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Cost-benefits analysis: Lecture note

Tapas Kundu

Section 2

Quantifying effects in the impacted market

So far, we have considered a general framework to quantify the impact of a policy by measuring the changes in social surplus within a market.

Ignoring the non-price goods for the time being, we can broadly classify the impacted markets into three categories: the output market, the input market, and the secondary market.

Measuring the change in surplus critically depends on whether we are dealing with an efficient or an inefficient market.

Recall that a market is allocatively efficient if the output is produced up to the level at which the marginal benefit is equal to the marginal cost. Consequently, the social surplus is maximized at the equilibrium production level.

If the market is efficient, then there will be no deadweight loss before or after the policy/project is implemented. Further, prices match the (social) marginal cost of production, thereby accurately mirroring the genuine opportunity cost of production. In contrast, in an inefficient market, prices fail to accurately represent the true opportunity costs. To quantify the cost of a project, it is customary to introduce the notion of a shadow price—a concept we will delve into later in our discussion. We will begin with a preview of the main findings/rules that we will derive.

- Changes in output markets
  - Value benefits as WTP for the change and costs as WTP to avoid the change.
  - Value change as net change in social (i.e., consumer and producer) surplus plus (less) any increase (decrease) in revenues.
- Change in input markets

  - Value costs as the opportunity cost of the purchased resources.
  - When the market is efficient: If supply schedule is flat, value cost as direct budgetary expenditure.
    If supply schedule is not flat, value cost as direct budgetary expenditure less (plus) any increase (decrease) in social surplus in market.
  - When the market if inefficient: Value costs as direct budgetary expenditure less (plus) any increase (decrease) in social surplus in market.

- Change in secondary markets
  - Most impacts in secondary markets can be valued in primary markets
  - If the market is efficient: If prices do not change in secondary market, ignore secondary market impacts.
    If prices do change, but benefits in primary market are measured using a demand schedule with other market prices held constant, then social surplus changes in the secondary market will always represent reductions in social surplus that should be subtracted from changes in the primary market.
    However, if benefits in the primary market are measured using a demand schedule that does not hold other prices constant, ignore secondary market impacts.
  - If the market is inefficient: Costs or benefits resulting directly from increases in the size of the distortion should, in principle, be measured.
    Other impacts in secondary market should be ignored if prices do not change.

The output market

A project or policy has the potential to shift the demand or supply curve in the output market. Such shifts in the demand and/or supply curves can sometimes lead to changes in prices (resulting in a price effect), while at other times, they may leave the price unaffected (resulting in a case without a price effect).

However, to accurately assess the impact of these shifts, it's crucial to comprehend the origins of the changes. For example, a shift in the supply curve might stem from alterations in the underlying production costs or the introduction of additional (free) goods. Similarly, a shift in the demand curve might arise from changes in underlying benefits or simply from the demand of an additional set of consumers. These diverse sources of shifts in demand and supply curves have implications for how we measure changes in social surplus.

We will now illustrate these issues using two examples. These examples pertain to efficient markets, where prices accurately reflect the marginal cost of production.

Example 1

Project (a): Suppose the government possesses certain good in excess quantities that it can supply to the market at zero cost.

Then the supply curve shifts to the right, resulting in an increased availability of goods to consumers at various price levels. However, if this increase in supply is relatively insignificant compared to the overall market supply, price will not drop.

Let's initially examine the scenario where price remains unaffected. If the government chooses to sell the additional units of the goods at the prevailing market price, it will be treated akin to other competitors in an efficient market. In this context, it will encounter a horizontal demand curve labeled as D.

Consider Figure 1, illustrating a rightward shift in the supply curve while maintaining the price at P_0.

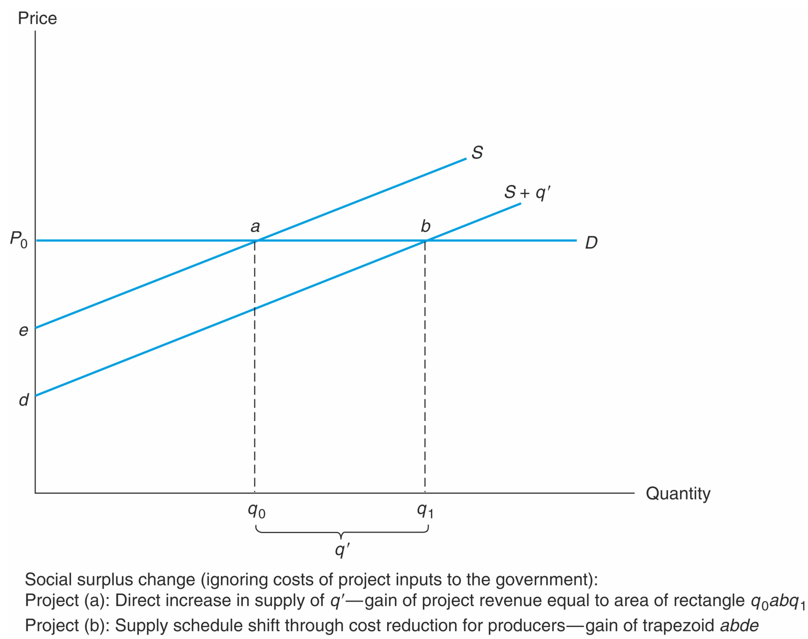


Figure 1: Shift of supply with no effect on price

What will be the extent of the surplus change resulting from a shift in the supply curve?

Given our exclusive focus on the output market, we can identify the affected parties as the consumers and producers within this market.

The demand curve being horizontal, the change in consumer surplus is zero. The interpretation is that even if these additional quantities being sold, what the consumers pay are the same as what they are willing to pay.

The change in producer surplus is also zero; albeit with a more intricate rationale. Despite the rightward shift observed in the supply curve, there is no reduction in the marginal costs of production for the units sold earlier.

The government receives revenue equal to P_0 times q', the area of rectangle q_0abq_1. The revenues received by the government are the only benefits that accrue from the project selling q' units in the market.

Suppose the government instead of charging the price P_0, offers the good for free. Then, the rectangle q_0abq_1 will constitute a positive change in consumer surplus with zero government revenue. Thus, whatever price government charges, the net gain from this shift of supply curve will remain unchanged and is measured by the area q_0abq_1.

