SOK-2014 . Fall 2023

Lecture note

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[*This lecture note covers materials from various sources. Supplementary reading materials includes GdR Chapter 4, and some additional reading materials (Supl.3-ch 6) that will be posted in Canvas/course webpage. In addition, also consult the "Veileder i samfunnsøkonomiske analyser" section 3.3, and 3.4*]

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.

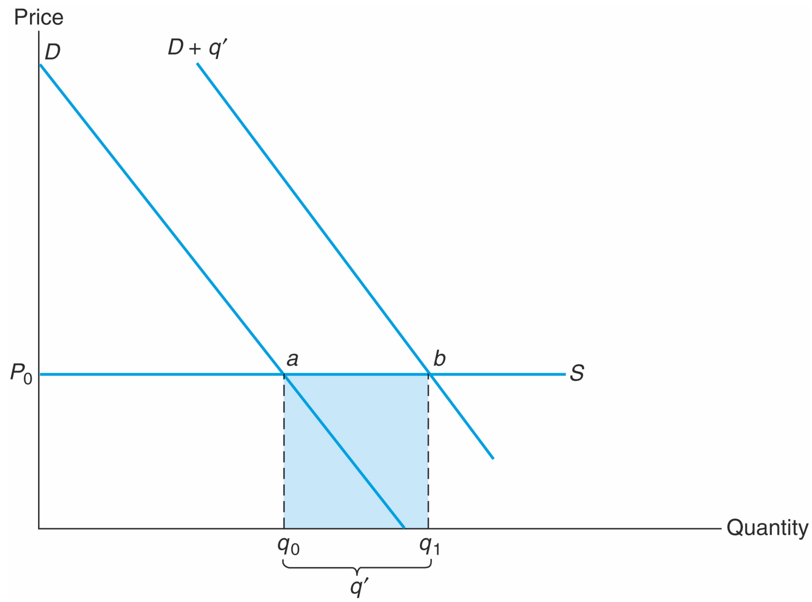

Figure 1: Efficient input market with perfectly elastic supply curve

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.

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.

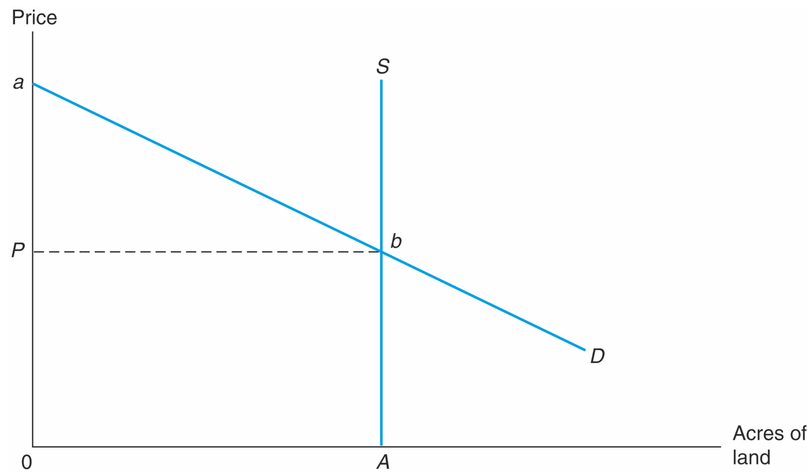

Figure 2: Efficient input market with perfectly inelastic supply curve

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 $q_1 = q_2 + q'$.

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.

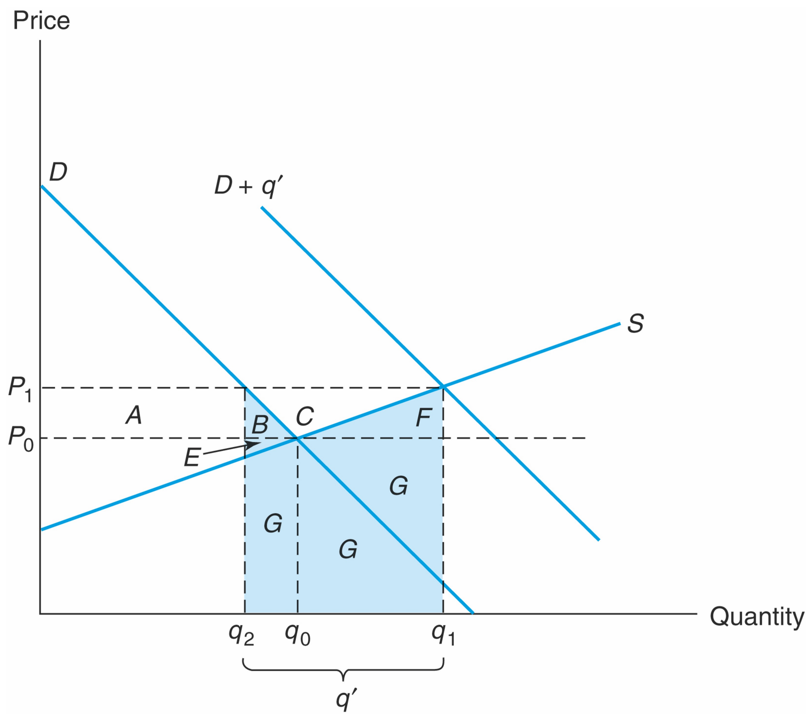

Figure 3: Change of price in an efficient input market

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.

