ABSTRACT

Non-tradable items are those which are not traded internationally. They include items such as services where the demander and producer must be in the same location, and commodities which have low value relative to either their weight or volume. In such cases the transportation charges prevent producers from profitably exporting their goods. Typically, non-tradable goods include such items as electricity, water supply, all public services, hotel accommodation, real estate, construction, local transportation; goods with very high transportation costs such as gravel; and commodities produced to meet special customs or conditions of the country. The key element to be borne in mind when considering the tradable and non-tradable classification is where the price for the good (or service) in question is determined. If this determination takes place in the world market, the good should be considered tradable. If the setting of the price takes place by supply and demand in the local market, the good should be considered non-tradable. This chapter describes how the economic prices of non-tradable goods and services are estimated.


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Keywords: Non-Tradable, Economic Prices, Tax Externalities
CHAPTER 11

ECONOMIC PRICES FOR NON-TRADABLE GOODS AND SERVICES

11.1 Introduction

Non-tradable items are those which are not traded internationally. They include items such as services where the demander and producer must be in the same location, and commodities which have low value relative to either their weight or volume. In such cases the transportation charges prevent producers from profitably exporting their goods. Typically, non-tradable goods include such items as electricity, water supply, all public services, hotel accommodation, real estate, construction, local transportation; goods with very high transportation costs such as gravel; and commodities produced to meet special customs or conditions of the country.

The key element to be borne in mind when considering the tradable and non-tradable classification is where the price for the good (or service) in question is determined. If this determination takes place in the world market, the good should be considered tradable. If the setting of the price takes place by supply and demand in the local market, the good should be considered non-tradable.

High rates of protection can easily cause a good which is internationally tradable to end up being properly classed as non-tradable. One example is rice in Japan, where imports until recently were explicitly forbidden, and where the internal price typically has been more than double the international price. Another is grocery items from advanced countries, which often sell in developing country markets for significant multiples of their fob price. Such high prices, whether caused by tariffs or by the low-volume, high markup characteristics of the imported good, lead to situations in which “similar” locally produced items have their prices determined by supply and demand in the local market,
well under the “umbrella” price of the imported counterpart but still not being exported. When the price of locally produced merchandise is well below the “corresponding” local price of imported items, it is quite appropriate to treat local production as non-tradable, despite the anomalous price relationship.

If the cif price adjusted to include tariffs, taxes and import subsidies is greater than the market price and no imports of the good are present in the country, then it is clearly a non-tradable good from the point of view of that country or region of the country. Imports cannot compete with domestic production, at least with the existing level of tariff protection. Alternatively, if the fob price, less export duties but inclusive of any export subsidies, is less than the domestic market price of the item and no exports of the commodity are taking place, then again it is non-tradable. The standard relationships among the adjusted cif, adjusted fob and the market prices are illustrated in Figure 11.1 for the case of limestone.

**Figure 11.1  World Prices, Domestic Price and Non-tradable Goods**

-- The Case of Limestone --
As the cif price, plus tariffs less import subsidies (P₁) on limestone, is above the domestic market price (P₀), the domestic demanders will be unwilling to purchase imported limestone. Similarly, since the fob price, less export duties plus export subsidies (P₂), is less than the market price, domestic producers will be unwilling to sell abroad for a lower price than they can sell to domestic demanders.

**11.1.1 Relationship between Tradable and Non-tradable Goods**

The distinction between tradable and non-tradable goods is quite naturally right at the core of the field of international economics, and it carries over quite well to the field of cost-benefit analysis. In this area, however, a special case arises with respect to items that have no market prices, but must nevertheless be assigned a value for project evaluation purposes. Examples are the value of time saved as a result of a highway improvement, or the amenity values created by a public park or other cases where consumer surplus benefits are assigned, on top of actual market prices paid. Such items, not being actual outlays (or receipts) are not subject to shadow pricing. All actual cash outlays and receipts, however, should in principle, be classifiable as referring to one of the two grand categories, tradables and non-tradables.

