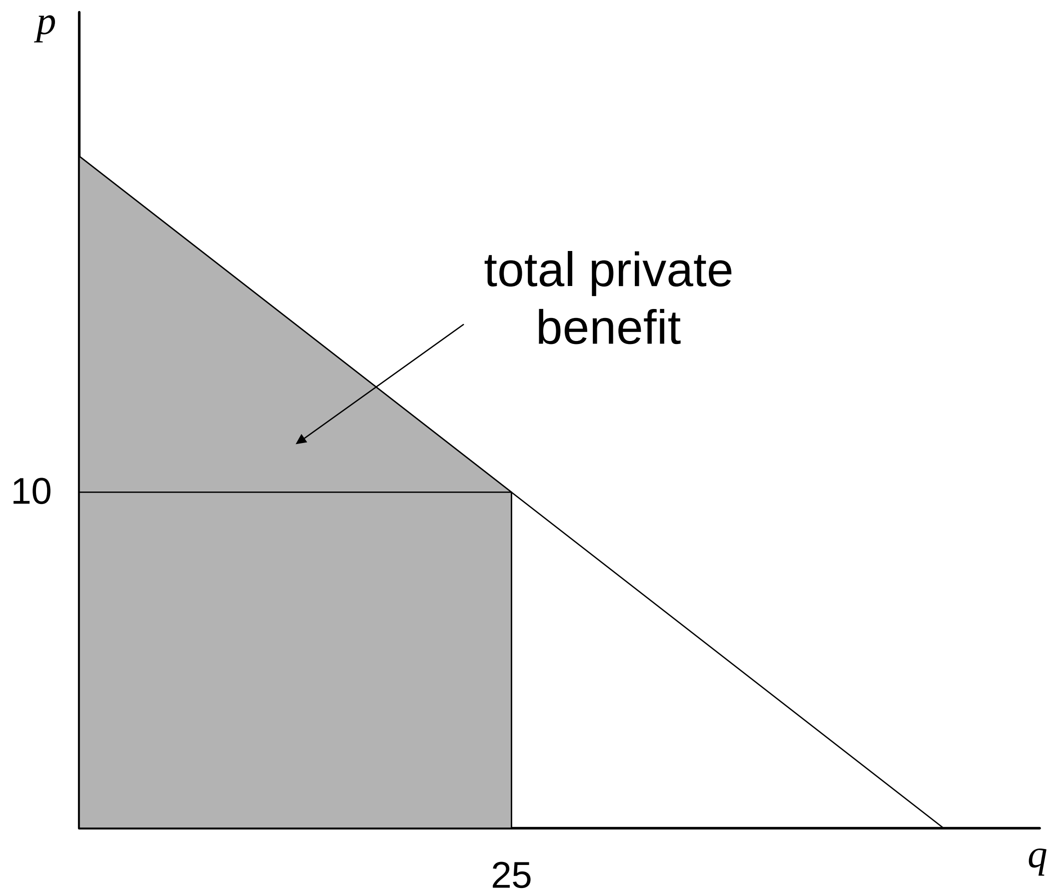
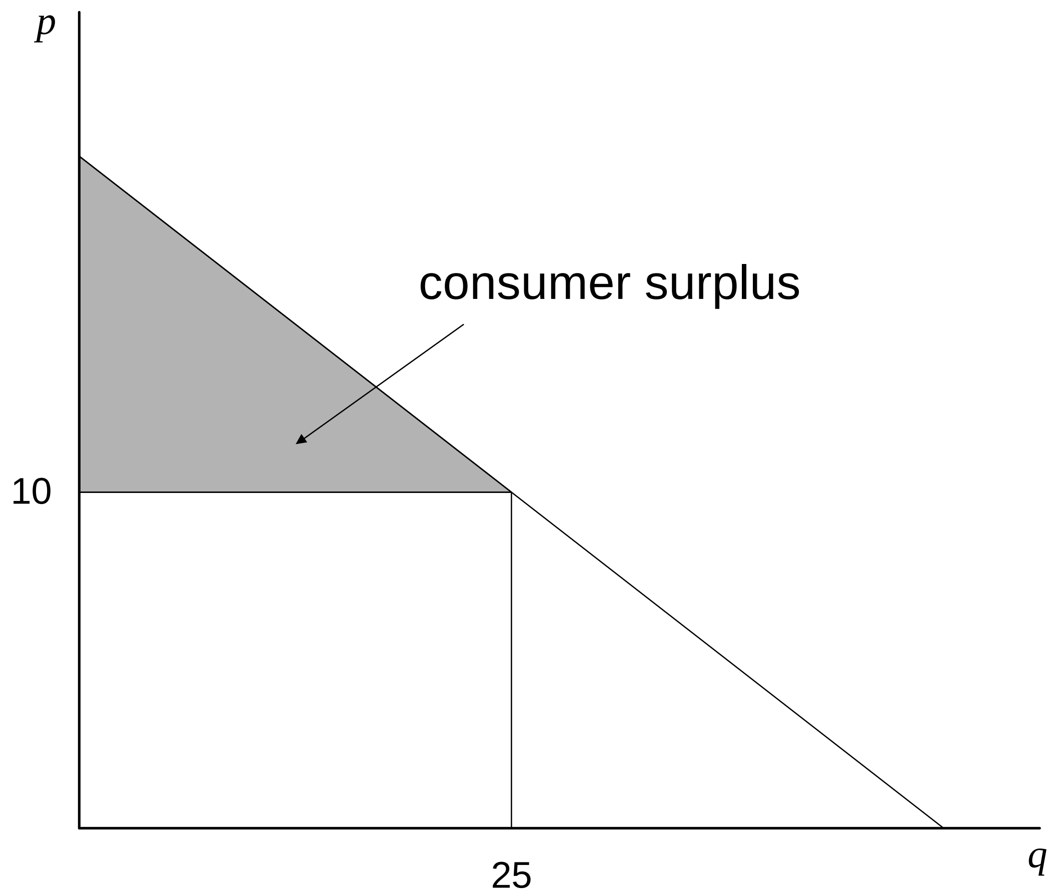


Figure 4.2



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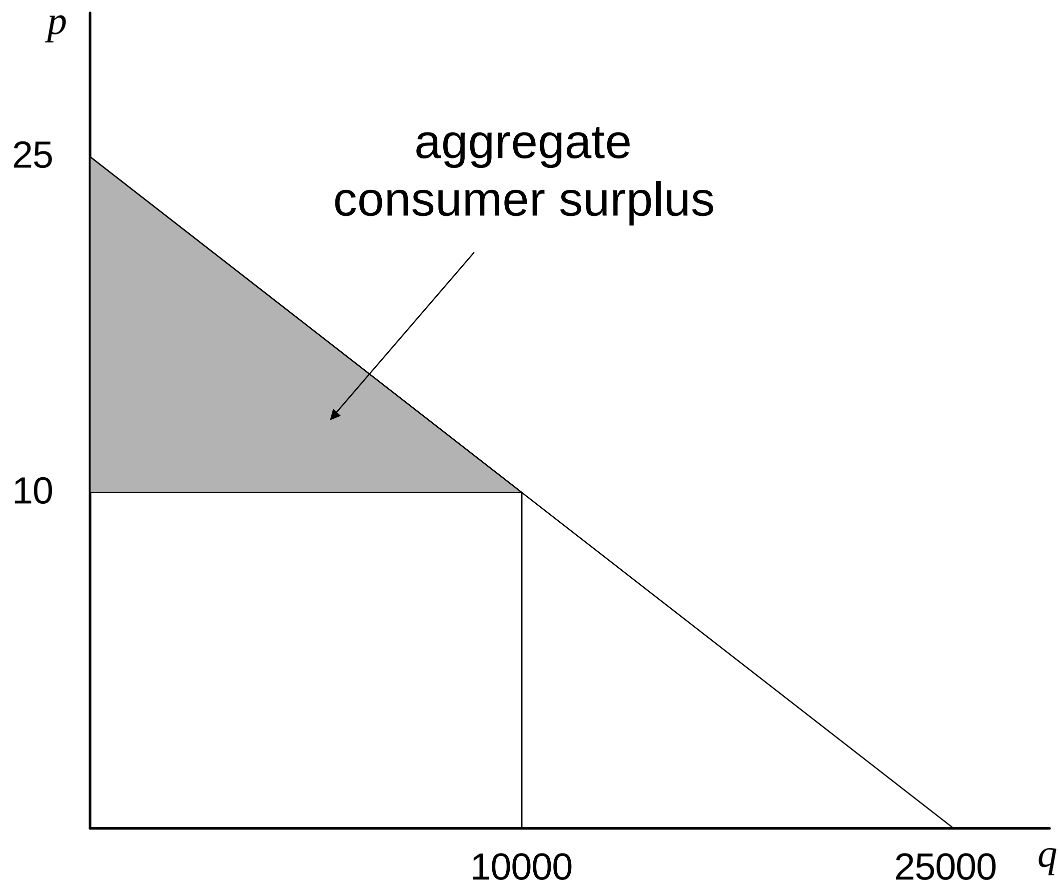

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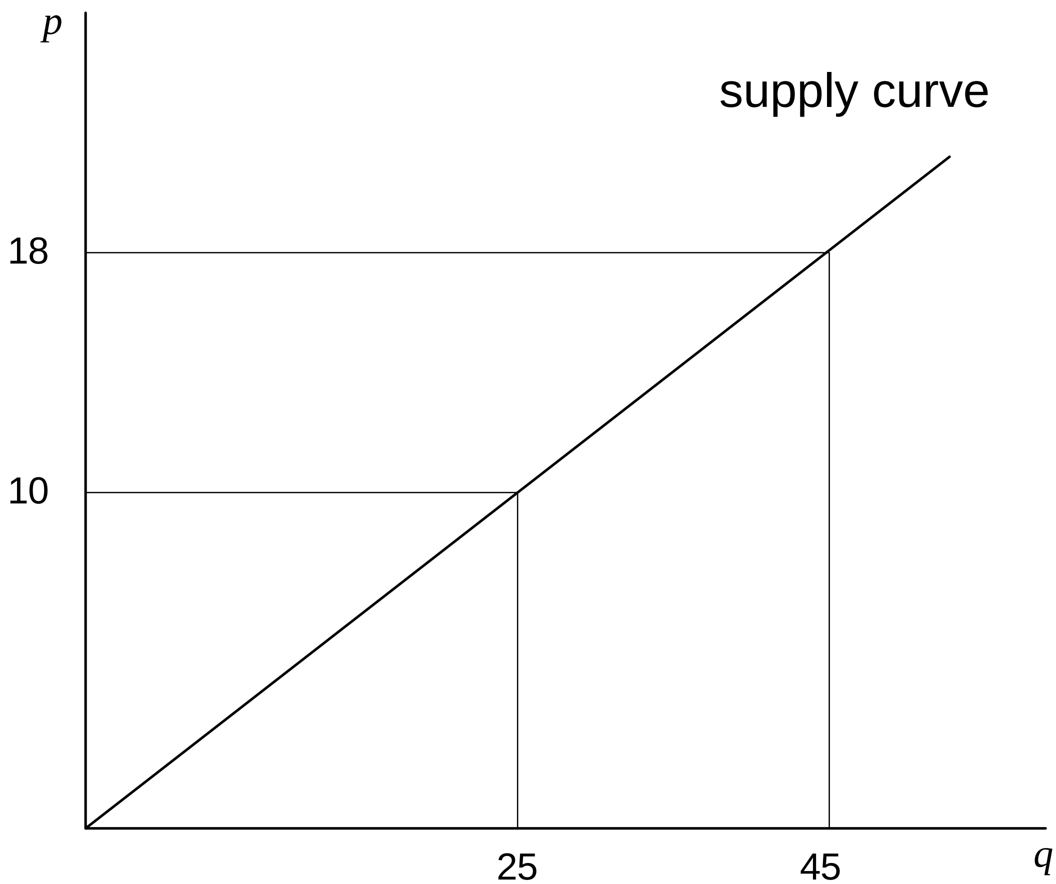

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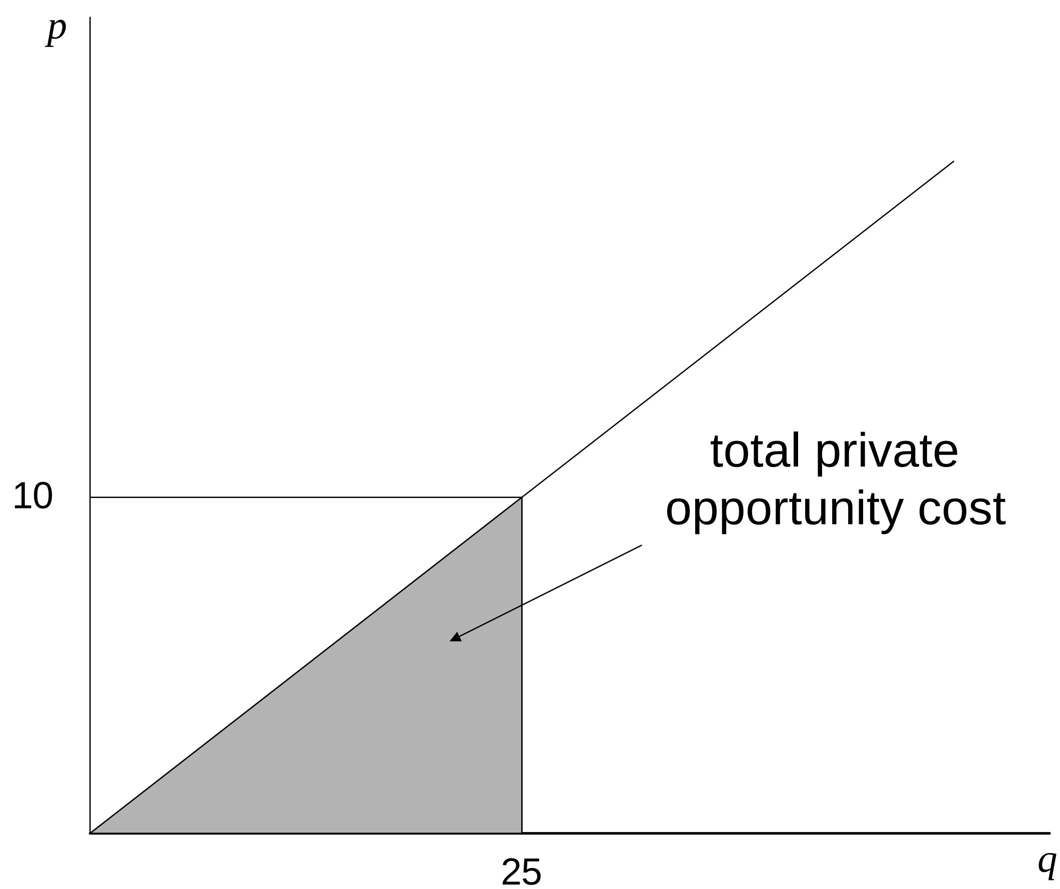