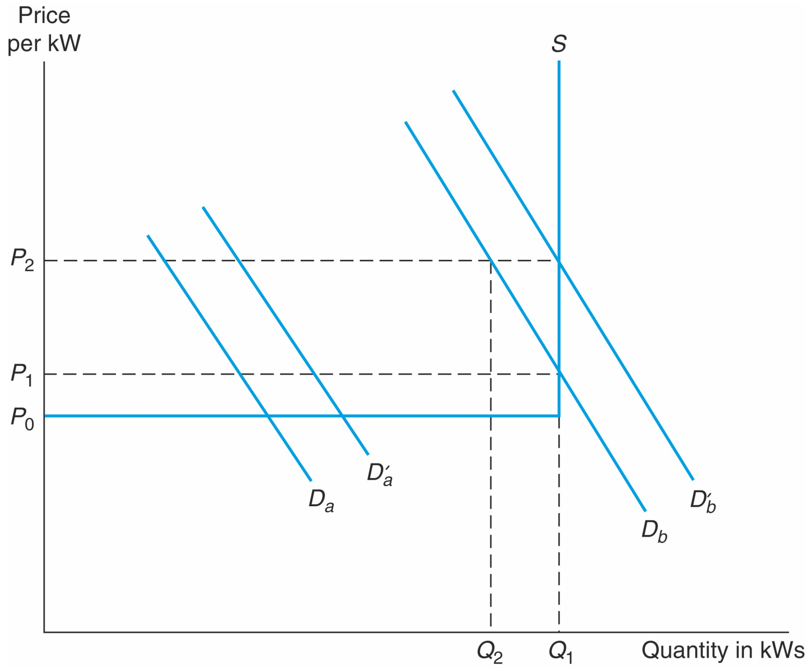

Figure 4: Input in fixed supply

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?

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,

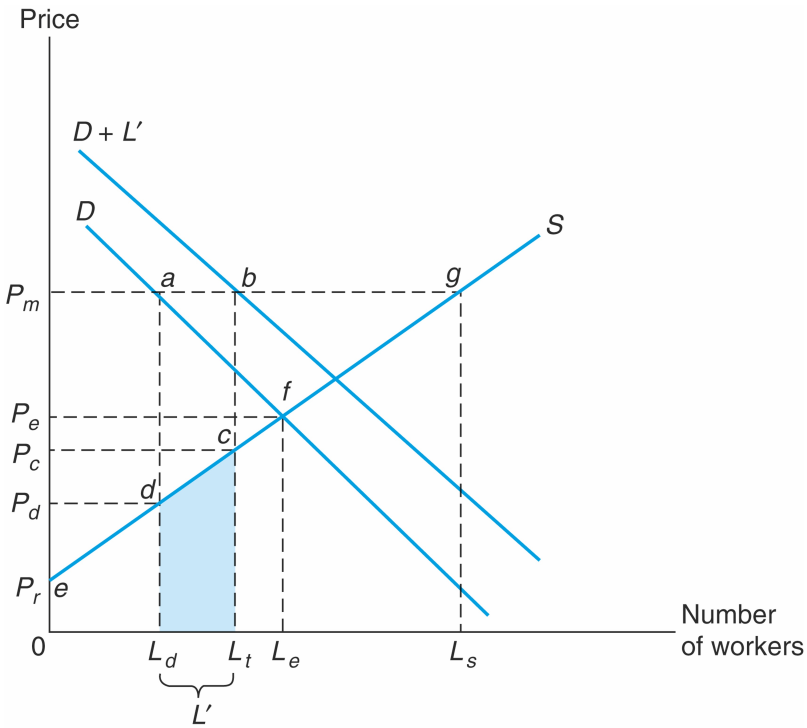

Figure 5: Labour supply with unemployment

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 $C + A$.

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

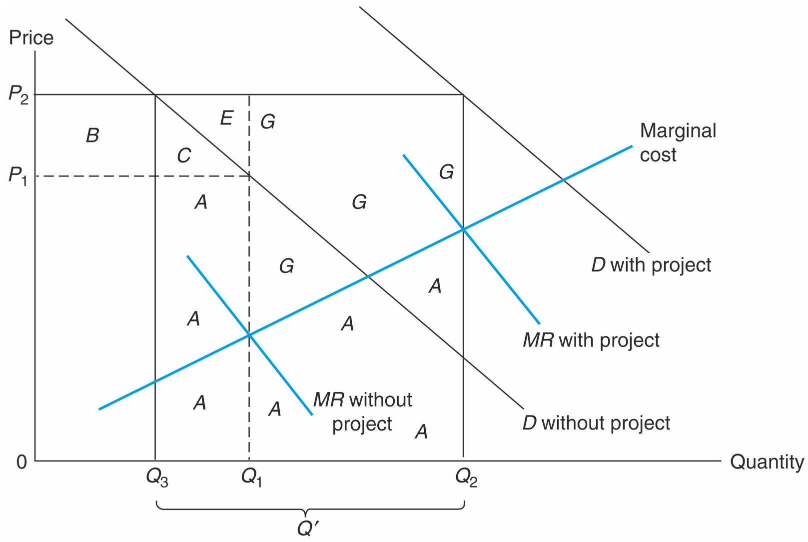

Figure 6: Input with a monopoly supplier

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.