To see how this distinction arises, and how it works, let us here simulate a certain path of evolution in our professional thinking about project evaluation. At the first step in this process, people focused on the actual imports that were made by a project, and the actual exports of its products. The cost of the imports reduced to the cost of acquiring the foreign exchange needed to buy them, and the value generated by the project’s exports was the value of the foreign exchange that they produced. Even at this early stage there was a clear need to calculate an economic opportunity cost of foreign exchange, in order
to accurately reflect the true economic costs (in local currency) of the project’s imports and the corresponding true economic benefits of its exports.

This step, however, was only the beginning. For it soon became clear that there was also domestic production of many of a country’s imported goods, and similarly, domestic use of many of its export products. In these cases, it really didn’t matter whether the copper bought by a project was domestically produced or imported -- copper bought from a domestic source in the U.S. would simply lead to somebody else importing an equivalent amount, and wheat demanded by a Canadian project would leave that much less wheat to be exported. Using $T_d$ and $T_s$ to represent the country’s own demand and supply of importable good $i$, we have that imports of $i$ ($M_i$) are equal to $T_d^i - T_s^i$. Similarly, using $T_j$ and $T_s$ to represent the country’s own demand and supply for exportable goods $j$, we see that exports of that good ($X_j$) are equal to $T_s^j - T_d^j$.

Now the country’s total imports ($M$) can be represented as:

$$M = \sum_i M_i = \sum_i T_d^i - \sum_i T_s^i$$

Similarly, its total exports ($X$) can be represented as:

$$X = \sum_j X_j = \sum_j T_s^j - \sum_j T_d^j$$

The country’s balance of trade is accordingly:

$$X - M = \sum_j T_s^j - \sum_j T_d^j - \left( \sum_i T_d^i - \sum_i T_s^i \right)$$

$$= \left( \sum_j T_s^j + \sum_i T_i^j \right) - \left( \sum_i T_d^i + \sum_i T_s^i \right) = T_d^i - T_s^i$$
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Here $T_s$ represents the sum of a country’s total supplies of all tradables $(\sum T_j^s + \sum T_i^s)$ and $T_d$ is the sum of its total demands for all tradables $(\sum T_j^d + \sum T_i^d)$.

From here it follows that when there is equilibrium in a country’s trade balance, there is also equilibrium between that country’s total demand and supply for tradables. Similarly, a given deficit $(M-X)$ in a country’s trade will reflect an excess demand of equal size $(T_d T_s)$ for that country’s total tradables.

The evolution of our ideas and procedures then moves a step further. It is certainly not enough just to look at the project’s own actual imports and actual exports (step one). Nor is it enough to extend this just by considering the project’s direct demand for and supply of tradable goods (step two). What is needed is a yet further extension to include the project’s overall impact on the country’s demand and supply of tradable goods (step three).

Although in principle a project may have more reverberations than we can conveniently capture the basic procedure that we suggest concentrates on the flows of “receipts” (sale of project output) and expenditures (project outlays for investment activities plus operating costs) over the course of a project’s economic life.

The division of project outlays is represented in Table 11.1. When the project purchases tradables directly, the purchases are classified under item 1. This is true regardless of whether we bought goods that were actually imported, or goods that were domestically-produced items falling in the “importable” category, or goods that were domestically produced but falling in the “exportable” category. It is deemed that all three of these categories put pressure on the foreign exchange market either via direct demand (a) or via indirect demand (b), in which others do the importing, or via reduced export supply (c).
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When the project purchases non-tradables the story is a bit more complicated, because there are various ways in which this type of purchase can end up being reflected in incremental demand for tradables. We first look at that part of the project’s non-tradables purchased \((d)\) that ends up as increased output of the goods or services in question. This increased output will be reflected either in increased value added \((d_1)\) or increased tradable inputs \((d_2)\) or increased non-tradable inputs \((d_3)\).