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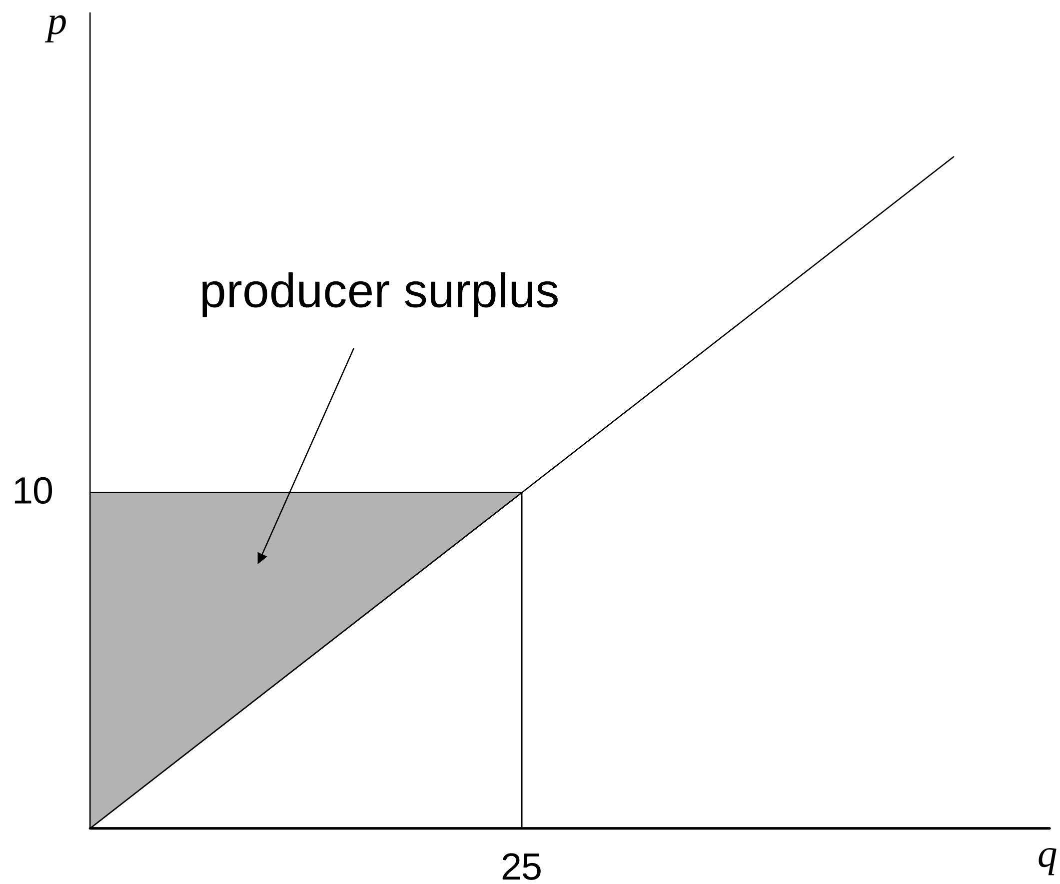

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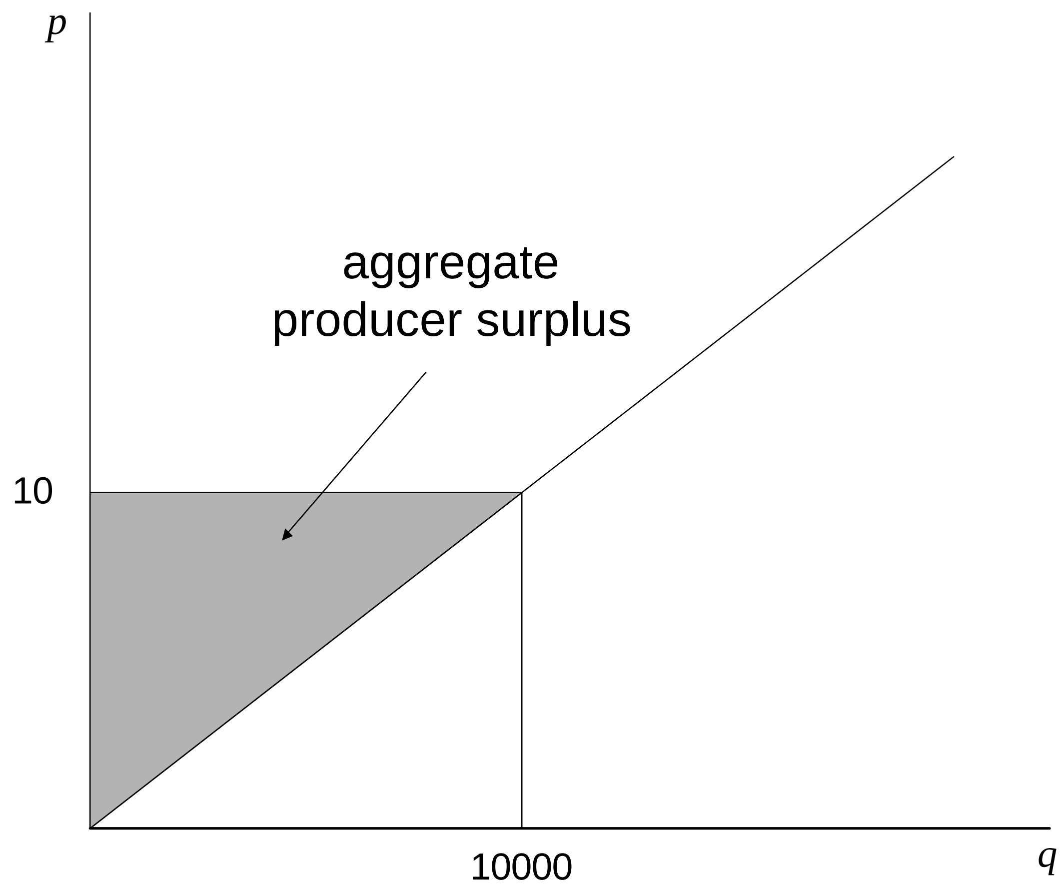

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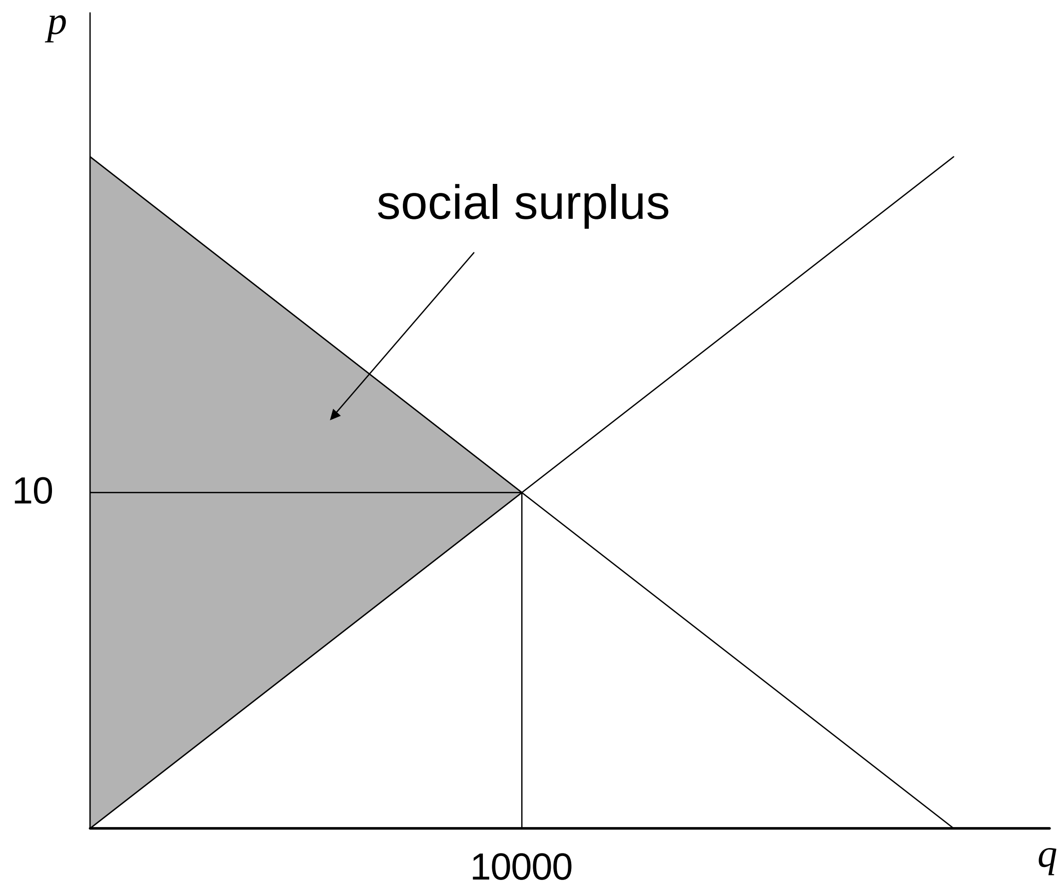

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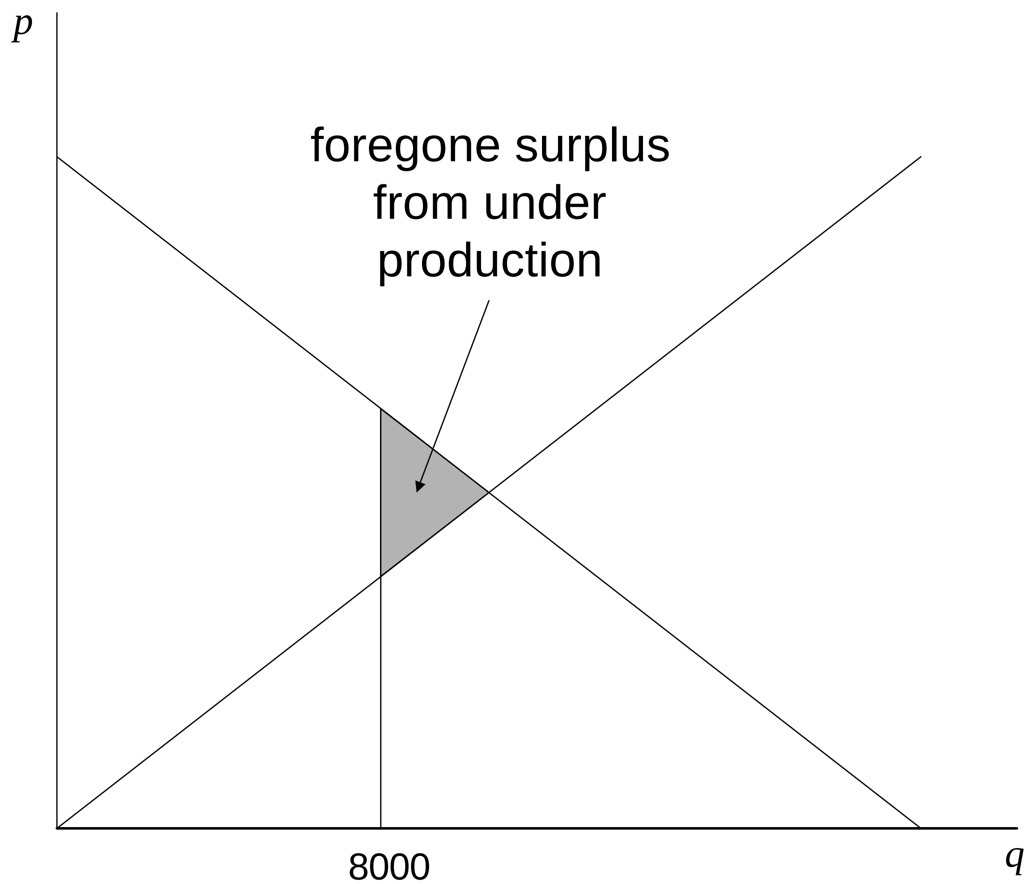

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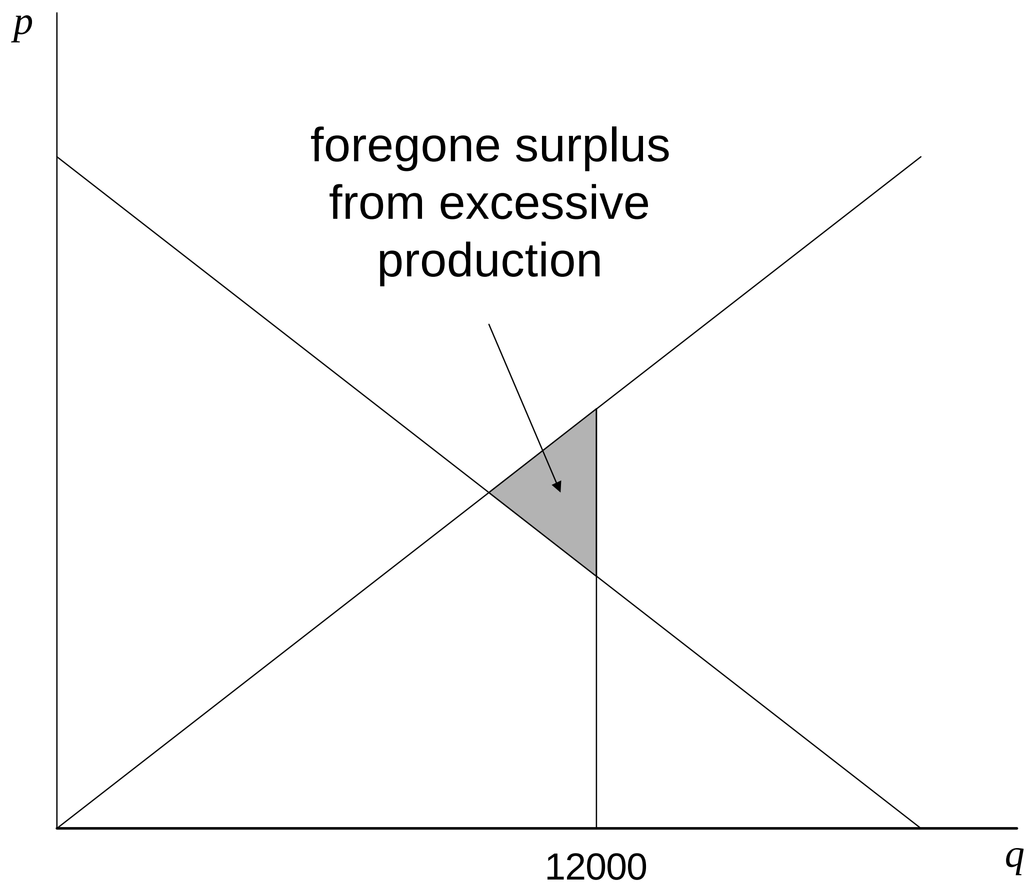

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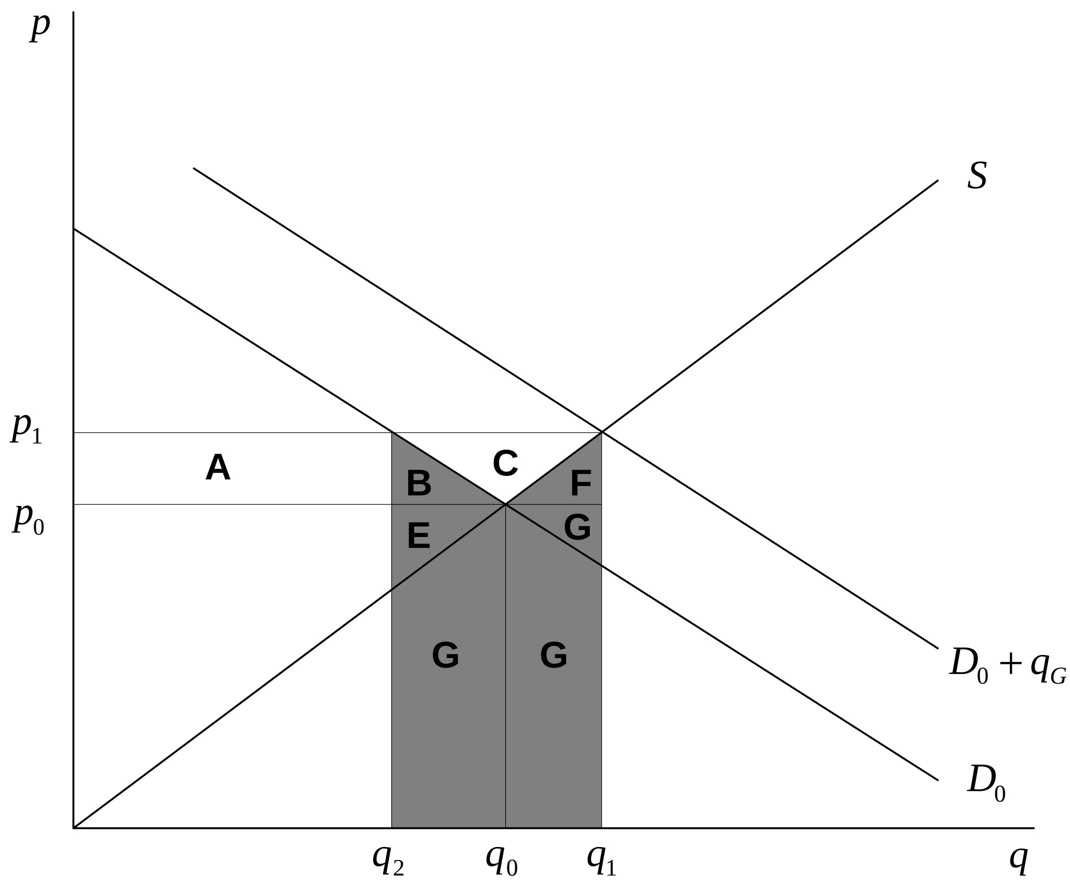