Here we ignore any additional costs of inputs to supply the surplus good to the market. Had there been any costs, it should be included in the calculation as well.

Project (b): Consider an alternative possibility in which the shift of the supply curve happens not due to the supply of some surplus goods, but because of an investment that reduces marginal costs of production. Such a reduction will move the supply curve downward and can be illustrated by a similar rightward shift as depicted in Figure 1.

In this case, measure the change in surplus for producer will be different. It will be represented by the trapezoid \$abde\$. No change in consumer surplus as before, due to the perfectly elastic horizontal demand curve at P_0.

Example 2

Next, consider a possibility similar to the project (a) above but assume that price moves downward due to a shift of the supply curve. Figure 2 illustrates this scenario with a downward sloping demand curve D.

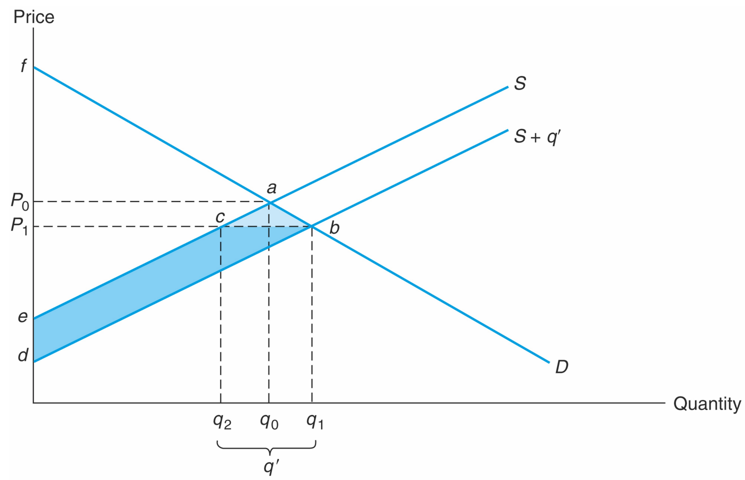
Due to drop in price, there is an increase in consumer surplus, measured by the trapezoid P_0abP_1.

The new equilibrium demand is q_1. The production level comprises of two kinds of good, one was originally produced with an upward sloping marginal costs curve, of volume q_2, and the surplus volume that the government supplies of $q_1 - q_2 = q'$ units.

As the shift of supply curve is not due to a reduction of the marginal costs, it implies that producer surplus must be going down on the earlier production volume q_2, and this reduction is measured by the trapezoid P_0acP_1 .

And, there is an additional government revenue from selling the surplus good, measured by the rectangle q_2cbq_1.

Adding these three changes, we can find that the total change in surplus will be the area of q_2cabq_1.



Social surplus change (ignoring costs of project inputs to the government):
Project (a): Direct increase in supply of q'—gain of triangle *abc* plus project revenue equal to area of rectangle q_2cbq_1
Project (b): Supply schedule shift through cost reductions for producers—gain of trapezoid *abde*

Figure 2: Shift of supply curve resulting in price reduction

As before, we assume that the surplus volume was available and could be supplied at zero costs. Otherwise, the cost of producing/supplying the additional goods should also be taken into account.

Project (b): We can also consider an alternative possibility in which the shift of the supply curve happens because of an investment that reduces marginal costs of production. Such a reduction will move the supply curve downward and can be illustrated by a similar rightward shift as depicted in Figure 2.

In this case, measure the change in surplus for producer will be different. The producer surplus before the project is the triangle P_0ae and the producer surplus after the project is the triangle P_1bd. Therefore the change in producer surplus is the trapezoid $ecbd$ - the trapezoid P_0acP_1.

There will be a gain in consumer surplus, measured by the area of the trapezoid P_0abP_1.

Adding all of them, the net change (gain) in surplus will be measured by the area $eabd$.

The above two examples illustrate the effects of a shift in the supply curve, either due to the supply of surplus volume or a reduction in marginal costs, within an efficient market.

In cases of market inefficiency, determining the changes in surplus can become more intricate. This complexity arises from the presence of deadweight loss at the market equilibrium, both prior to and following the implementation of a policy.

As we covered in the previous lecture, taxes or subsidies can lead to allocative inefficiency (resulting in deadweight loss) in an otherwise efficiently functioning perfectly competitive market.

Additionally, other factors can contribute to market inefficiency, such as monopoly, information asymmetry, and externalities, among others.

The secondary markets

A project's effects can be extended to markets beyond the primary output market. Suppose that undertaking a project results in a lower price for a good.

It is expected that the demand for a complement product would increase. If this complementary product is in perfectly elastic supply, there will be no change in its price.

However, since the demand curve for the product has shifted right, the area of consumer surplus measured under the demand curve must have increased.

Should this increase in consumer surplus be measured and included in CBA?

In theory, the answer depends on whether the secondary market is efficient (such that the price there equals the marginal costs of production) or distorted.

Consider first the case of an efficient secondary market.

We refer to Figure 3(a), in which we consider a project that reduces marginal costs of production in the primary market resulting in a drop of price. In Figure 3(b), we observe a rightward shift of the demand curve of a complementary good.

Efficienct market and no price change

Suppose the secondary market has a perfectly elastic supply curve, and therefore there will be no price change even after the demand shift. The question is whether we should include the apparent gain in consumer surplus, measured by the area $cdfe$ in our analysis?

The answer is no.

The shift in demand within the market for the complementary good reflects consumers reallocating their expenditures to capitalize on the lower price of the good provided by the project. The advantage of this lower price is comprehensively quantified by the change in consumer surplus, as measured in the project's output market.

To illustrate this point (refer to supplementary material Chapter 7 for further discussion), let's consider the example of stocking a lake near a city with fish, which subsequently reduces fishing costs for residents. As depicted in Figure 3(a), this leads to an increase in the number of fishing days for residents and results in a gain in consumer surplus.