But the above does not tell the whole story, except when our project’s full demand for non-tradables is met through increases in their supply. In the typical case, some fraction \(f^d_k\) of our project’s demand will be met by squeezing out other demanders for the non-tradable goods and services in question. As we look for the consequences of this process, we must ask about the activities that are stimulated as some of the previous demanders of \(H_k\) reassign that demand to other activities. In particular we have to recognize that some of the relevant substitutes for \(H_k\) will themselves be tradable items, while others of the substitutes will, though non-tradable themselves, have tradable inputs. This is why, in Table 11.1 we have two items \((e_1 \text{ and } e_2)\) representing increases in tradables demand arising out of what happens when our project satisfies some of its extra demand for nontradables by displacing other demands for them.

Table 11.2 presents a numerical example, which may help readers see that the framework presented here is in the final analysis quite simple and straightforward. Here the direct outlays of the project are assumed to be divided 40 to direct purchase of tradables and 60 to the direct purchase of non-tradables. All of the amount spent on tradables stays there. The ground for this is that there is presumably no incremental domestic production of tradables arising out of our project’s demand.

Things are different when it comes to our project’s demand for non-tradables. Here there is every reason to believe that some increased production will be stimulated, but this will involve greater value added plus greater use of both tradable and non-tradable inputs.
Thus, in the example of Table 11.2, we have 60 spent on construction of buildings by the project, of which 28 represents a net increase in construction and 32 represents a displacement of the demand of others; of the 28 of net increase, 6 are assumed to reflect increased demand for tradable inputs ($d_2$), while 22 reflect either increased value added in construction (14) or increased use of non-tradable inputs (8).

We now turn to the items representing project demand met through displacing other construction. What we are looking for here is not what resources were used to satisfy the demand before it was displaced. These resources are assumed now to be satisfying our project’s demand. What we really want to learn about is what resources will be used in other places to satisfy the demand of others, which our project has managed to displace.

In item e it is assumed that part of this displaced demand (7) moves directly to the purchase of tradable substitutes. The remaining 25 is assumed to be shifted to non-tradables substitutes. But here it contains three components: tradable inputs (materials) taking 9, non-tradable inputs (purchased services) taking 6, and value added taking 10. In all, then, the correct division of our 100 of project outlays is 62 to tradables and 38 to non-tradables, almost the reverse of the initial 40 - 60 division of the direct expenditures.

In terms of the 60 of non-tradables purchased, its tradable content as a proportion of the total purchased is $T = 22/60 = 0.36$ and $NT = 38/60 = 0.64$. 
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Table 11.1
Classification of Project Outlays

<table>
<thead>
<tr>
<th>Final Classification</th>
<th>Tradable (T)</th>
<th>Non-Tradable (H)</th>
</tr>
</thead>
</table>

1. Project Purchases of Tradables
   a. Actual Imports by Project (Mi)  X
   b. Importable Goods Produced in the Country (T_s)  X
   c. Exportable Goods Produced in the Country (T_s)  X

2. Project Purchases of Non-Tradables (H_p_k)
   d. Project Demand Met Through Increased Domestic Supply
      \[ (f_{s_p}^{s_p} P_{k H}) = \Delta H_k \]
      \[ d_1 \text{ Value added in activity } k = (v_k \Delta H_s)_k \]  X
      \[ d_2 \text{ Tradable inputs into activity } k = a_t k (\Delta H_s)_k \]  X
      \[ d_3 \text{ Non-tradable inputs into activity } k = a_h k (\Delta H_s)_k \]  X
   e. Project Demand for (H_p_k) Met Through Displacing
      Other Demanders (f_{d_p}^{d_p} H_k) = (-\Delta H_k)
      \[ e_1 \text{ Demand displaced into tradable substitutes } b_t k (-\Delta H_d)_k \]  X
      \[ e_2 \text{ Demand displaced into non-tradable substitutes } b_h k (-\Delta H_d)_k \]  X

\[ b_h k (-\Delta H_d)_k \]
\[ \text{value added } e_{2v} = v_h k b_{h k} (-\Delta H_d)_k \]  X
\[ \text{tradable inputs } e_{2t} = c_t k b_{h k} (-\Delta H_d)_k \]  X
\[ \text{non-tradable } e_{2n} = c_h k b_{h k} (-\Delta H_d)_k \]  X
### Table 11.2
Classification of Project Outlays -- Numerical Example