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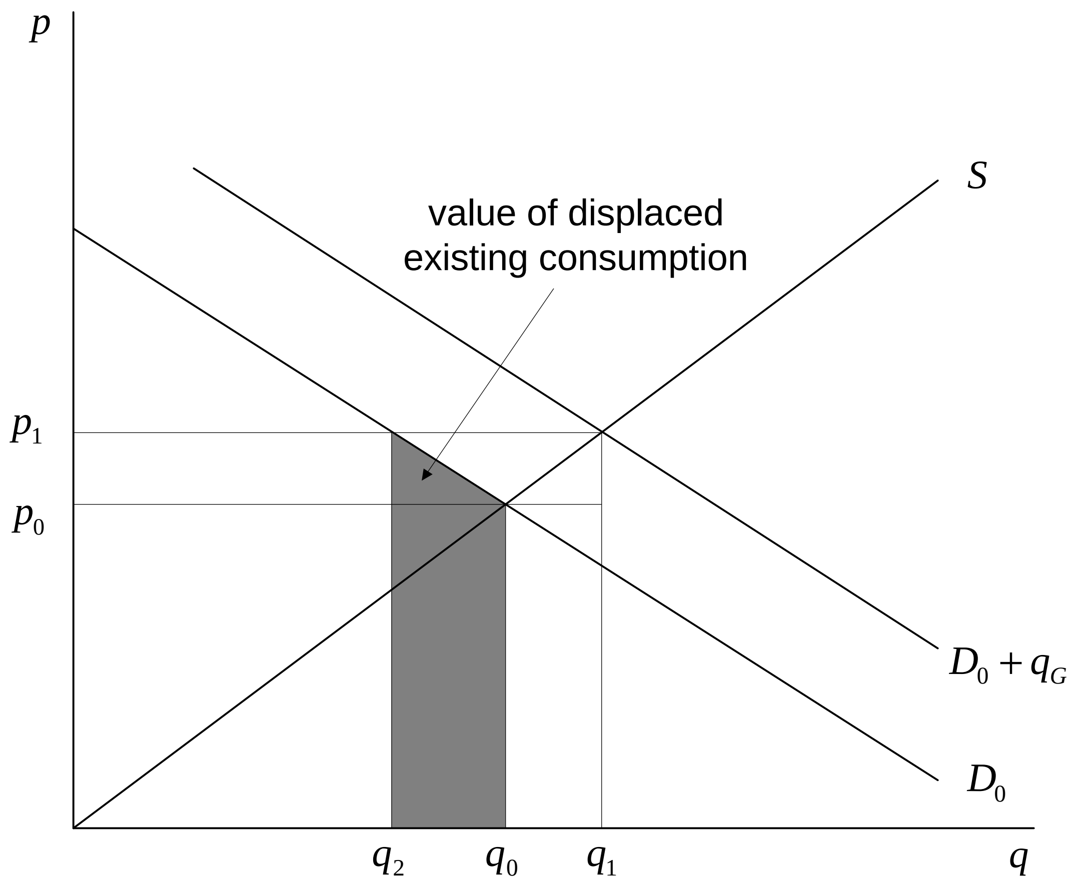
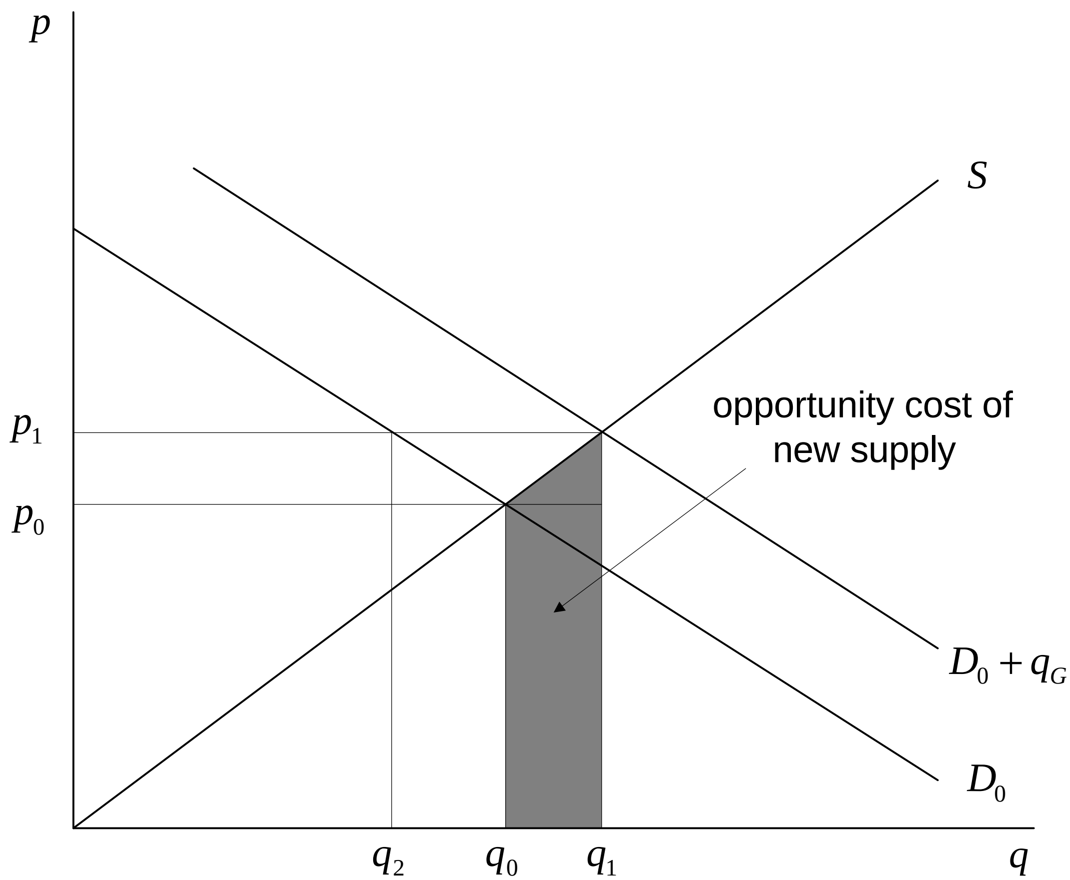

p
S
value of displaced
existing consumption
p_1
p_0
$D_0 + q_G$
D_0
q_2
q_0
q_1
q

Figure 4.13



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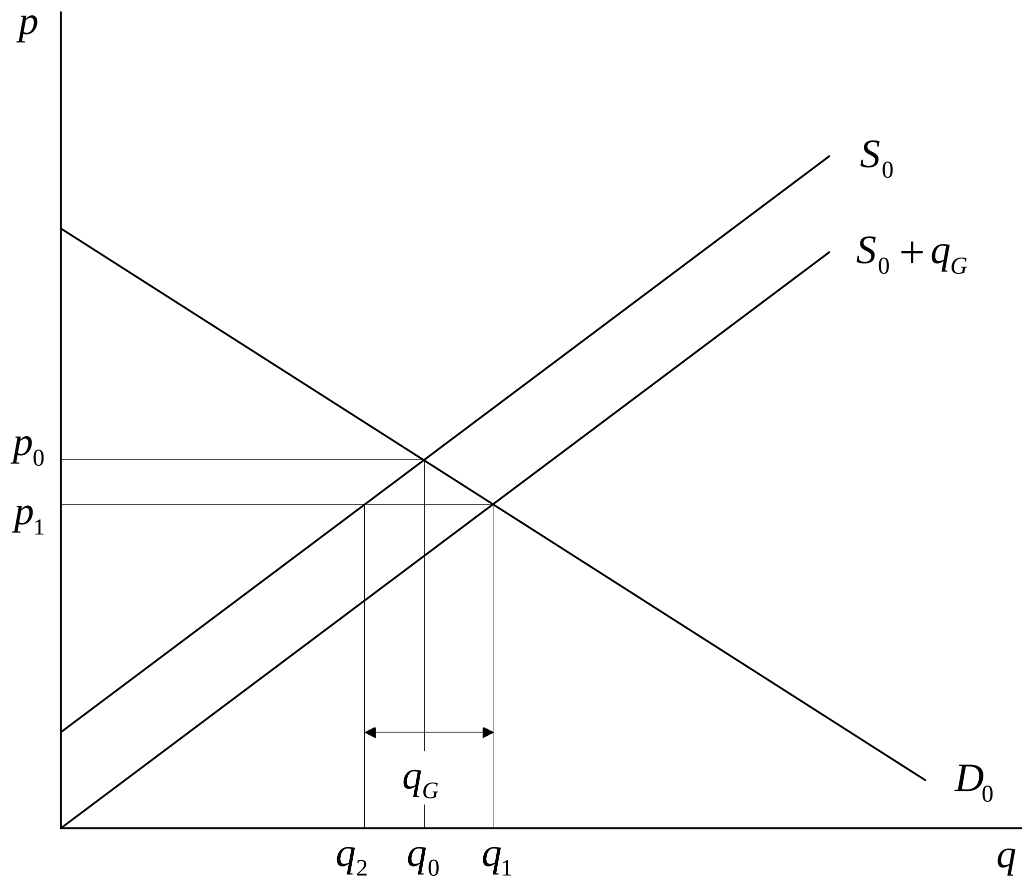

Figure 4.15

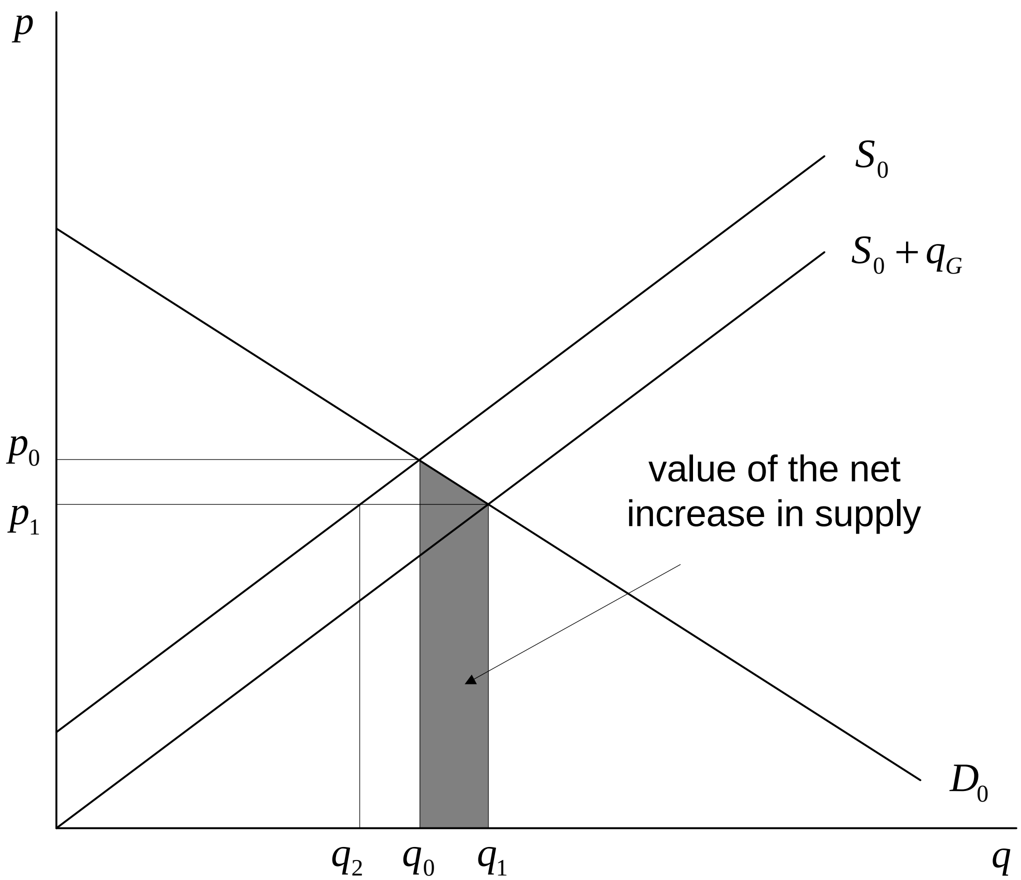

Figure 4.16

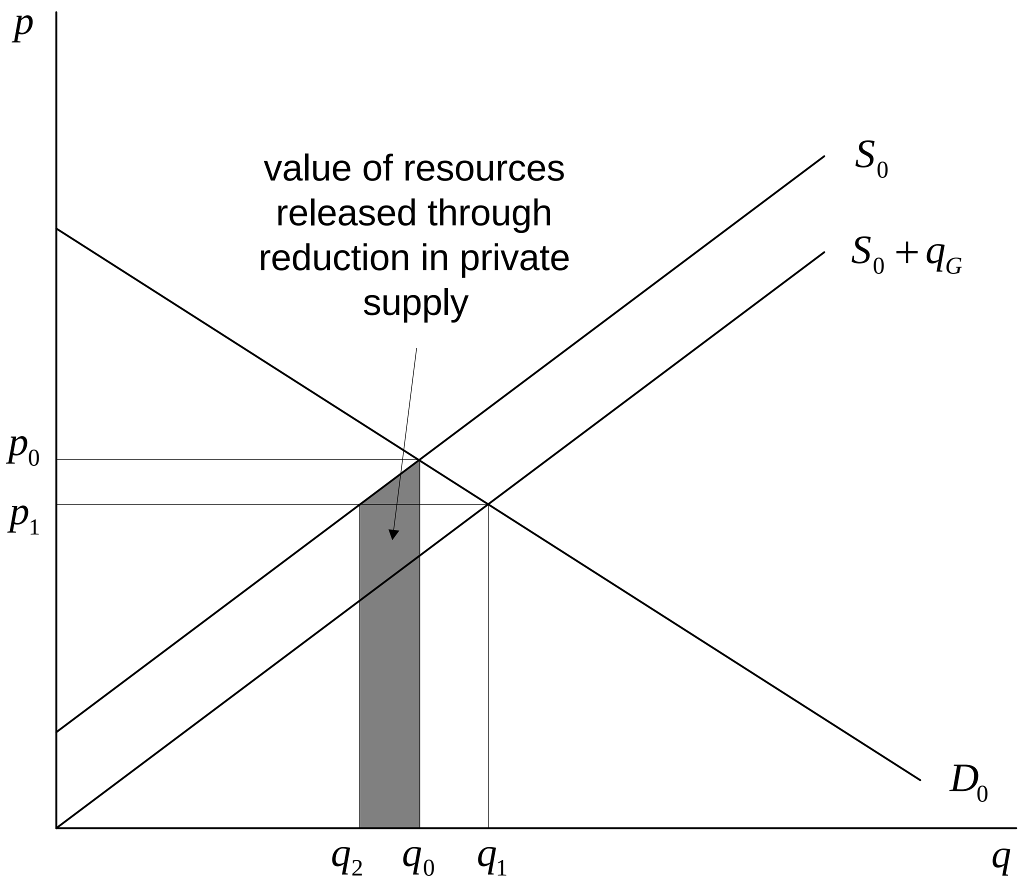
p
value of resources
released through
reduction in private
supply
S_0
$S_0 + q_G$
p_0
p_1
D_0
q_2
q_0
q_1
q