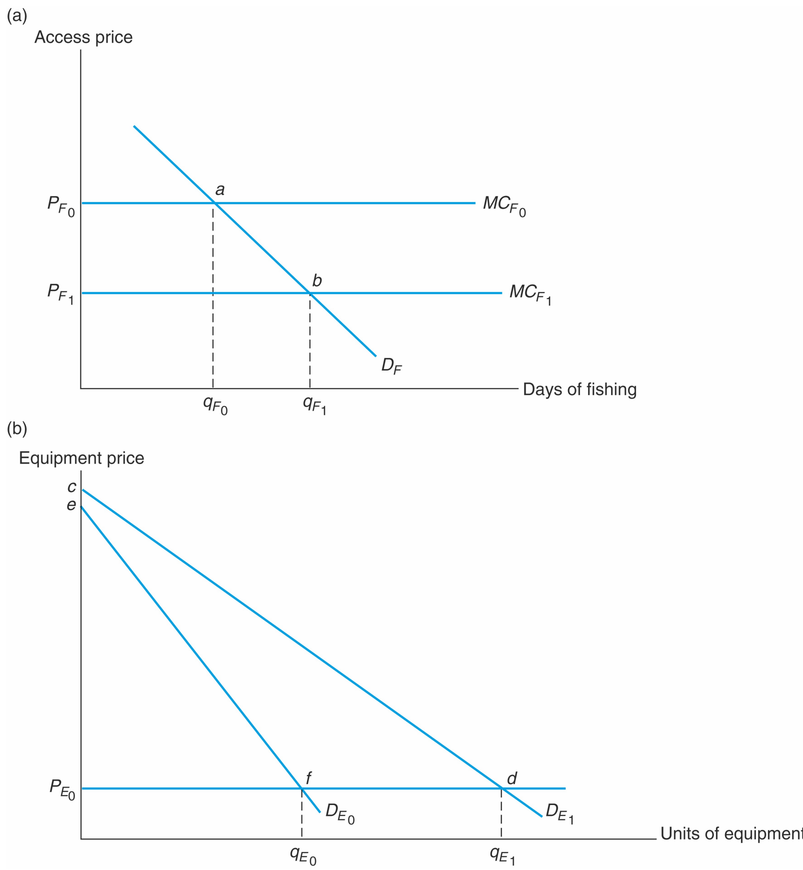


Figure 3: Efficient secondary market with no price effect

The market for fishing equipment constitutes a secondary market and has witnessed an upswing in demand, as indicated in Figure 3(b). However, accounting for this surplus gain in the secondary market would result in duplicating the benefits.

To understand why, let's recognize two types of consumers that could potentially comprise the additional consumer base in the primary market: those who already possess the equipment and thus would not contribute to the supplementary demand for equipment, even if their valuation for it has increased; and those who previously lacked the equipment and could now join the augmented demand in the secondary market.

Nonetheless, for the second type of consumer, their willingness to pay for fishing days in the primary market has already factored in the potential benefits and costs of acquiring the equipment in the secondary market. Consequently, their net benefits are encompassed in our calculation of the change in consumer surplus in the primary market.

Efficienct market but with price change

Suppose the price changes in the secondary market. Can we still disregard the change in surplus there to avoid double counting? The answer is yes, but the argument is somewhat more intricate.

Figures 4(a) and 4(b) build upon the previous example illustrating the cost reduction in the primary market for fishing. This extension considers a potential secondary market involving golfing activities, which can be viewed as a substitute for fishing activities.

To understand these figures, first observe the effect in the primary market. Stocking the lake with fish reduces the marginal cost of fishing, and a movement along the demand curve D_{F_0} from the point a to the point b. This movement is equivalent to a reduction of price from P_{F_0} to P_{F_1} in the primary market.

A consequence of the price reduction in the primary market implies a leftward/downward shift of the demand curve for the substitute good, golfing activities. This movement is captured in Figure 4(b) by the shift of demand curve from D_{G_0} to D_{G_1}. Assuming a upward-sloping supply in this secondary market implies a drop in price there, in particular, from P_{G_0} to P_{G_1}.

What is the measure of change in surplus in the secondary market? And, should we include that in our CBA?

As we discussed in the previous example (no price change), had there been no changes to the price, the downward shifting of the demand curve would not constitute any additional loss to consumer surplus that is not captured in the calculation of change of surplus in the primary market.

However, in this case, the drop in price in the secondary market implies existing consumers there would have a gain in surplus (they are paying less than what they were paying previously) and a drop in producer surplus (they are receiving less than what they were getting before).