<table>
<thead>
<tr>
<th>Final Classification</th>
<th>Tradable (T)</th>
<th>Non-Tradable (H)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Project Buys Tradable Goods (40)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Actual Imports of Vehicles</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>b. Petroleum (an Importable) from Local Sources</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>c. Cotton (an Exportable) from Local Sources</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Sub-Total for Tradable Outlays</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>2. Project Constructs Buildings (Non-Tradables) (60)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Project Demand met through net increase in construction (28)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d1. Value added in this increase in construction</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>d2. Tradable inputs used in same (materials)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>d3. Non-tradable inputs used in same (purchased services)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>e. Project Demand met through displacing other construction (32)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e1. Demand displaced into tradable substitutes (machinery and equipment)</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>e2. Demand displaced into non-tradable substitutes (maintenance and repair)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e2l (materials)</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>e2h (purchased services)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>e2v (value added in maintenance &amp; repair)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Sub-Total for Non-Tradable Outlays</td>
<td>22</td>
<td>38</td>
</tr>
<tr>
<td>Totals for Project</td>
<td>62</td>
<td>38</td>
</tr>
</tbody>
</table>
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11.1.2 Economic Valuation of Non-Tradables

The estimation of the economic costs or benefits for tradable goods is simplified by the assumption that world prices of these goods and services can be taken as given. Unfortunately, the analysis is more complicated for non-tradable goods. It is similar, however, to the tradable case when supplies of the non-tradable goods in question are highly elastic. In such a case when more of a non-tradable is purchased by a project any tax paid on the input’s purchase is included in the project’s financial cost. Such taxes are excluded from the costs when estimating the economic cost of the input since the tax is not a true economic cost.

When a non-tradable good or service is produced purely by non-tradable inputs, the premium for expenditures on non-tradable goods and services, NTP, (calculated from the estimate of the shadow price of non-tradable outlays, SPNTO) should be added to the net of tax financial cost of the item purchased. The estimated value of NTP captures the value of the externalities lost when funds to finance the project’s costs are raised from the capital market and the proceeds are used to buy non-tradable goods. The converse is also true. The value of NTP also measures the value of the externalities gained per dollar of output produced when the project sells a non-tradable output.

If our project produces or demands a standard non-tradable good with an upward-sloping supply curve and downward-sloping demand curve, their economic values are determined by the demand and supply of the good as well as the impact of the act on the rest of the economy. These cases are discussed in detail in the following sections.

Section 11.2 describes how the economic value of non-tradable outputs can be measured in the case of infinite supply elasticity. Section 11.3 considers the case of a non-tradable good in the standard supply and demand framework. Section 11.4 identifies some unique features of applying economic prices to the measurement of net economic benefits of a
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project. Section 11.5 provides an example how the economic value of a non-tradable project input can be measured. Conclusions are made in the final section.

11.2 The Case of Infinite Supply Elasticity

The simplest case is for a project producing non-tradable outputs where its market supply function is infinitely elastic.\(^1\) Electricity projects make an almost ideal case in point, for a number of reasons. First, the true intrinsic value of electricity to its demanders is quite hard to gauge. Second, electricity projects can take many forms -- run-of-the-stream hydro projects, daily reservoirs, seasonal dams, inter-annual storage dams, plus many others. To some, it seems almost hopeless to try to measure the benefits of each such project (heterogeneous even within any one of the listed types). Such fears are calmed, however, once it is realized that the true measure of the benefits of almost any type of electricity project is the alternative cost of generating a similar flow of energy by some more “standard” means. Standard alternatives exist, and they are in highly elastic supply. They consist of thermal generators of different types, which can closely approximate the type of energy flow that is likely to come from any given “idiosyncratic” project (with its own pattern of costs). The use of data in different types of thermal generating facilities enables us to give an alternative cost (= economic price) of energy of any given description (base load, peaking capacity, etc.). We can then calculate the economic cost of approximately replicating the energy output of any given new project. When the project is undertaken, its benefit is measured by the alternative cost of generating an equivalent flow of energy by “standard” thermal means. Such costs would be largely for tradable inputs -- the generators themselves, the fuel that would be used, etc.