Figure 4.17

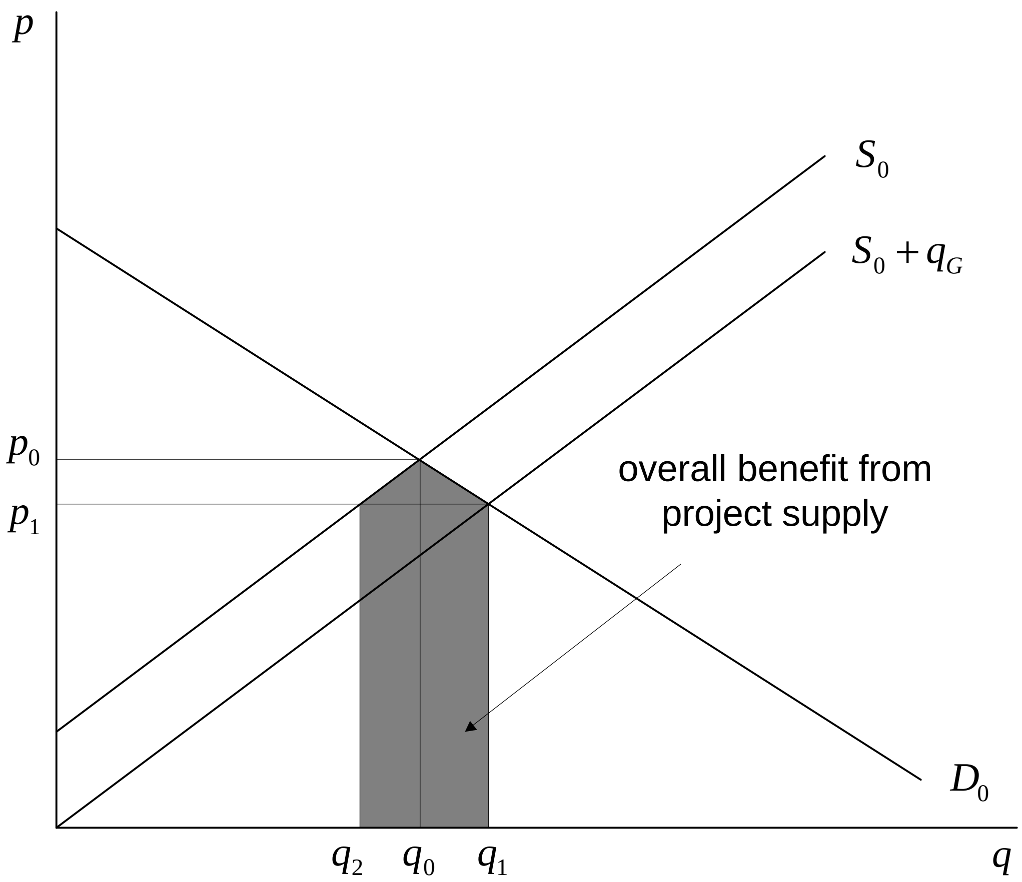
p
S0
S0 + qG
p0
p1
overall benefit from project supply
D0
q2 q0 q1
q

Figure 4.18

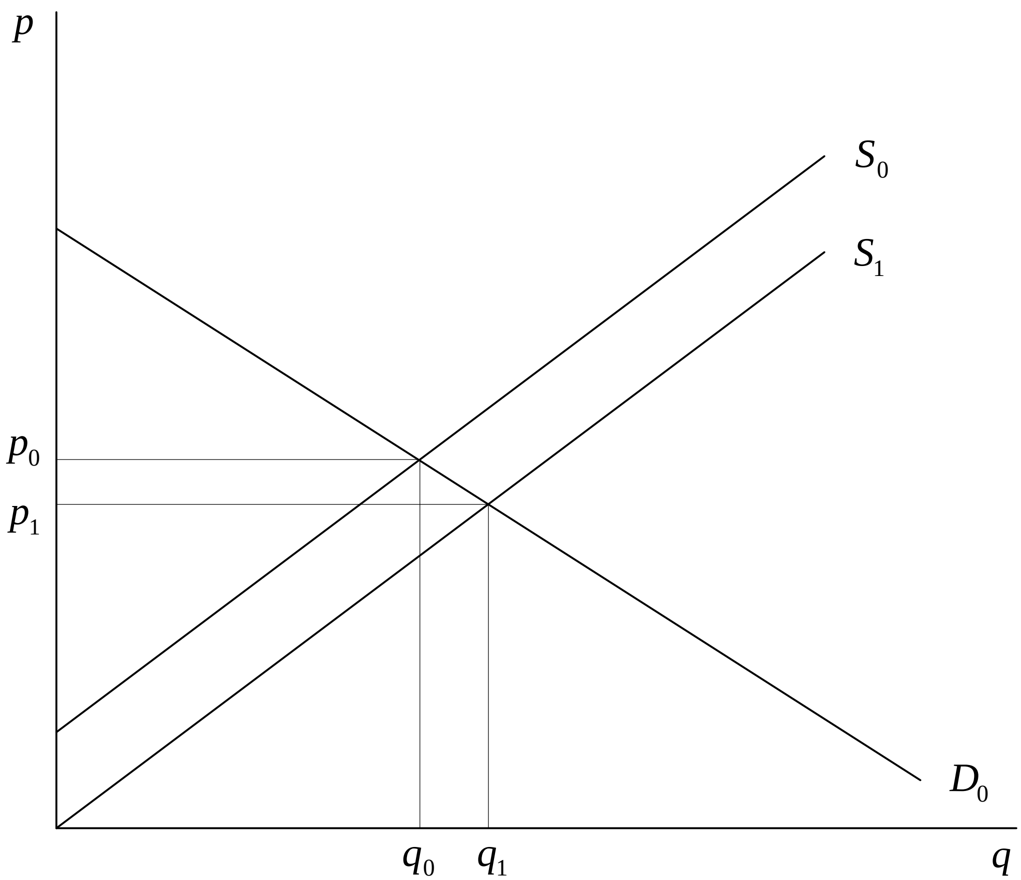

Figure 4.19

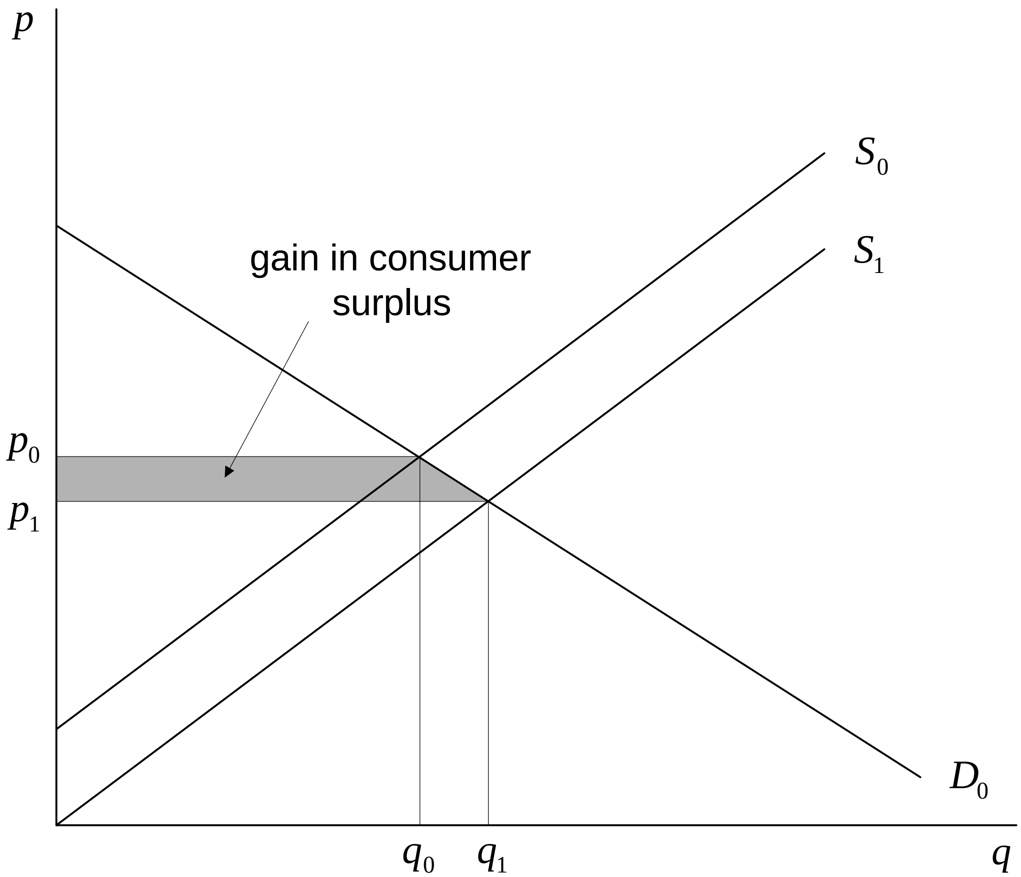

Figure 4.20

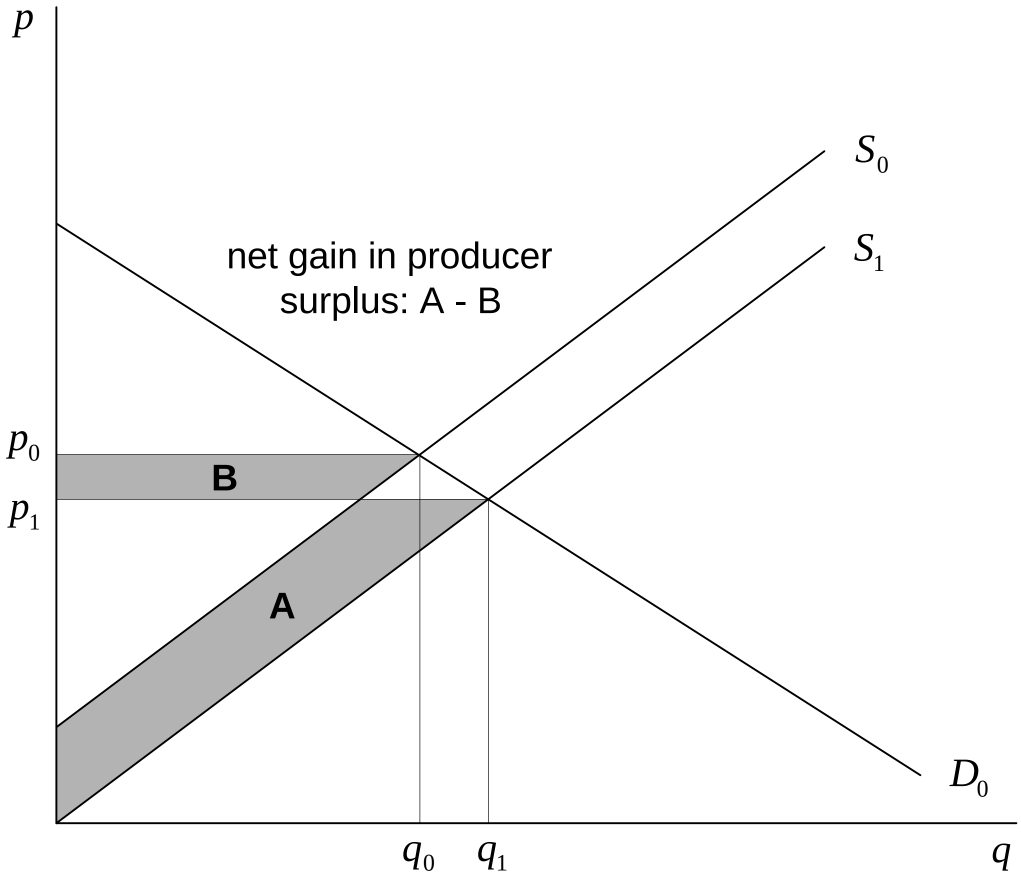

Figure 4.21

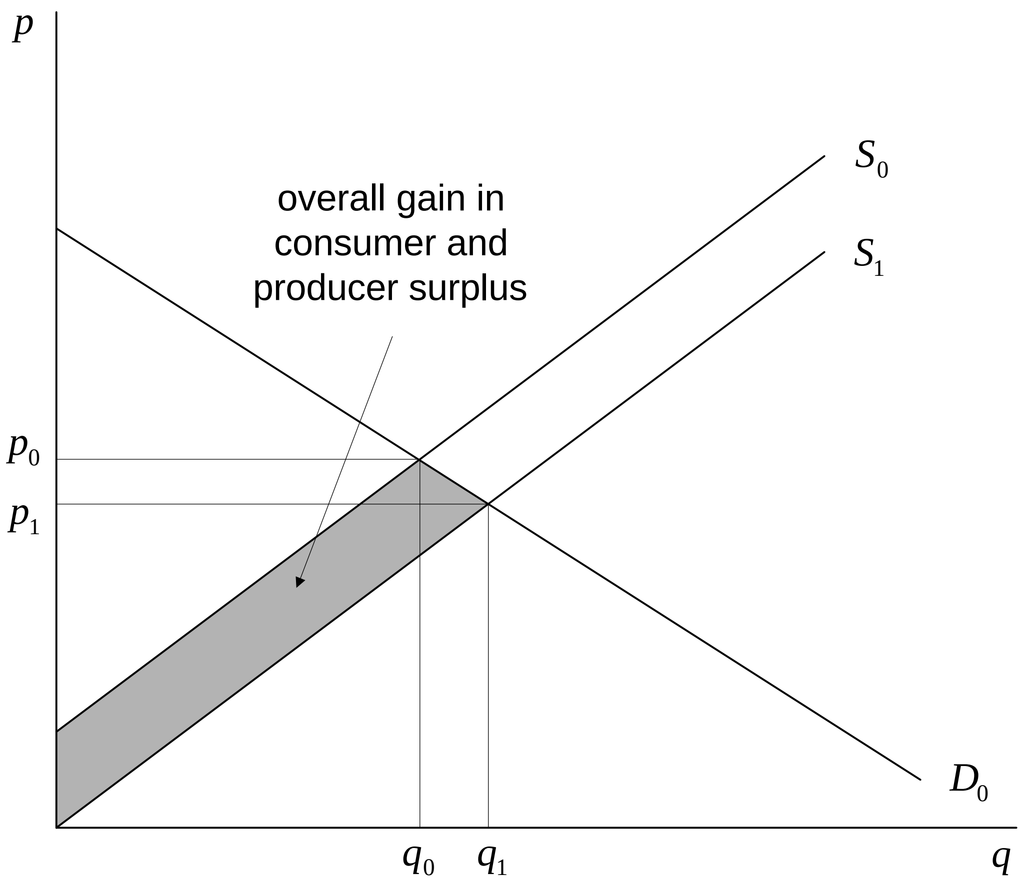
p
S0
S1
overall gain in
consumer and
producer surplus
p0
p1
D0
q0
q1
q

Figure 4.22

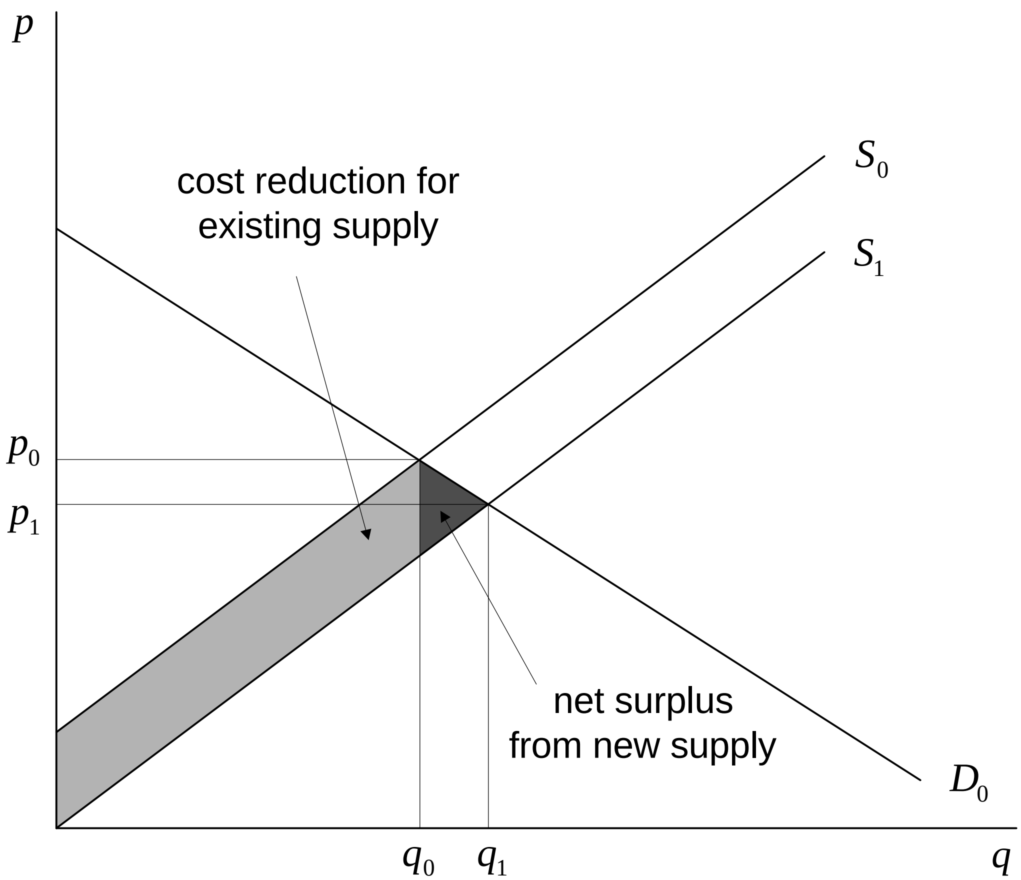
p
S0
S1
cost reduction for
existing supply
p0
p1
net surplus
from new supply
D0
q0
q1
q