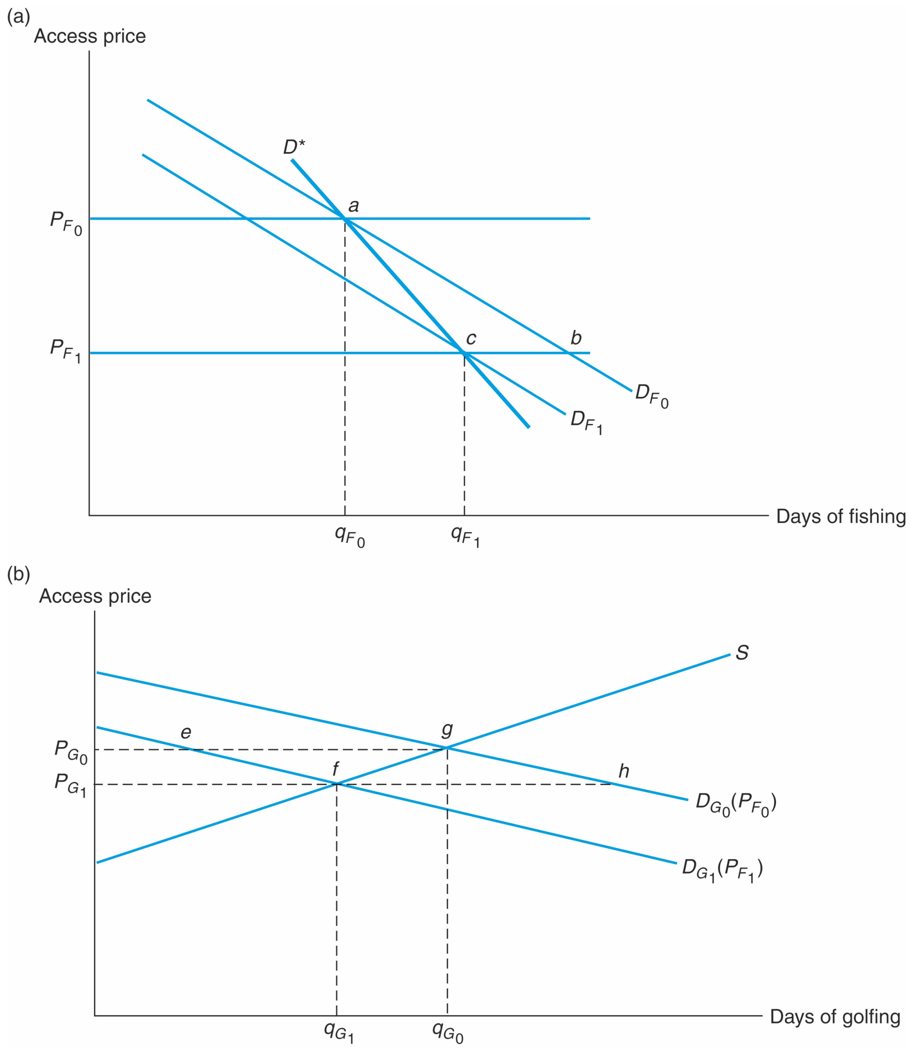


Figure 4: Efficient secondary market with price effect

But some of these changes are simply transfer between producers and consumers and should not constitute as a change of social surplus. To have a better estimate of the change, observe first what consumers might be gaining: the area $P_{G_0}efP_{G_1}$ - this is because the existing q_{G_1} consumers are experiencing the lower price (in addition to a lower willingness to pay).

In contrast, the producers would losing the area $P_{G_0}gfP_{G_1}$ - this is because the price drops and the consumer base is also shrinking.

The net effect is a loss of surplus the area efg in the secondary market, arising from the change in price and shrinking of the consumer base.

Should we take it into account in CBA?

This effect is solely a first-order price effect in the secondary market. Any alteration in the price of the substitute good within the secondary market should also impact the primary market. How do we assess the second-order feedback effect in the primary market?

A decline in price for the substitute good indicates a corresponding decrease in demand for fishing activities. This, in turn, results in a downward or leftward shift in the demand curve, leading to a reduction in prices within the primary market.

Given that we can anticipate a series of feedback effects between these two markets due to price changes, let's consider, for the purpose of our analysis, that the equilibrium price in the secondary market stabilizes at P_{F_1}, causing a corresponding shift in the demand curve to D_{F_1} in Figure 4(a). It's important to note that these demand schedules signify the demand for fishing activities while keeping prices in other markets constant. In particular, D_{F_0} and D_{F_1} represent the demands in the primary market when the price in the secondary market is held at P_{G_0} and P_{G_1}, respectively.

The initial equilibrium in the primary market is at point a and after the project is implemented, it moves to point c in Figure 4(a). Upon connecting these two points, we arrive at what we commonly refer to as an observed demand schedule D^*—representing the demand curve in the primary market without the assumption of constant prices in other markets.

From an empirical perspective, we frequently estimate the observed demand schedule rather than the demand schedule that presumes constant prices in other markets. However, quantifying surplus based on the observed demand schedule under-represents the change in consumer surplus in the primary market. It's measured by the area $P_{F_0}acP_{F_1}$ instead of the area $P_{F_0}abP_{F_1}$, which signifies the surplus gain in the primary market. The disparity is depicted by the triangle area abc —a measure of the underestimation when estimates are drawn from the observed demand schedule D^*.

The underestimation of surplus in the primary market, as determined by the area abc, is often a practical approximation for not estimating the loss in producer surplus within the secondary market, represented by the triangle area efg.

In fact, this approach of estimating surplus change based on the observed equilibrium demand schedule in the primary market, while disregarding the corresponding change in the secondary market (assuming the secondary markets are efficient), is recommended. This recommendation stems from the empirical difficulties involved in identifying all conceivable substitutes or complements for the primary good.

Taking into consideration our observation from the scenario where no price changes occur, as previously discussed, we can formulate a guiding principle here: *Irrespective of whether price adjustments occur in the secondary market, when measuring change of surplus in the primary market through empirically derived demand schedules that were estimated without holding prices constant in secondary markets, it is advisable to disregard effects in efficient secondary markets.*

Distorted secondary markets

If the secondary market has distortion or inefficiency, meaning that the price does not accurately represent the (social) marginal cost, the estimation of the surplus change in the primary market even using the observed equilibrium demand schedule will unfortunately overlook certain pertinent effects within the secondary market. This is because the changes in deadweight losses before and after the project will not be reflected in the measure of change in surplus in the primary market.

The following example, which is an extension of the previous example of stocking a lake with fish, can illustrate this possibility.

Suppose in the secondary market for fishing equipment, there is some negative externality from production, because of which the social marginal cost is higher than the private marginal cost of production. In this case, even in absence of the project, there will be excessive (socially costly) production. However, now with the implementation of the project, as the demand curve shifts further to the rights (because the market for fishing equipment faces a higher demand due to a drop in cost of fishing at the lake), there will be an additional deadweight loss, measured by the shaded area in Figure 5.

Similar distortionary effects can also be found in the secondary markets, due to government intervention, such as taxes, subsidies, quotas etc.

However, in practice, obtaining an accurate estimate of the surplus change in the secondary market, beyond what we can capture through our measurements in the primary market, is typically challenging and empirically complex. Estimation issues arise when attempting to gauge the extent of demand shifts in secondary markets, as well as when measuring the magnitude of these distortions.

If price fluctuations in secondary markets are expected to be minor, it is reasonable to anticipate that significant demand shifts are unlikely to occur in those markets. Consequently, even in cases where secondary markets experience distortions, disregarding these markets may lead to relatively minimal bias in CBA.