Figure 4.23

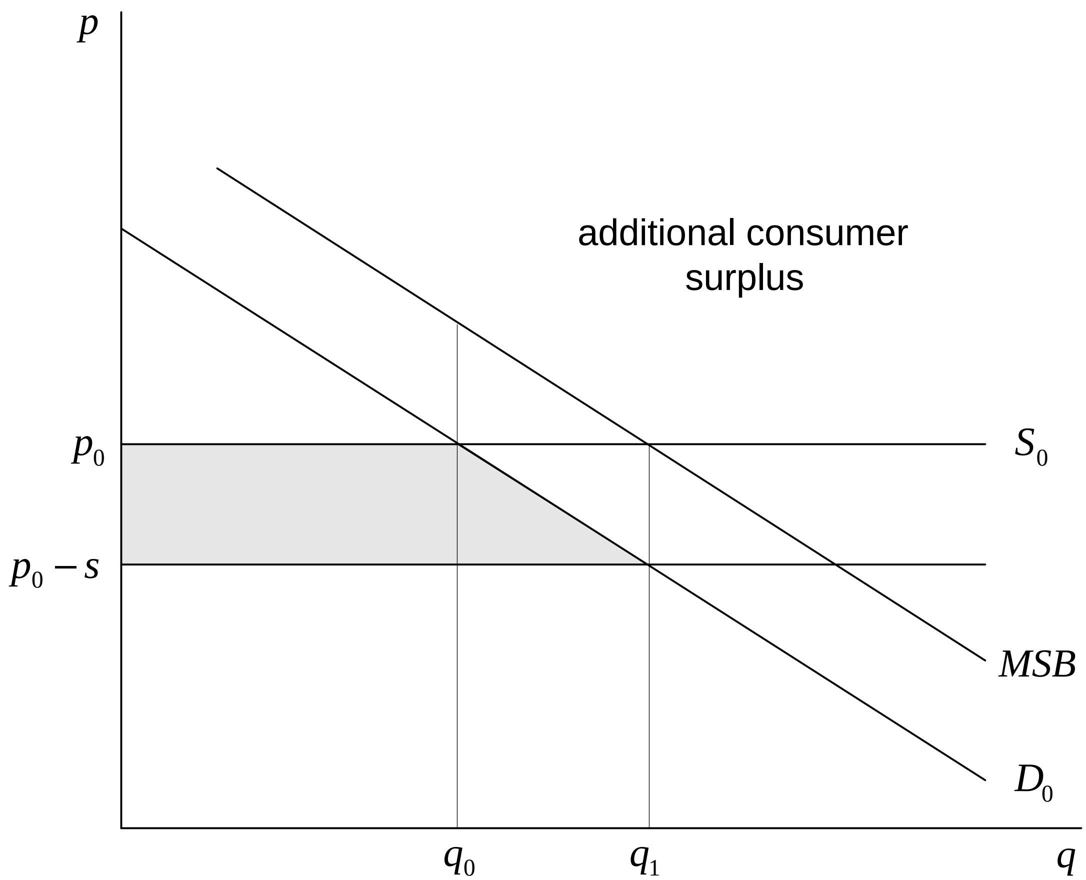

Figure 4.24-1

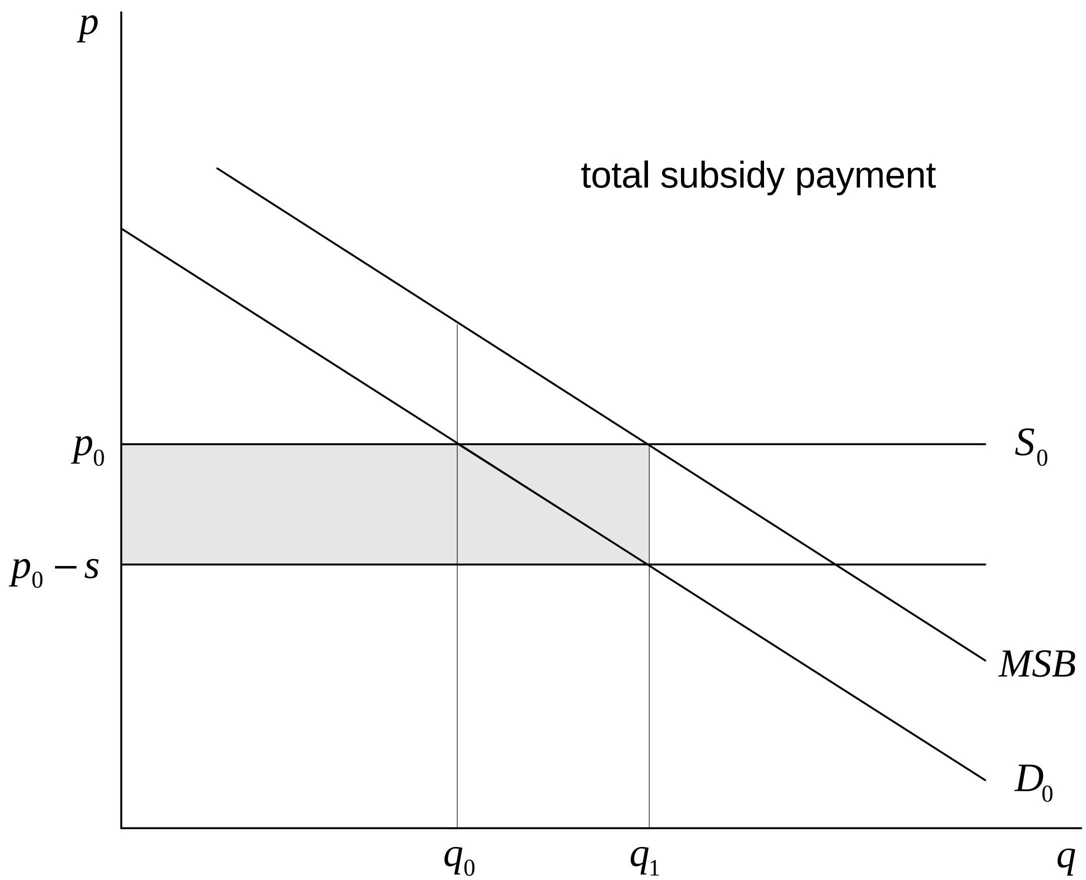

Figure 4.24-2

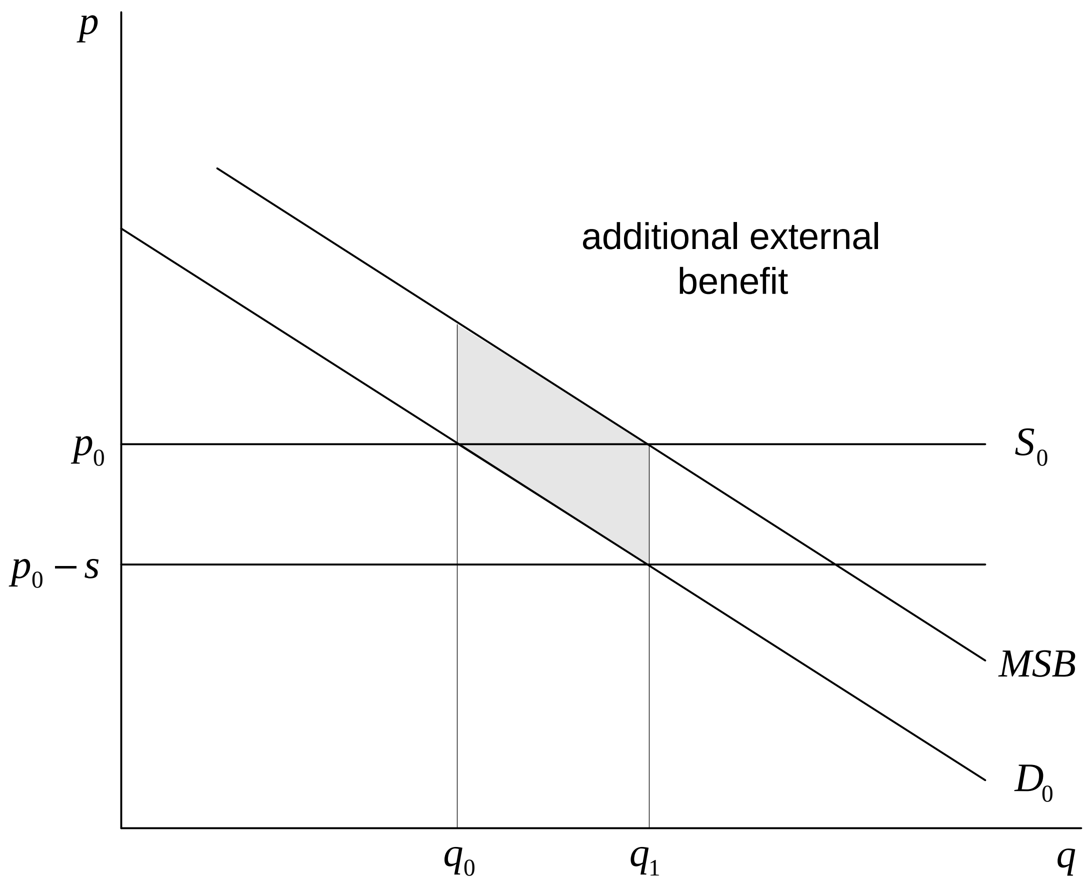

Figure 4.24-3

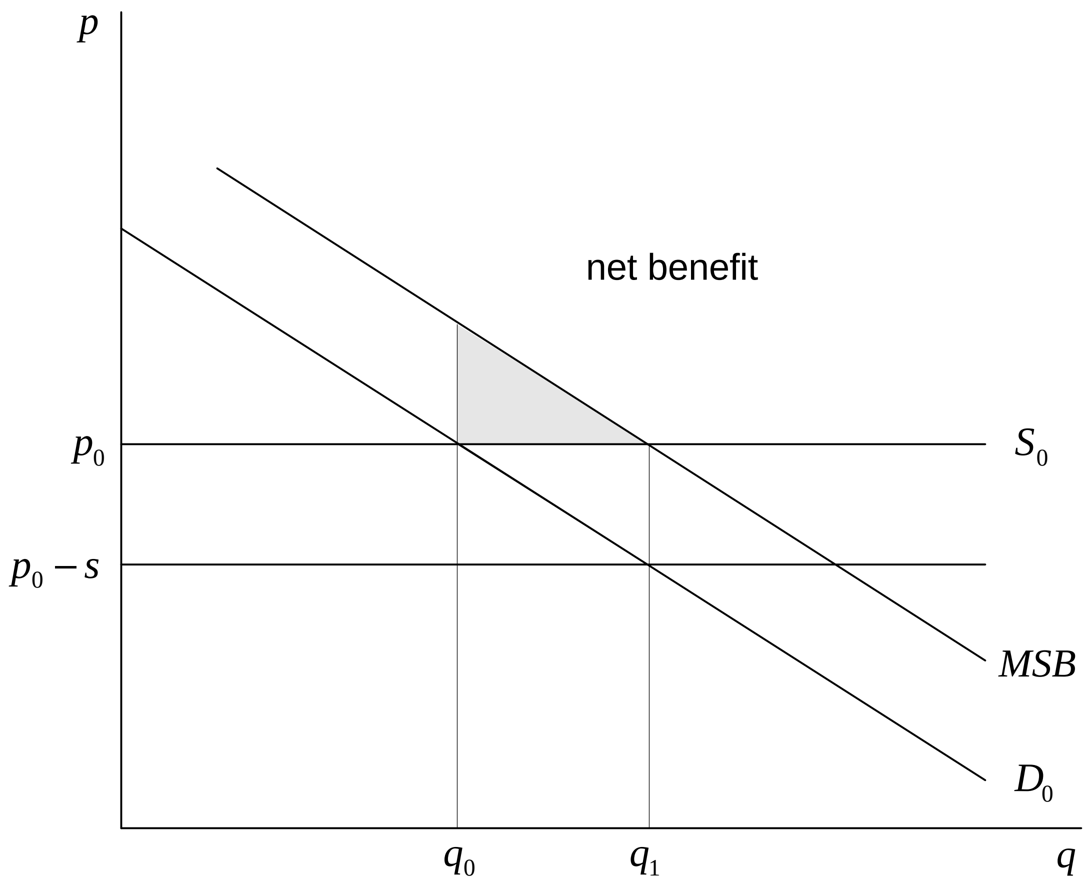

Figure 4.24-4

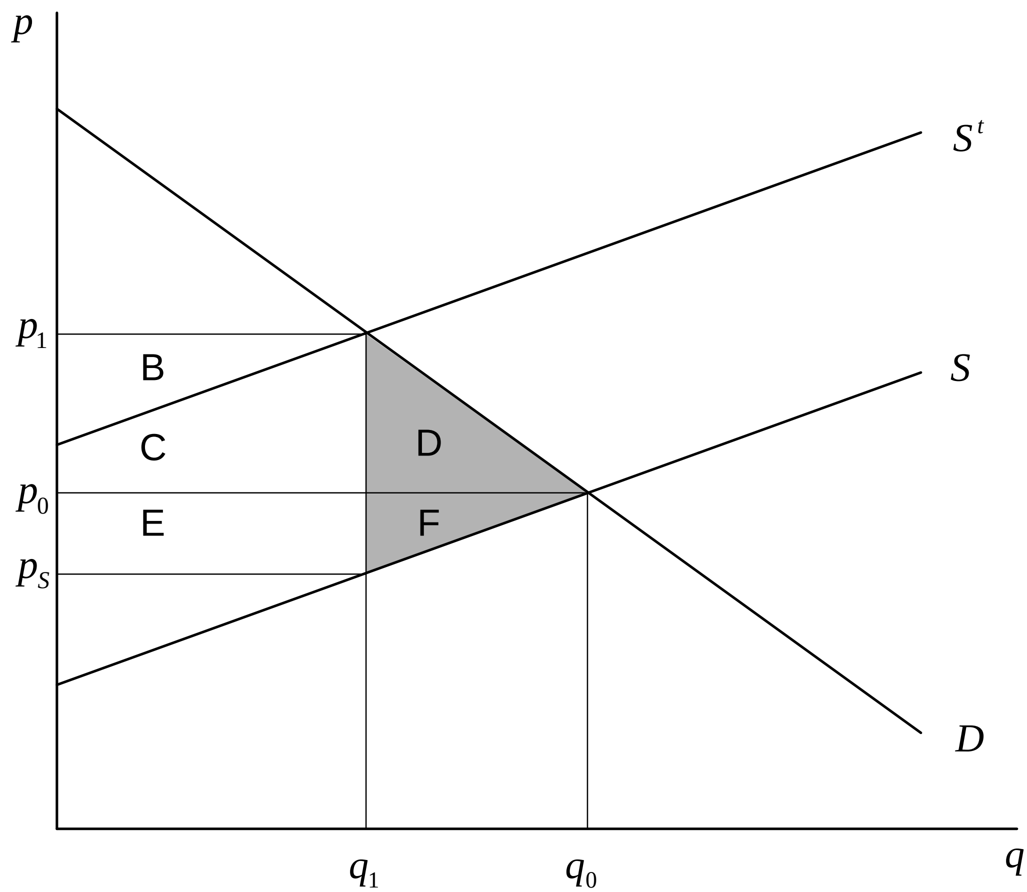

Figure 4.25

	Benefits	Costs
Existing buyers		A + B
Sellers	A + B + C	
Government agency		B + C + G + E + F
Social cost		B + G + E + F

Table 4.1

	Benefits	Costs
Foregone consumer surplus		B + C + D
Foregone producer surplus		E + F
Tax revenue raised	B + C + E	
Cost funds		D + F

Table 4.2

Supplementary Module S4.1
Compensating and Equivalent Variation

If we could measure utility directly then we could measure welfare change for an individual in terms of a utility difference. However, we cannot measure utility. Instead we frame the answer in terms of WTP or WTA. These could be expressed in terms of any numeraire good, but it is most convenient to use a money metric.