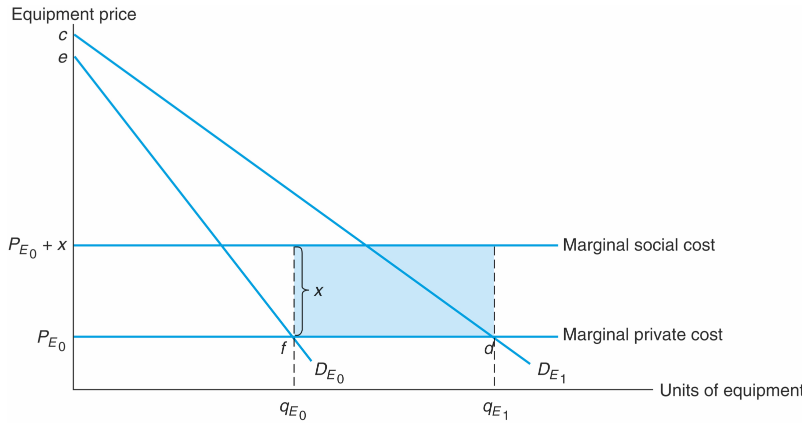


Figure 5: Secondary market with negative externality

Other sources of indirect effects

In the previous examples, the indirect effects in secondary markets stem from shifts in the demand for complementary or substitute goods due to price changes in the primary market. Additional sources of indirect effects may also be present; for example, a shift in the cost curve within markets where the primary good is used as an input.

While this effect differs in nature, a similar question arises: Can the change in surplus within these indirectly affected markets be adequately captured by concentrating solely on the change in surplus within the primary market?

In both scenarios, the recommendation remains consistent. If the indirectly affected markets are free from distortions, then we can disregard the indirect effects. However, in cases of distortion, it is important to acknowledge them, although we can anticipate that neglecting these markets might introduce relatively minimal bias, particularly if substantial price changes are not observed within those markets.

The argument unfolds as follows: Let's consider a situation where a policy intervention in the primary market leads to a reduced cost of input in another market. Naturally, this circumstance would likely increase producer surplus in the second market. Nevertheless, the degree to which producers can retain this surplus hinges on the competitive pressure within the second market. When competition is intense, producers are inclined to transfer this surplus to consumers by lowering prices (or if the goods are intermediary, it will raise consumer surplus in subsequent markets as well). However, as we've previously discussed in examples of demand shifts in secondary markets, such indirect increases in consumer surplus are already captured within the direct surplus gain achieved in the primary market. Our argument, however, relies on the efficient operation of secondary markets.

Quantifying effects in the input market

Before we delve into issues related to measuring changes in surplus in the input market, we briefly discuss the concept of a shadow price, which will frequently be utilized in our analysis. Remember that in an inefficient market, prices fail to precisely represent the real opportunity costs.

As an example, public universities have recently introduced student fees for non-EEA students. However, as of now, the exact amount is not determined through a market clearing mechanism. It's highly unlikely that this fee accurately represents the true incremental cost of education for the marginal applicant or their benefits. In some instances, we might not even encounter a fee or price – consider, for instance, the valuation of an industrial worker's accident at the workplace.

When prices are not readily observed, or when observed prices fail to accurately capture the social value of a good, we assign explicit values or adjust observed prices to align them as closely as possible with the correct social values. These adjusted prices are called shadow prices. These shadow prices, for instance, the value of a statistical life saved or the social cost of different pollutants, are essential elements of CBA and various methods are being used to determine them.

In some of our analyses below, particularly regarding the measurement of input costs in distorted markets, we assume the explicit utilization of shadow prices.

The central question of interest here is: *What is the cost of a project*?

The implementation of a project requires resources. Once resources are assigned to the project in question, they become unavailable for other productive activities. Consequently, every project entails an opportunity cost, which is the focal point of our measurement.

When assessing the opportunity cost of a project, it is important to consider whether the resources are sunk. In the scenario where a project is already underway and certain resources have been committed to the process, calculating the opportunity cost of the project at an interim stage requires identifying the most advantageous alternative utilization of those resources. For instance, if the optimal alternative involves selling those resources in the secondhand goods market after incurring scrapping costs, then the opportunity cost would be the difference between the price of the used goods and the scrapping cost. This might even result in a negative value.

In conceptual terms, this opportunity cost is equivalent to the value of the most valuable alternative uses of these resources. However, we might only have knowledge of the current budgetary expenditures we are incurring, such as the price times the volume of resources used. When does this expenditure accurately represent the opportunity cost, and when does it fall short of doing so?

The answer depends critically on how the input market functions and whether it is distorted or not.

As previously, we will first illustrate the case of an efficient market.

Measuring input costs in an efficient market

Assume that the input market is efficient, indicating that the factor price accurately represents the genuine marginal cost of the input. We can explore two distinct scenarios.

The first involves no price effect: the implementation of the project brings about no alteration in the factor price.

The second scenario deals with a price effect: the implementation of the project results in a change in the factor price.

Efficient input market and no price effect

An example of this case arises when the project increases the demand for an input, yet its price remains unaffected due to a perfectly elastic supply curve. This situation is more probable when the rise in demand for the input isn't substantial in relation to the overall national demand for that input.

Consider Figure 1. Assume that the project creates an additional demand for input, shifting the demand curve in the input market from D to $D+q'$. As the input supply is perfectly elastic, there is no change of price, the equilibrium point moves from a to b. The area under the supply curve represents the total opportunity costs of the factor. Consequently, the opportunity costs of using the additional q' units of inputs to the project is simply $P_0.q$, as measured by the shaded area abq_1q_0.

Therefore, in this case, the budgetary expenditure perfectly reflects the opportunity costs.

However, when the project's input has a perfectly inelastic supply curve, even if the input market functions efficiently, presents a different situation. Consider, for example, the government acquires land for the project, which could otherwise be traded in the private market where consumers could purchase it for developing buildings/houses.

In such situations, government often decides to pay a 'fair' market based price to the seller to acquire the land via eminent domain. Consider Figure 2, which presents a similar case. Here, the government expenditure is given by the area $PbAO$.

Does it also reflects the social opportunity costs of the input? No, it underestimates the costs. The reason is that the potential private buyers of the land lose consumer surplus, measured by the triangle aPb in Figure 2, as a result of the government taking away their opportunity to purchase land. This loss is not included in the government's purchase price.

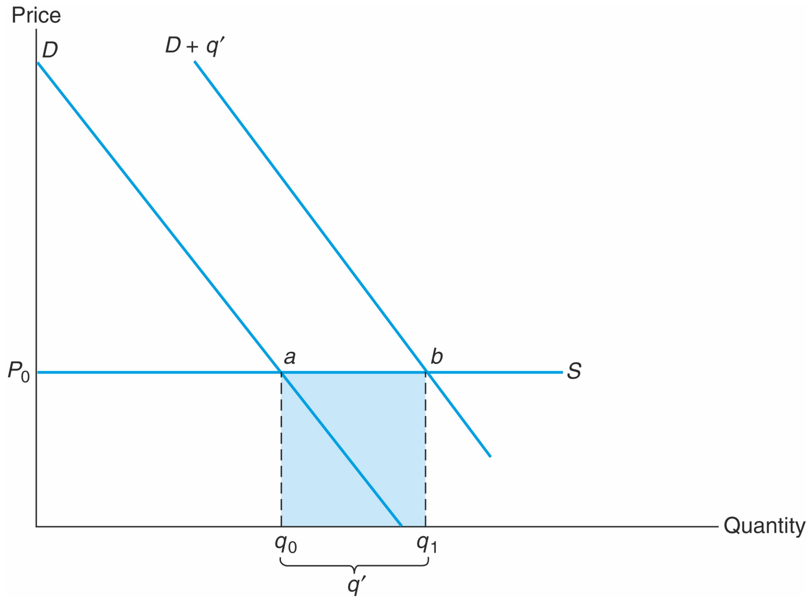


Figure 6: Efficient input market with perfectly elastic supply curve

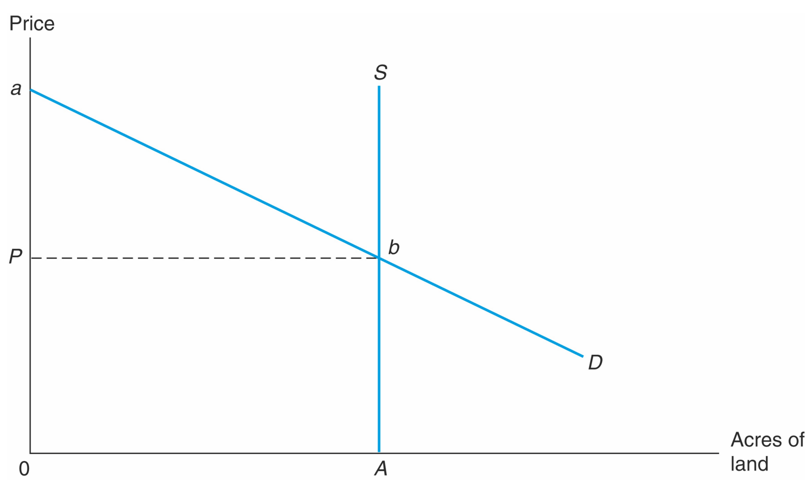


Figure 7: Efficient input market with perfectly inelastic supply curve

Efficient input market and significant price effect

When a large quantity of an input is purchased, its price may increase, even when purchased in an efficient market. In such a scenario, the project encounters an upward-sloping supply curve for the resource.

The price increase will have an adverse impact on the original buyers in the input market. Refer to Figure 3: The purchases made by the original buyers decrease from q_0 to q_2, while the total purchase of the input rises to $q_1 = q_2 + q'$.

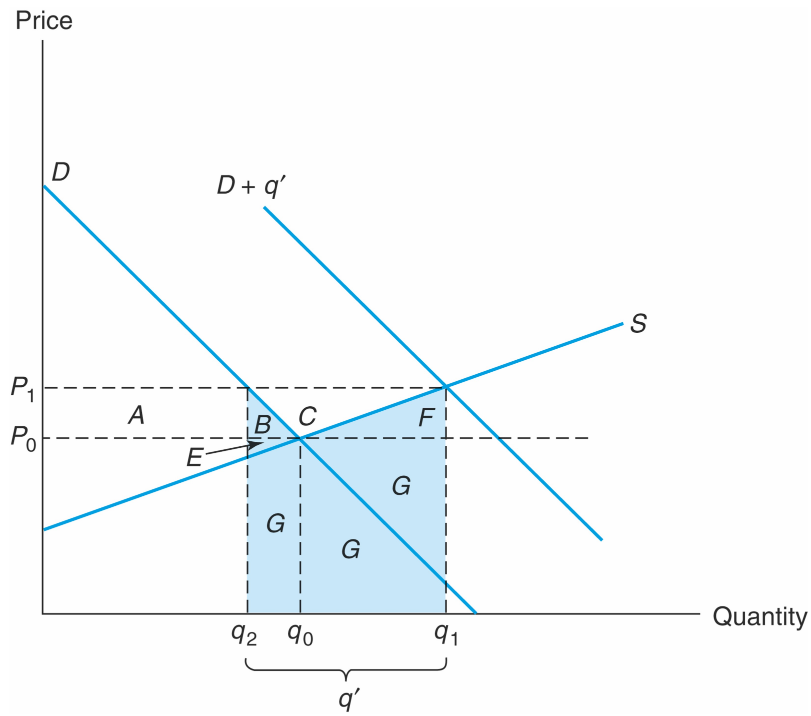


Figure 8: Change of price in an efficient input market

The q' units of the resource purchased by the project come from two distinct sources:
(1) units bid away from their previous buyers and
(2) additional units sold in the market.

For (1), there will be a transfer of surplus between consumer and producer, measured by A, and a loss of surplus, measured by $B + E$.

For (2), a part of total expenditure is a transfer to the producer surplus, measured by $B+E+C$, and the rest is the total cost of supplying $(q_1 - q_2)$ units of input, which is the area below the supply curve, measured by $G + F$.

However, when we measure the cost of the project simply by the budgetary expenditure, which is $P_1.q'$, we cover the whole area $B+C+E+G+F$, it does not exclude a potential transfer from the government in the form of producer surplus, measured by C. The budgetary expenditure therefore overestimates the true opportunity costs of the project.

Also, note that the true opportunity cost in this case actually exceed the real cost of supplying the input, which is measured by $G + F$.

Sometimes, instead of paying a fixed price (the cost of the marginal unit) for every unit, the government estimates the total cost of supply and purchases the aggregate volume at its cost value. In the above figure, this implies that the government expenditure in that case will be $G + F$. However, even then, the expenditure will not perfectly reflect the opportunity cost of the project, as it ignores the loss of surplus measured as B, which constitutes a part of the opportunity costs of the project.

The fundamental point here is that when prices change, budgetary outlays do not equal social costs. Unless the increase in prices is substantial, however, the change in social surplus will be small relative to the total budgetary costs. This suggests that in many instances, budgetary outlays will provide a fairly good approximation of the true social cost. If prices do increase significantly, though, budgetary costs need to be adjusted for CBA.