Two alternative money metric measures of welfare change for an individual are *compensating variation* (CV) and *equivalent variation* (EV).

The difference between EV and CV relates to the choice of reference point for measuring the welfare change. The EV uses the new allocation as the reference point while the CV uses the initial allocation as the reference point. The appropriate reference point depends on the assignment of property rights implicit in the cost-benefit analysis. We will return to this point later.

(a) Compensating variation

Compensating variation measures the amount of money that would have to be given to an individual after some policy-induced change to enable her to attain the same level of utility she enjoyed before the change.

That is, how much money would it take to compensate the individual for the policy-induced change? Note that the reference point is initial utility: we are compensating back to the initial level of utility given the post-policy conditions.

Note that if a policy causes only a change in income then the associated CV is simply the amount of the income change.

It is customary to state CV as the negative of the compensation required to offset the welfare change; that is,

- CV<0 if the agent is made worse-off
- CV>0 if the agent is made better-off

It is useful to interpret CV in terms of WTP and WTA:

- if the individual is made worse-off by the policy then $|CV|$ measures her (minimum) WTA in compensation for the policy
- if the individual is made better-off by the policy then $|CV|$ measures her (maximum) WTP to have policy

It is clear that we could consider the converse: her WTP not to have the policy if it would make her worse-off, and her WTA for not having the policy if it would make her better-off. Measuring costs and benefits from this perspective involves using equivalent variation.

(b) Equivalent variation

Equivalent variation measures the amount of money that would have to be taken away from an individual in the absence of the policy-induced change to leave her with the same level of utility she enjoys after the change.

That is, what amount of income difference change would be equivalent to the policy-induced change in conditions? Note that the reference point is post-policy utility: we are measuring the equivalent income change needed to achieve the post-policy level of utility given the pre-policy conditions.

It is customary to state EV as the negative of the income that would have to be taken away to achieve the equivalent welfare change associated with a policy; that is,

- EV<0 if the agent is made worse-off
- EV>0 if the agent is made better-off

The EV is also related to WTP and WTA:

- if the individual is made worse-off by the policy than the $|EV|$ measures her WTP not to have the policy.
- it the individual is made better-off by the policy then the $|EV|$ measures her WTA for not having the policy.

Should we use EV or CV?

EV and CV are generally not equal because the reference point for measuring the welfare change is different in each case.

In fact, the difference between EV and CV could even be infinite: WTP is bounded by income (and must be finite) but WTA is not bounded by income and could in principle be infinite. For example, consider the WTP not to die and the WTA for dying.

The difference between WTP and WTA is a function of the elasticity of substitution between money and the policy-induced change. No amount of money can substitute for the loss of some things (such as life itself).

When should we use CV and when should we use EV? This depends on the assignment of property rights implicit in the analysis:

- if the individual is assumed to have a right to the benefit of the policy or a right not to be harmed by the policy then we should use WTA

    $\Rightarrow$ use EV if she gains from the policy and CV if she loses from the policy.
- if the individual is assumed to have no right to the benefits of the policy or no right not to be harmed by the policy then we should use WTP

    $\Rightarrow$ use CV if she gains from the policy and EV if she loses from the policy.

Graphical representation

Suppose a policy changes the budget set for an individual, causing her switch her optimal consumption bundle from x^0 to x', as illustrated in figure S4.1.

The associated CV is illustrated in figure S4.2. (It is customary to represent CV and EV graphically in terms of the good measured on the vertical axis, rather than in money terms; that is, we represent CV and EV graphically as the amount of x_2 that the dollar amounts would buy).

In contrast, the associated EV is illustrated in figure S4.3.

Compensated demand curves

The EV and the CV can be interpreted as areas beneath a compensated demand curve.

Recall that the ordinary or Marshallian demand curve represents the relationship between price and the quantity demanded with income held constant. A change in income is reflected in a shift of the demand curve.

The Marshallian demand response to a price change can be decomposed into an income effect and a substitution effect. Figure S4.4 depicts the demand response to a fall in the price of x_1 when income remains unchanged.

The *substitution effect* is defined as the demand response associated with the price change given that the individual is compensated with income and restored back to her initial level of utility. (By definition this income compensation is the $|CV|$ for the price change).

The *income effect* is the demand response due to the change in real income associated with the price change. Note that figure S4.4 is drawn for the case of a normal good: the income effect and substitution effect work in the same direction. (For an inferior good the income effect for a price fall is negative).

The *Hicksian* or *compensated demand curve* measures the substitution effect associated with a price change. That is, it represents the relationship between price and quantity demanded when utility is held constant via an income compensation.

The relationship between the ordinary and compensated demand curve drawn for the initial (pre-price change) level of utility is illustrated in figure S4.5.

The compensated demand is denoted $H(u^0)$ and is drawn for the initial level of utility u^0. It is steeper than the ordinary demand when the good in question is normal. (For an inferior good the compensated demand is flatter).

The area beneath $H(u^0)$ bounded by p_1^0 and p_1' is the $|CV|$ associated with the price change $p_1^0 \to p_1'$.

The compensated demand curve $H(u^0)$ in figure S4.5 is drawn for u^0. It can also be drawn for other utility levels, including the final (post-price change) level u'. This is illustrated in figure S4.6 as $H(u')$.

The area beneath $H(u')$ bounded by p_1^0 and p_1' is the $|EV|$ associated with the price change $p_1^0 \to p_1'$.

Note that $H(u')$ does *not* measure the substitution effect for the price change $p_1^0 \to p_1'$. However, $H(u')$ can be interpreted as measuring the substitution effect of the reverse price change, viz., $p_1' \to p_1^0$. Thus, the $|EV|$ associated with the price change $p_1^0 \to p_1'$ is equivalent to the $|CV|$ associated with the price change $p_1' \to p_1^0$, and vice versa. More generally, $|WTP(x^0 \to x')| \equiv |WTA(x' \to x^0)|$.

The CV and EV for the price fall $p_1^0 \to p_1'$ are illustrated together in figure S4.7.

Note that the EV is larger than the CV in the case illustrated. (The WTA to forego the price fall exceeds the WTP to have the price fall).

In general,

- price fall for a normal good: $|EV| > |CV|$
- price rise for a normal good: $|CV| > |EV|$
- price fall for an inferior good: $|CV| > |EV|$
- price rise for an inferior good: $|EV| > |CV|$

If more than one price changes then the CV and EV can be calculated as the sum of the CVs and EVs associated with the individual price changes taken sequentially.

The value of the total CV or EV is invariant to the order of the calculation. That is, the sequence of price changes assumed for the calculation is irrelevant. This property of the CV and EV is called *path independency*.

Relation to consumer and producer surplus

The change in consumer surplus (ΔCS) associated with a price change is an approximation of the EV and CV for a price change. The relationship between EV, CV and ΔCS for a price fall for a normal good is illustrated in figure S4.8. The shaded area is ΔCS . (Compare with figure 4.7).

ΔCS is always bounded by EV and CV:

- if $|EV| > |CV|$ then $|EV| > |\Delta CS| > |CV|$
- if $|CV| > |EV|$ then $|CV| > |\Delta CS| > |EV|$

If all goods whose prices have changed are income-neutral, then $|CV| = |\Delta CS| = |EV|$.

Path dependency

A problem with ΔCS is that it is *path dependent;* that is, it is not invariant to the sequence of changes assumed for the calculation when more than one price changes or if prices and income change. This reflects the presence of income effects in ordinary demand curves, which means that cross-price effects are generally not symmetric (unless preferences are homothetic). Thus, it matters which demand curve is allowed to shift first for the purposes of measuring areas.

In contrast, EV and CV are path independent because they are measured under the compensated demand curves which are free from income effects by definition, and so have symmetric cross-price effects.

Despite its shortcomings, ΔCS is a reasonable approximation for measuring welfare change (for small projects). The theoretical appeal of EV and CV is likely to be overshadowed in practice by difficulties associated with estimating compensated demand curves.