How do we make this adjustment in practice?

We often measure the opportunity cost by multiplying the amount purchased by the average of the new and old prices – that is, by $\frac{1}{2}(P_1 + P_0)$ times q'.

The average of the new and old prices here serves as a shadow price; it reflects the social opportunity cost of purchasing the resource more accurately than either the old price or the new price alone.

Measuring input costs in a distorted market

A variety of circumstances can lead to inefficiency, including the absence of a functioning market, market failures (e.g., public goods, externalities, monopolies, and information asymmetries), and distortions resulting from government interventions (such as taxes, subsidies, regulations, price ceilings, and price floors).

Any of these distortions can arise in factor markets, making the estimation of opportunity costs more complex. Shadow pricing becomes necessary to accurately measure the opportunity cost of inputs in such cases.

We will now discuss some of these scenarios:

1. The government makes purchases of an input that is in fixed supply.
2. The government hires labour from a market in which there is unemployment.
3. The government purchases inputs for a project from a monopolist.

Inputs with inelastic supply

When the supply of an input is fixed (e.g., due to an import quota), then a project will increase the market price of the input, thereby reducing the consumption of it by current consumers.

See Figure 4 and consider the pre-project input demand as D_b and post-project input demand as D'_b. Because of the project, price increases, and the government's budgetary expenditure will be $P_2.(Q_1 - Q_2)$.

Does it actually reflect the opportunity cost of the project? No.

To see this, note that a section of old consumers will no longer remain as consumers, measured by $Q_1 - Q_2$, which is replaced by the project's input demand.

Further, the existing consumers face an increase in price and thereby a loss of surplus. However, this loss of surplus for the current consumer is simply a transfer, and therefore, a gain in the form of producer surplus and would not appear in CBA.

For the outgoing consumer, the loss of consumer surplus is given by the triangular area below the demand curve D_b and above the price line P_1 for quantities between Q_1 and Q_2. The gain in producer surplus due to purchase of input for the project is the rectangle between the price lines P_2 and P_1 and for quantities between Q_1 and Q_2. The sum of two changes results in a positive net surplus in the form of producer surplus. Thus, a part of the government's budgetary expenditure is a transfer in the form of a producer surplus, which we would not have seen if the project was not undertaken.

To obtain an estimate of the opportunity costs, we would need to subtract this potential transfer from the government expenditure. As mentioned earlier, a common practice in this context is to determine the cost of the project by using the average of the old and new market prices as a shadow price.

Hiring unemployed labours

When the unemployment rate is high, a project is likely to draw a significant proportion of its workers from the unemployed labour force. If a portion of the labour input would have been unemployed in the absence of the project, how can we measure the opportunity cost of the project?

Consider Figure 4. Let's assume that, for certain reasons, such as union pressure or wage laws, there is a wage floor set at P_m. This implies that the employment level remains at L_d, while $L_s - L_d$ segments of the labour force are willing to work at the wage level of P_m but remain unemployed.

As a result of the project, let's suppose that labour demand shifts to$D + L'$, leading to the employment of an additional $L_t - L_d$ workers. The budgetary expenditure amounts to $P_m.(L_t - L_d)$; does this accurately reflect the opportunity cost of the project's use of labour?

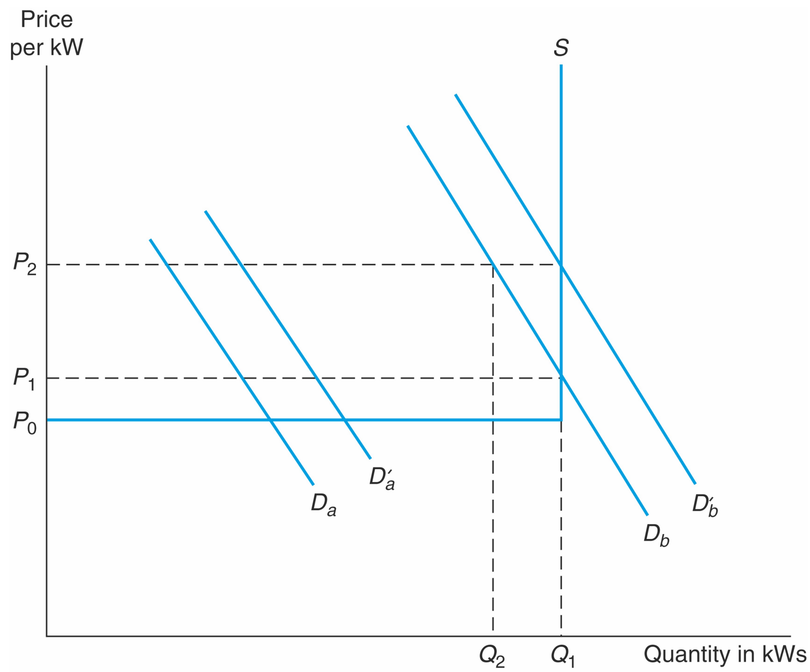


Figure 9: Input in fixed supply

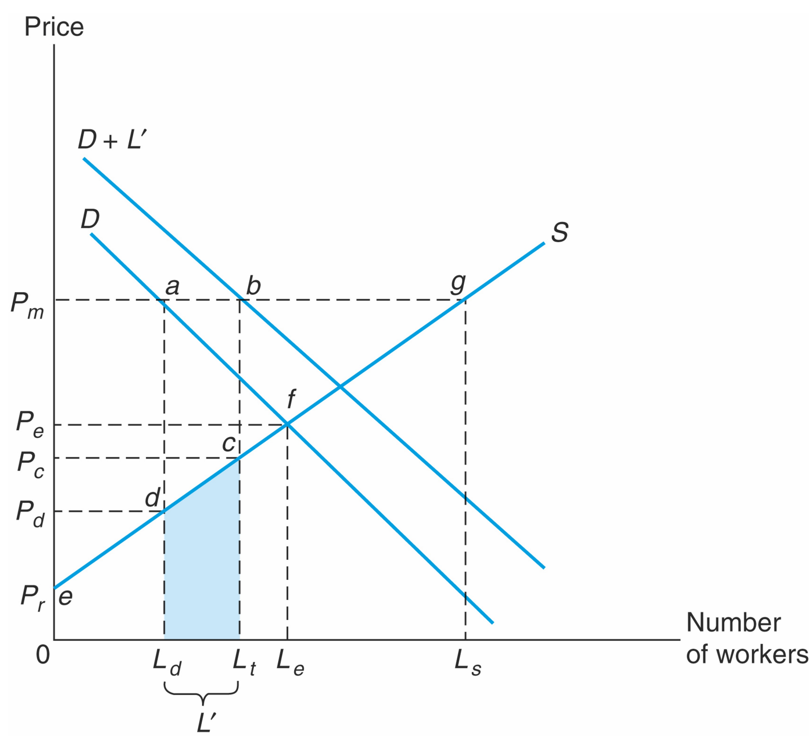


Figure 10: Labour supply with unemployment

Various solutions have been proposed in different scenarios, yet the issue remains quite complex. First, can we regard the opportunity cost as zero because these workers would be unemployed otherwise? Not necessarily, as doing so would imply treating the unemployed as if their time is valueless. This approach is inappropriate for two reasons.

First, many unemployed individuals are engaged in productive activities such as job searching, childcare, and home improvements. Second, even if the unemployed were entirely at leisure, leisure itself holds value for those enjoying it.

So, one possibility could be to estimate the wage at which they are willing to accept a job offer. In other words, this would provide us with a measure of their opportunity cost of labour, which is given by the shaded area in Figure 5.

However, this measure can still be inappropriate for the following reasons: The labour supply curve presents workers in the order of their respective willingness to accept a wage offer. When the project recruits workers, it may not necessarily be in the same order. Even those already employed are not necessarily the workers who are willing to accept lower wages. Therefore, the shaded area hardly captures the opportunity cost of labour for the new workers.

It is common practice to consider a shadow price, typically calculated as an average of P_m and the reservation wage P_r. However, there are empirical challenges associated with estimating the reservation wage, as it is likely to vary depending on the nature of work and the heterogeneity of the workforce. At times, a compromised solution is to use a shadow wage of $\frac{1}{2}P_m$.

Input market with a monopoly supplier

Consider a scenario where inputs are procured from a monopoly, as illustrated in Figure 6. Recall that the monopolist supplies up to the point where marginal revenue equals marginal cost.

In Figure 6, before the project, the monopolist supplies up to Q_1, and the price remains at P_1. With the project being implemented, the demand curve shifts to the right, resulting in an increase in both price and quantity sold to P_2 and Q_2, respectively.

The government's budgetary expenses is $P_2.(Q_2 - Q_3)$. Does it accurately reflect the opportunity costs? No, it is an overestimate.

To illustrate this, consider that the monopolist's producer surplus increases as it sells more at a higher price. Initially, a portion of the original buyers exits the market, resulting in a loss of surplus equivalent to area C. The remaining consumers, apart from the project, also experience a loss in surplus due to the high price, measured by B. However, the loss of B effectively transfers to the monopolist as an increase in her producer surplus. In addition to B, the monopolist also realizes an additional gain in her producer surplus, measured by the area $C + E + G$.

When we sum up the changes in the surplus of the existing consumers and the monopolist, we find a net positive gain, represented by the area $E+G$. The monopolist realizes this gain only because the project is implemented. Therefore, to obtain an accurate estimate of the project's opportunity cost, we must deduct this gain from the government expenditure, resulting in a true measurement represented by the area $C+A$.

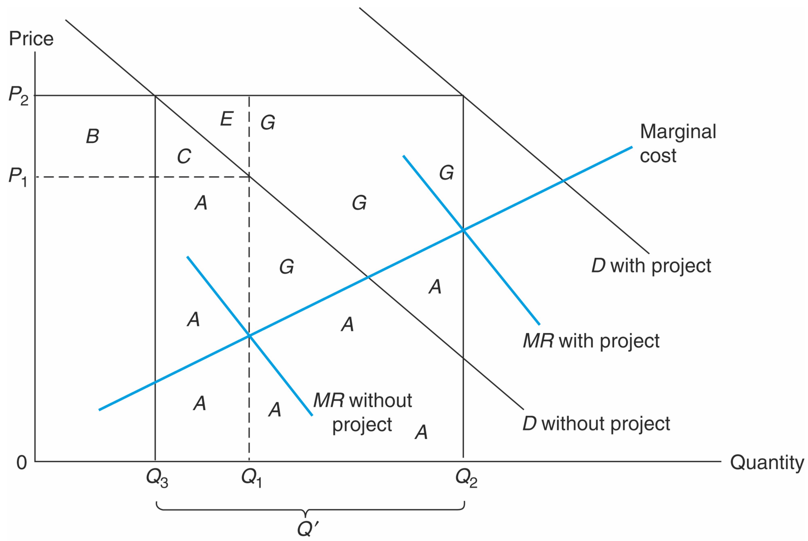


Figure 11: Input with a monopoly supplier

To rectify the overestimation of the opportunity cost, the price should be adjusted downward using shadow pricing. There is no fixed formula for this adjustment, but it's important to consider several contributing factors to the overestimation. These factors include the steepness of the demand and supply curves, the extent of price change, and more.

For instance, the error resulting from the use of unadjusted budgetary expenditures may not be significant if the price charged by the monopolist is not substantially higher than the marginal cost, indicating that the monopoly lacks significant market power.

Other distortions

There can be other sources of distortion in the input market, for instance, taxes or subsidies, and externalities.

If supply of an input is taxed, direct expenditures overestimate the opportunity cost; if subsidized, expenditures underestimate the opportunity cost.

If there are positive externalities of the input supply, expenditures overestimate the opportunity cost; in presence of negative externalities, expenditures underestimate the opportunity costs.

An essential part of CBA is to understand the extent to which the budgetary expenditure accurately represents the opportunity costs of the project. As demonstrated by the previous examples, there are several reasons why it might fail to reflect the true cost. While the concept of using a shadow price helps in correcting possible over- and under-estimations of the project's costs, determining an appropriate shadow price is also a complex exercise.

Reading materials

1. Boardman et al. Chapters 5, 6 and 7.
2. "Veileder i samfunnsøkonomiske analyser" section 3 and 4.