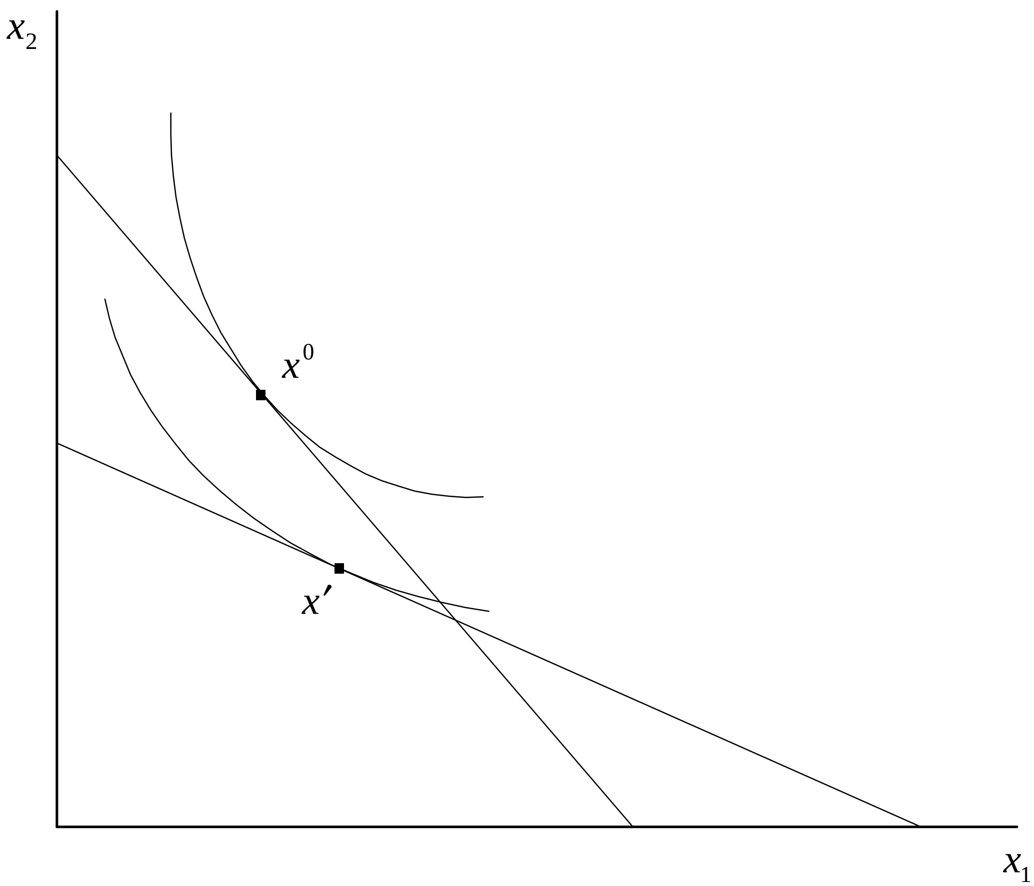

Figure S4.1

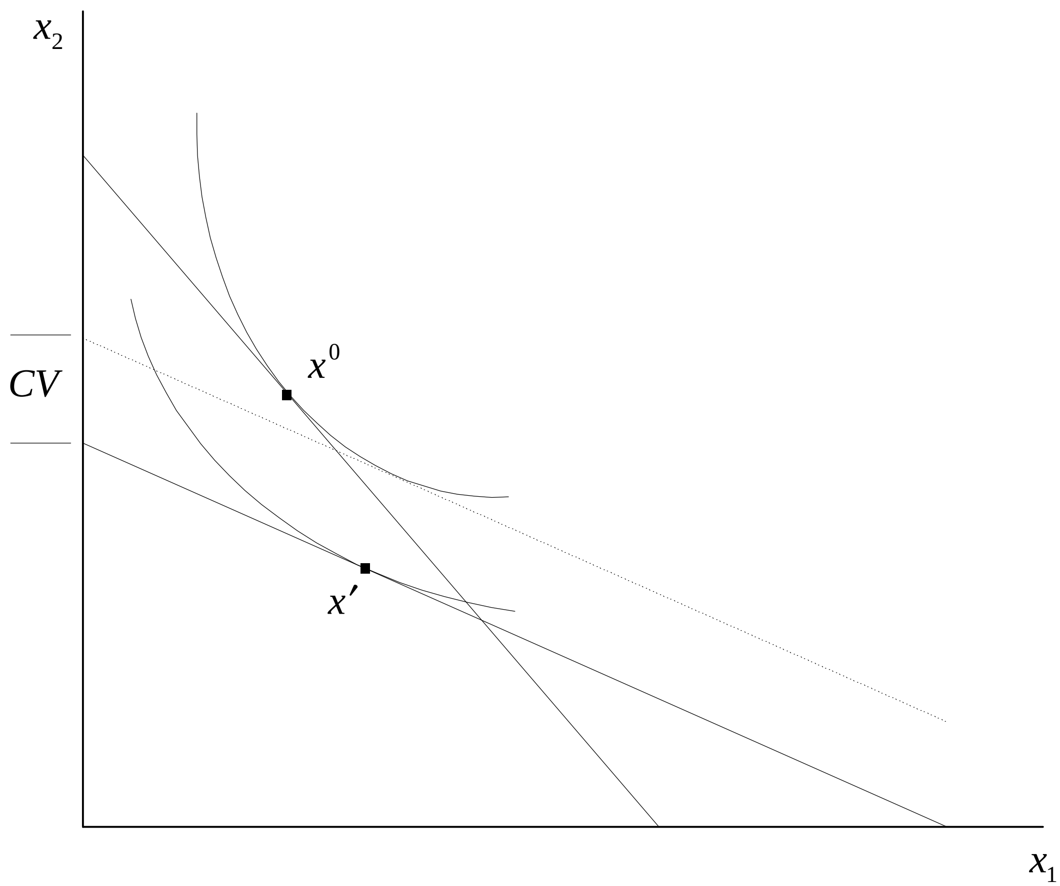

Figure S4.2

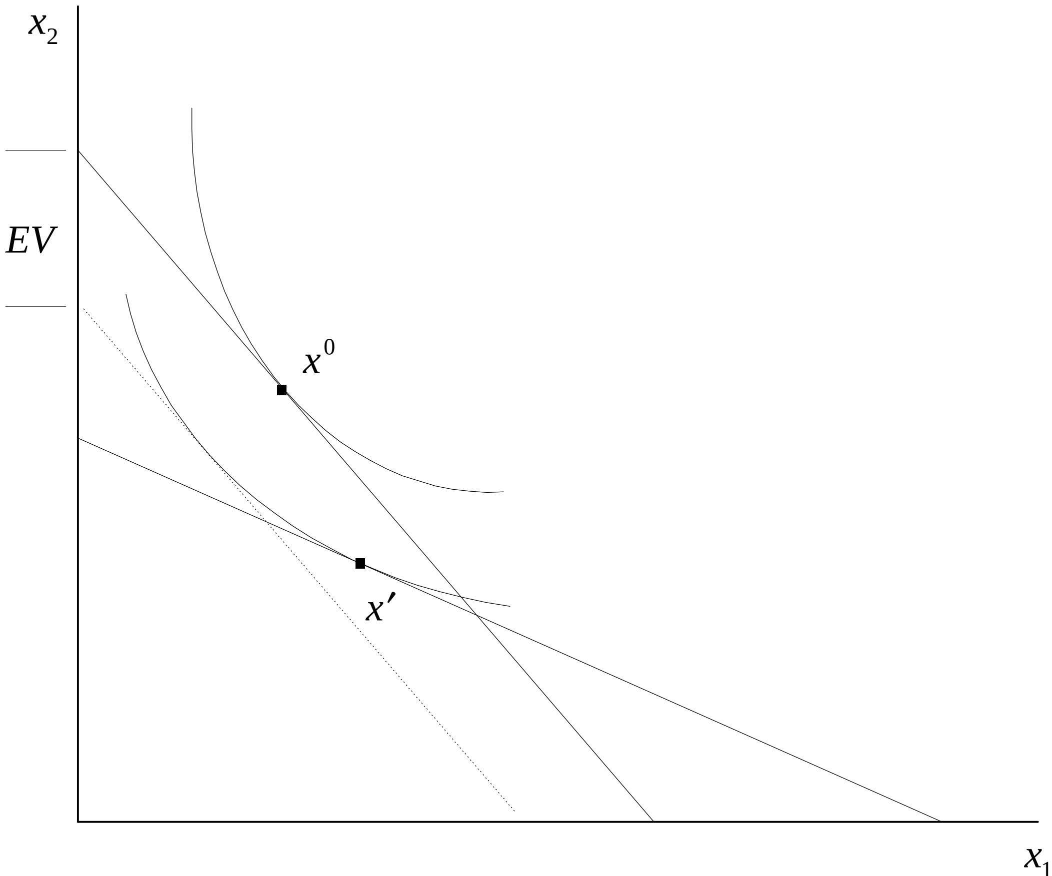

Figure S4.3

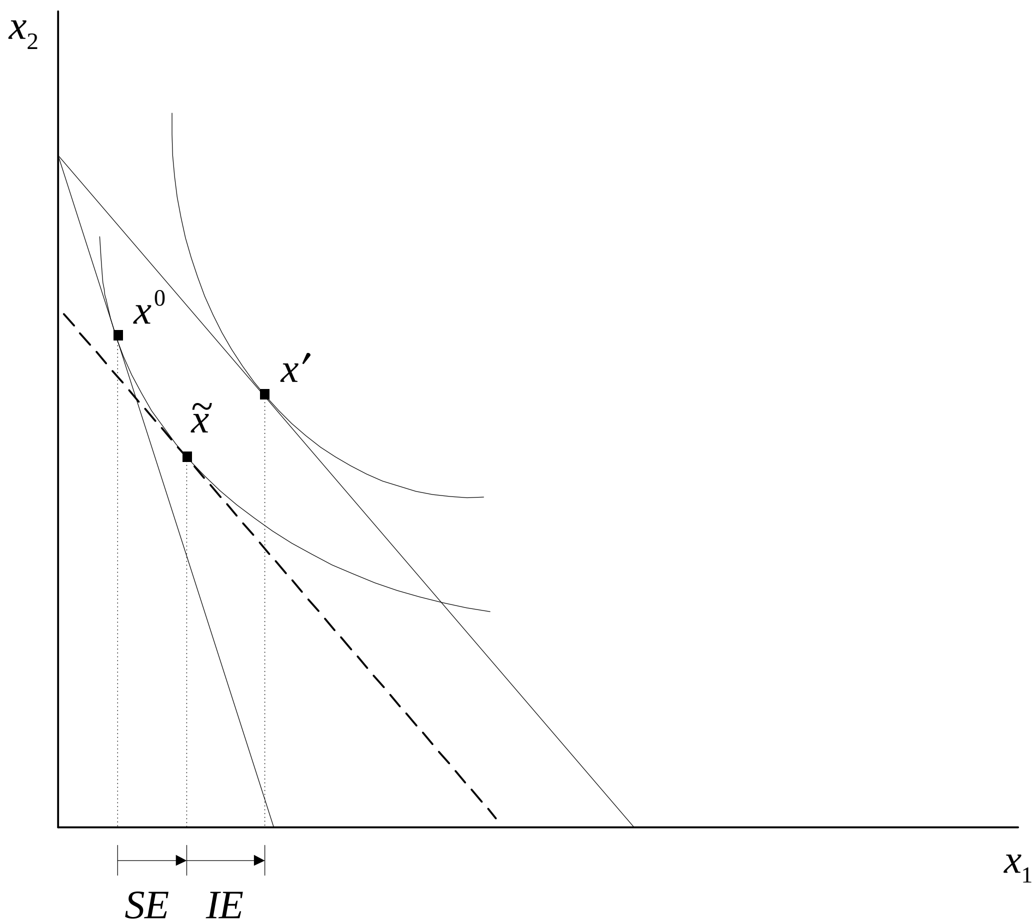

Figure S4.4

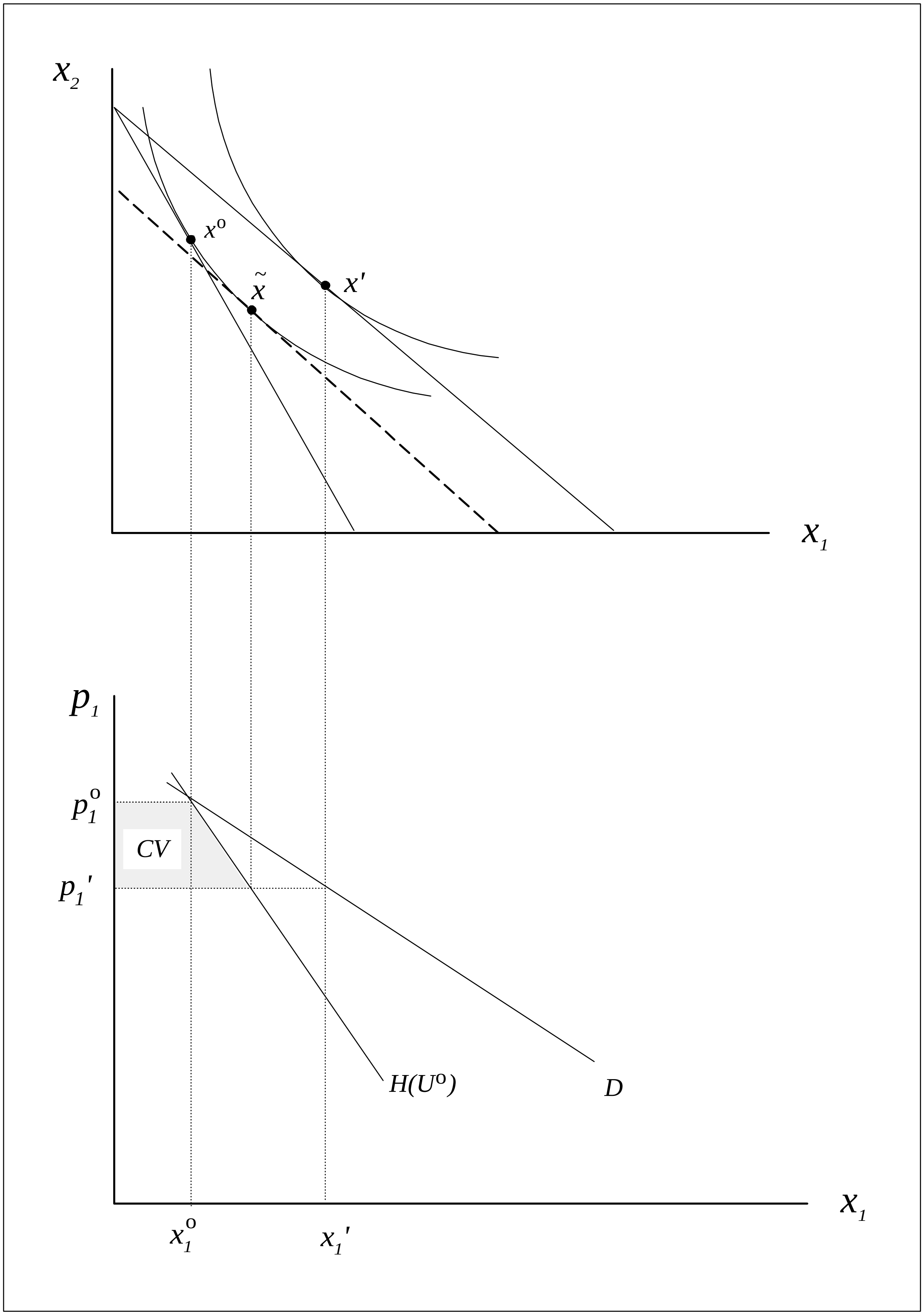

Figure S4.5

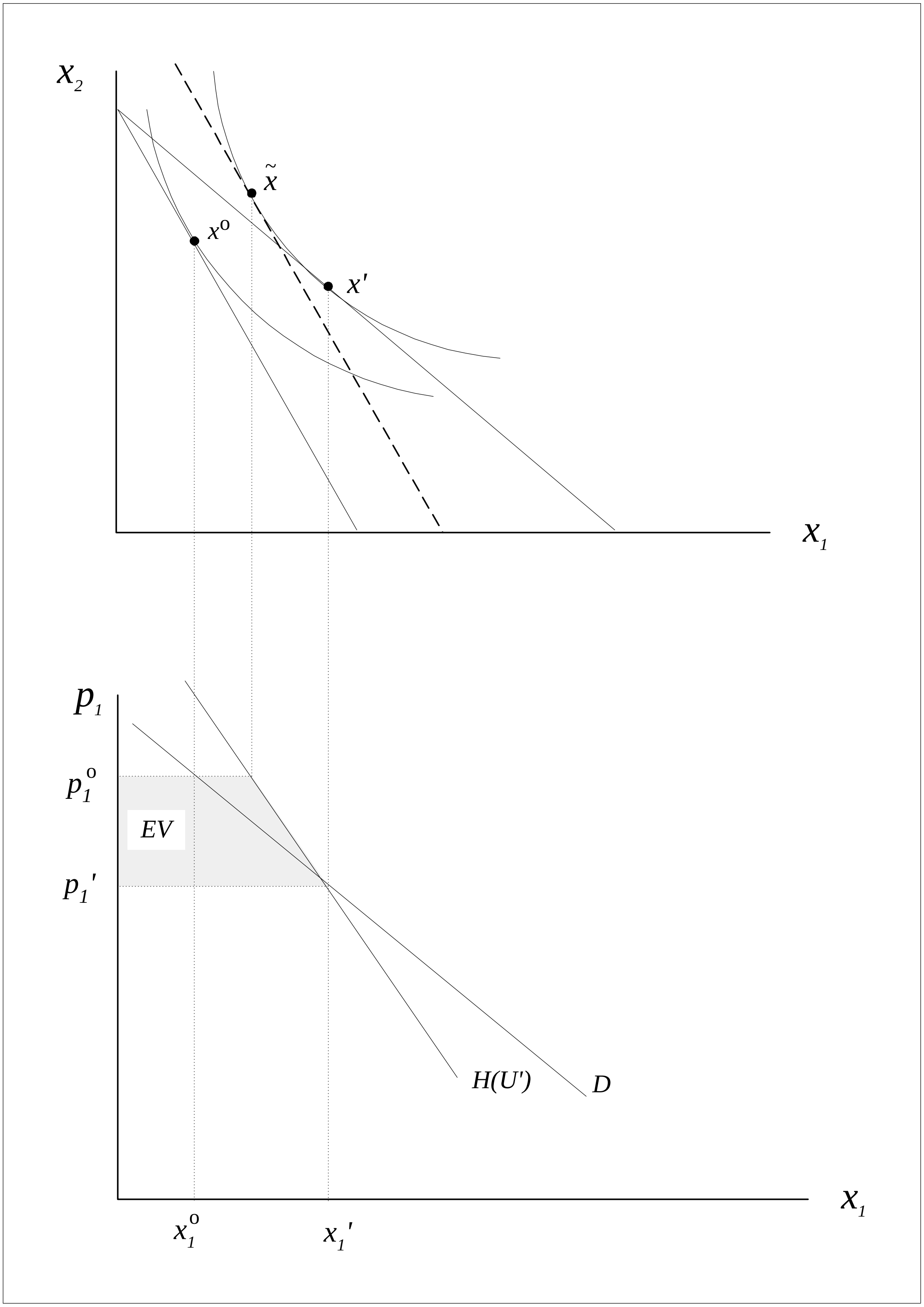

Figure S4.6

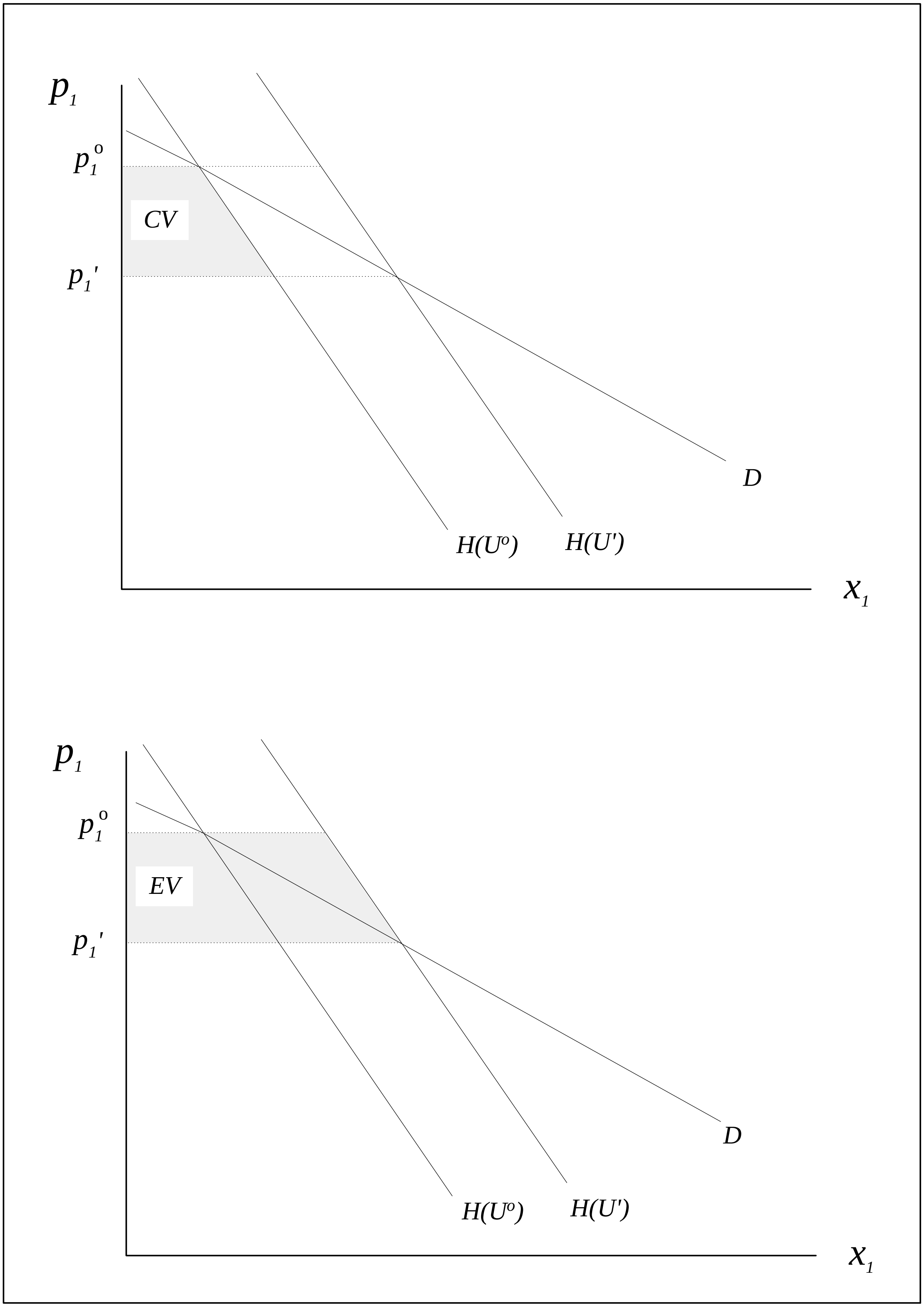

Figure S4.7

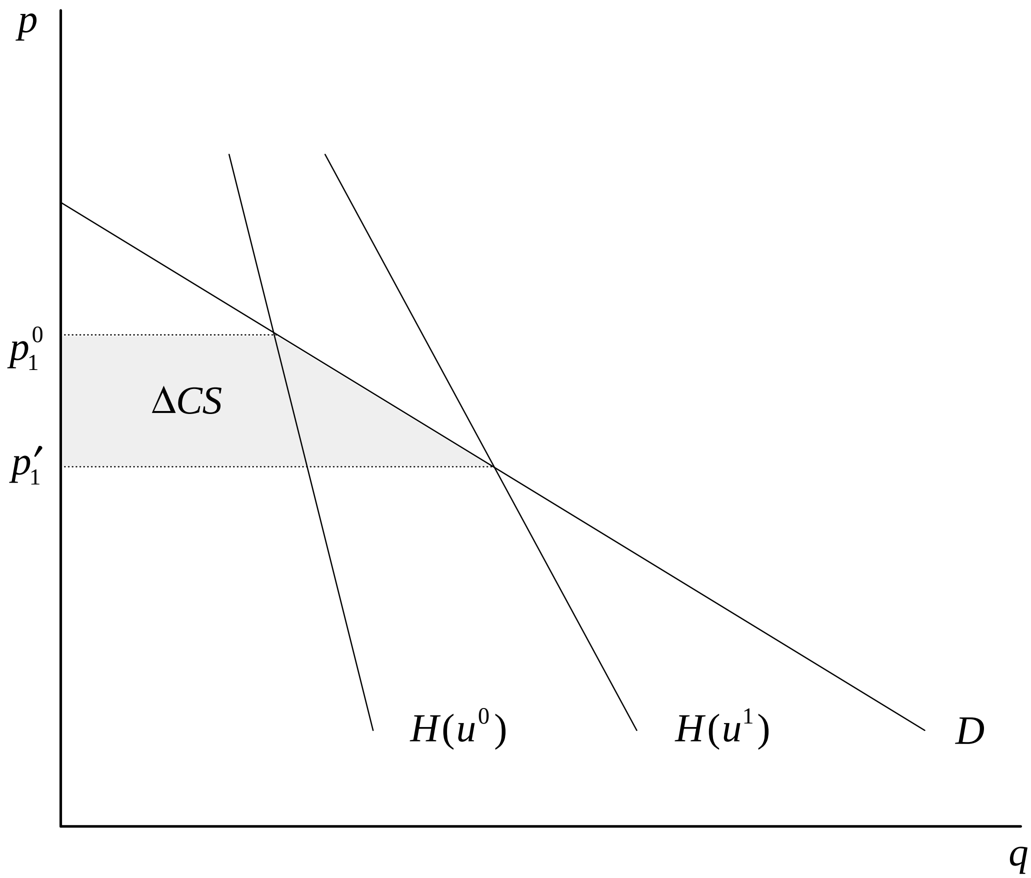

Figure S4.8

Supplementary Module S4.2
Estimating a Change in Consumer Surplus and Producer Surplus Using Elasticity Estimates

Consumer surplus
Recall the definition of demand elasticity:

$$e = \frac{\%\Delta q}{\%\Delta p} = \frac{\Delta q}{q} \Big/ \frac{\Delta p}{p} = \frac{\Delta q}{\Delta p}\frac{p}{q}$$

The value of demand elasticity is not necessarily constant along the demand curve. For example, along a linear demand curve, elasticity falls as price rises. Thus, an estimate of demand elasticity is generally an estimate of a "point elasticity"; that is, the elasticity estimated at a particular point on the demand curve.

Denote the estimated point elasticity of demand at the current price and quantity as

$$e_0 = \frac{\Delta q}{\Delta p}\frac{p_0}{q_0}$$

Then we can predict a change in quantity for a given change in price as

$$\Delta q = \frac{e_0 q_0 \Delta p}{p_0}$$

We can then use this predicted change in quantity to estimate the associated change in consumer surplus. For a linear demand curve:

$$\Delta CS = -q_0 \Delta p + \frac{|\Delta p| \Delta q}{2}$$

See Figure S4.9

Thus, for a linear demand curve:

$$\Delta CS = -q_0 \Delta p + \frac{|\Delta p| e_0 q_0 \Delta p}{2 p_0}$$

Producer surplus
Recall the definition of supply elasticity:

$$h = \frac{\%\Delta q}{\%\Delta p} = \frac{\Delta q}{q} \Big/ \frac{\Delta p}{p} = \frac{\Delta q}{\Delta p}\frac{p}{q}$$

The value of supply elasticity is not necessarily constant along the supply curve. Thus, an estimate of supply elasticity is generally an estimate of a "point elasticity"; that is, the elasticity estimated at a particular point on the supply curve.

Denote the estimated point elasticity of supply at the current price and quantity as

$$h_0 = \frac{\Delta q}{\Delta p}\frac{p_0}{q_0}$$

Then we can predict a change in quantity for a given change in price as

$$\Delta q = \frac{h_0 q_0 \Delta p}{p_0}$$

We can then use this predicted change in quantity to estimate the associated change in producer surplus. For a linear supply curve:

$$\Delta PS = q_0 \Delta p + \frac{|\Delta p| \Delta q}{2}$$

See Figure S4.10

Thus, for a linear supply curve:

$$\Delta PS = q_0 \Delta p + \frac{|\Delta p| h_0 q_0 \Delta p}{2 p_0}$$

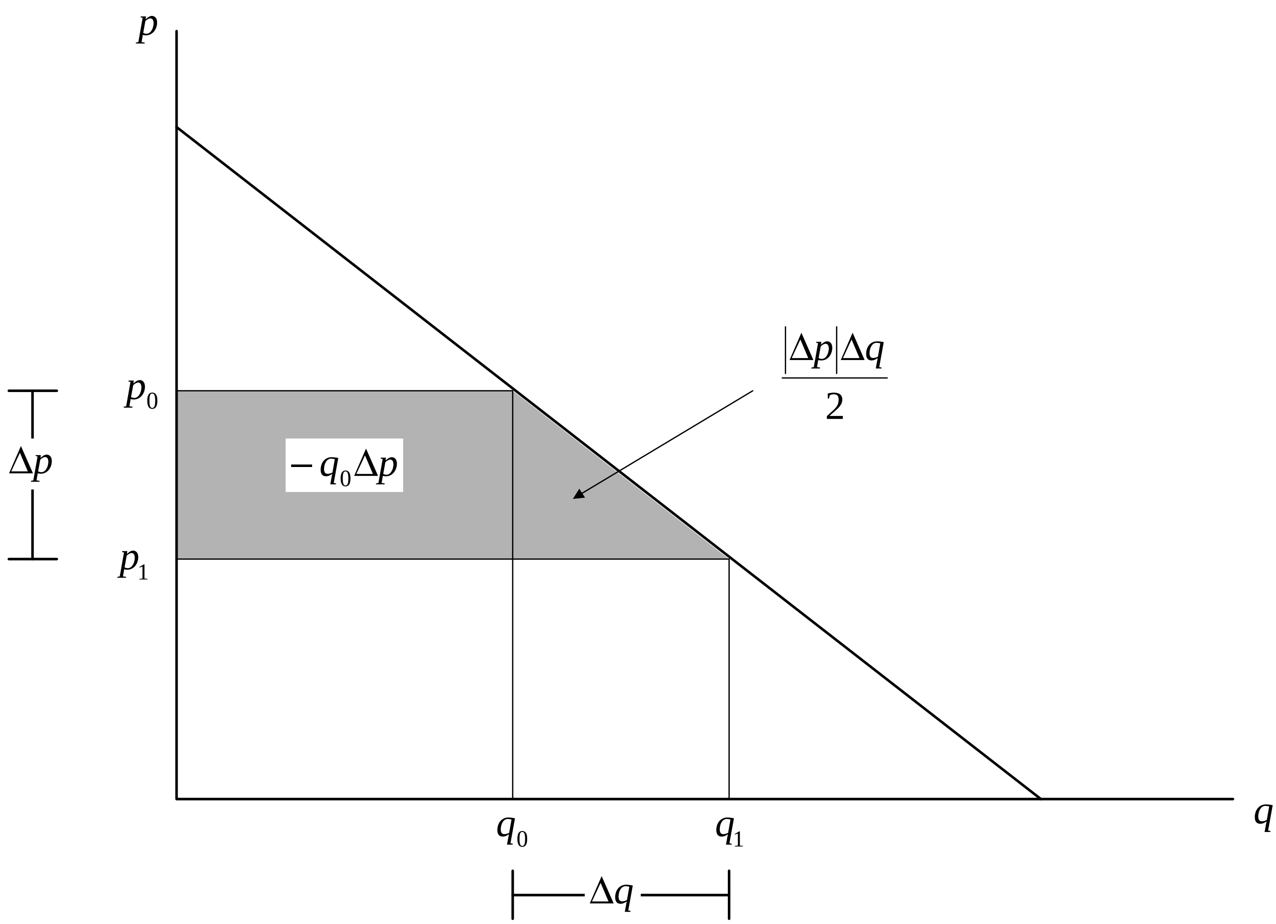

Figure S4.9

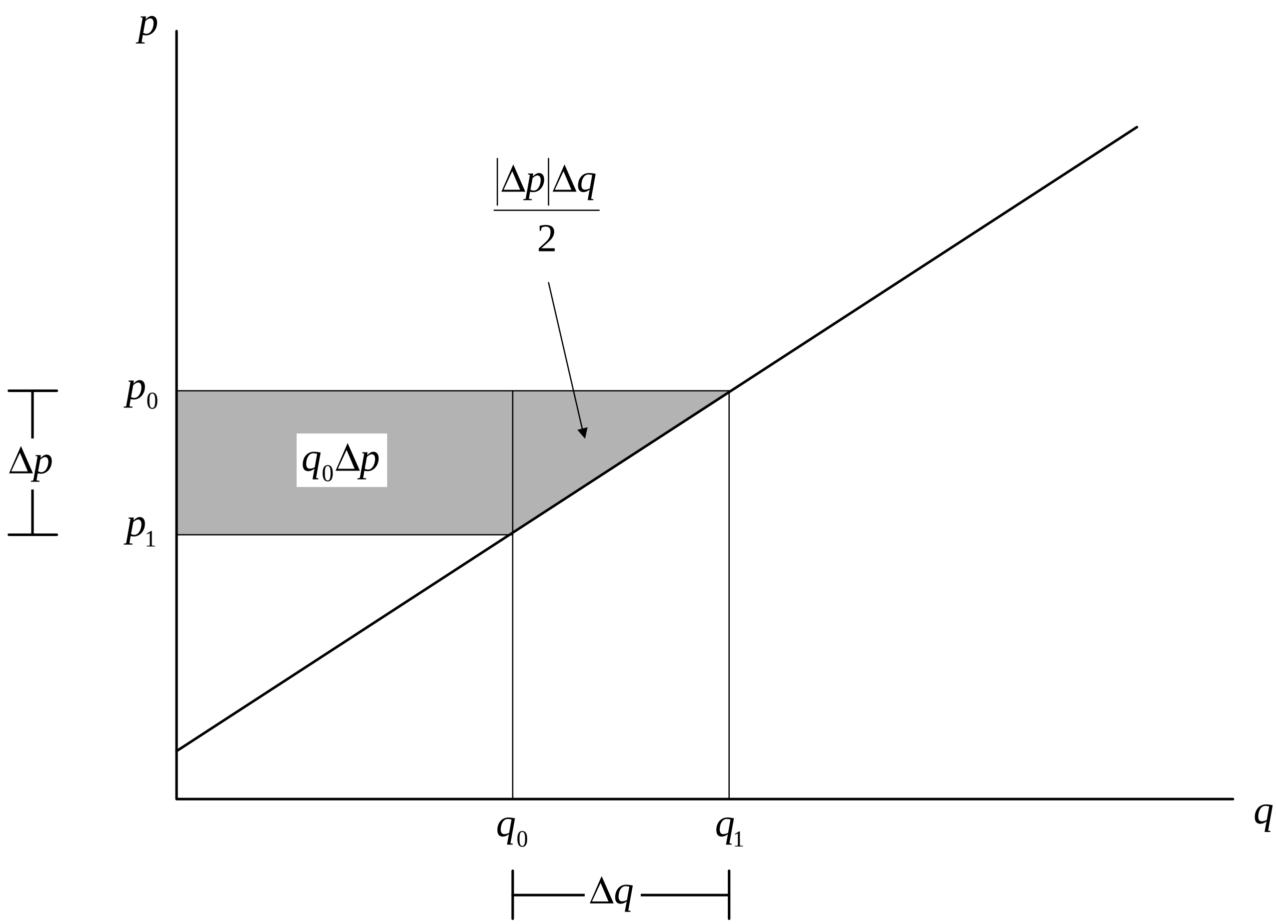

Figure S4.10

Supplementary Module S4.3
"Job creation benefits"

The opportunity cost of unemployed labour reflects only the private value to the agent of the activities foregone when he or she chooses to work. This is *the private opportunity cost of labour* (POCL).

There may be additional elements given up that the agent does not take into account; that is, there may be external values. These external values could potentially be positive or negative. For example, if the agent is doing volunteer work, the value of which to the recipients exceeds the altruistic value derived by the agent, then the volunteer work has an external benefit that is lost when that work stops. In that case, social opportunity cost of labour (SOCL) exceeds the POCL. This would tend to make the true economic cost of using unemployed labour higher than a value based on *POCL* alone.

Conversely, if the unemployed agent is currently engaged in crime or other socially destructive activity then $SOCL < POCL$; the non-work activity has an associated external cost. In reality, these external costs could be quite significant; unemployment is correlated with poverty, and poverty is correlated with poor health, crime, higher rates of alcoholism and spousal abuse, and lower school performance by children. These factors impose extremely high external costs on society.

The alleviation of some of these problems could potentially mean that $SOCL < 0$ for currently unemployed labour. That is, the use of unemployed labour could constitute a *benefit* of the project rather than a cost.

This possibility underlies the notion of "job creation benefits". However, this is a badly misused term, and is the source of a great deal of wrong-headed thinking in CBA. In particular, it is all-too-common to see the total wages paid to workers on a project recorded as a "job creation benefit". This is clearly wrong from an economic perspective.

True job creation benefits - those due to the alleviation of external costs when unemployment people are given work - are nonetheless a potentially important factor to consider in any project or policy. The measurement of these values is extremely difficult but this is no excuse for ignoring them. (We will say more about the measurement of non-market values in chapter 6). To the extent that they can be measured, any job creation benefits should be included as a separate benefit item in the CBA.

Supplementary Module S4.4
An optimal subsidy

The optimal subsidy is set equal to *MEB* evaluated at the optimum; that is,

$$s^* = MEB(q^*)$$

where q^* is defined by $MSB(q^*) = MSC(q^*)$. This is known as the "Pigouvian rule". The subsidy is meant to reward producers for the external benefits of the good that are otherwise not captured in the market price (because consumers do not take the external effect into accounts in their private demand for the good). Setting the subsidy equal to the *MEB* effectively internalizes the externality and so implements the efficient outcome as a corrected equilibrium.

Supplementary Module S4.5

Indirect effects: secondary markets

We have already noted that a full general equilibrium analysis is necessary to properly deal with effects of the project in secondary markets. However, even a partial equilibrium analysis should attempt to capture any secondary effects that are expected to be very important and significant.

A distinction is sometimes made between "indirect effects" and "induced effects", the latter being somewhat further removed from the project. This distinction is an arbitrary one and will not be made here; we will use "indirect effects" to describe all secondary market impacts.

Indirect effects occur when changes in markets affected directly by the project precipitate shifts in supply and demand in other markets. Perhaps the most important example is the impact that project-induced job losses or gains have on regional incomes and the demand for services in those regions. We will focus on that example.

The first step in calculating the indirect effects is to determine the impact of the direct effect on income in the specified region:

$$\Delta Y = \text{ change in after-tax income + change in UA payments received}$$

This change in income will affect the demand for services in the region, and the demand for labor in the provision of those services. Each secondary market thought to be important should be considered. Surplus changes in each of the markets affected are calculated according to the same principles used above.

A note on impact multipliers

In practice it is uncommon for secondary effects to be calculated in each individual market affected. The task is simply too expensive and time-consuming. Instead "impact multipliers” are used to summarize aggregate income and employment changes in a region due to changes in a primary market.

For example, suppose 50 direct logging jobs are to be lost as a consequence of a protected area designation, with an associated loss of $2m in after tax income. A regional income impact multiplier of 2 means that an additional $2m in regional income will be lost due to secondary effects, for a total income loss of $4m; that is, the direct loss multiplied by 2. A job impact multiplier of 2 means that an additional 50 jobs in the region will be lost, for a total of 100 jobs.

Impact multipliers are usually calculated on the basis of a simple input-output model of the regional economy concerned. In British Columbia impact multipliers are calculated by the Ministry of Finance. (For example, the estimated province-wide job impact multiplier for the logging industry is 2).