Consequently their foreign exchange costs will have to be inflated to take into account the existence of a foreign exchange premium. Additionally, non-tradable outlays would have to be adjusted to reflect the shadow price applying to them.

\(^1\) For the supply of the output to be in perfectly elastic supply, it will also require all the inputs used in producing the output to also be in perfectly elastic supply. The infinite elasticity assumption is a good approximation of the economic value of a non-tradable good, especially in the long run, which is most relevant for the present analysis.
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The end result of such an exercise would be the economic opportunity cost of providing the same energy of our project, but by standard thermal means. Our new plant, which is producing output $x$, would be worthwhile if its cost, appropriately adjusted to reflect economic rather than financial considerations, were less than (or at most equal to) those of its standard thermal alternative.

In this situation the value assigned to the electricity generated by our new plant is the value of the resources saved by not having to generate the electricity by alternative means. In the terminology of the three basic postulates of applied welfare economics\footnote{Arnold C. Harberger, “Three Basic Postulates for Applied Welfare Economics,” Journal of Economic Literature, IX, No. 3, (September, 1971).} this economic value, $P^e_x$ is equal to the supply price of the alternative electricity service of $P^x$. In some situations the market price, $P^x$, of this alternative generation technology may not reflect its true economic price. For example, this economic price would exclude any taxes that might exist on the fuel used by the alternative source of supply. These taxes might include such items as tariffs, excise and value added taxes on tradable goods, and value added taxes and excise taxes on non-tradable goods and services. Such taxes on inputs are not a resource saving or cost, but are transfers to the government. This adjustment is equal to $\Sigma a_{i,x}P_{i,m}d_i$ where $a_{i,x}$ is the input-output coefficient of the input, $i$, used to produce a unit of $x$, while $P_{i,m}$ is the price of a specific input $i$, and $d_i$ is the tax wedge associated with the use of input $i$ in the production of $x$. In this case the economic price of electricity is,

$$P^e_x = P_{nx} - \Sigma a_{i,x}P_{i,m}d_i$$

(11.1)

Note that $d_i$ expresses the tax or subsidy wedge as a fraction of the market price, $P_i$.

Suppose the inputs used in the production of electricity by the other electricity suppliers
are made up of tradable inputs equal to a proportion \((T_x)\) of the total costs of production, and non-tradable inputs equal to a proportion \((N_T_x)\) of total costs. In deriving the economic value of a unit of electricity produced by our project a final adjustment must be made for the foreign exchange premium on the tradable resources released (FEP), and the value of the premium on non-tradable outlays (NTP) released by the alternative suppliers. In the case of thermal electricity supply we would expect \(T_x\) to be close to 1 and \(N_T_x\) to be quite small. Of course, \(T_x + N_T_x = 1\), by definition.

This adjustment is an additional benefit that arises as tradable and non-tradable resources that are now made available to the economy as a consequence of our new plant’s increase in supply. It measures the value of the generalized economic externalities enjoyed by the economy when resources are released as a consequence of our project. The opposite situation would exist if our project were demanding additional electricity that would be entirely supplied by these alternative generation facilities. Now the generalized externality would be counted as an additional economic cost of the input purchased. To summarize, in this special case of an infinitely elastic supply of alternative production, the economic value of a unit of good \(x\) being produced by our project is equal to:

\[
p^e_x = p^n_x - \sum_{i \in \text{prod}} p^m_{im} d_i + [p^n_x \times T_x \times FEP] + [p^n_x \times N_T_x \times NTP]
\]

\[(11.2)\]

### 11.3 A Non-Tradable Good in the Standard Supply-and-Demand Framework

Many markets for non-tradable goods (whether they be items that are produced by a project or goods and services that are purchased to build or operate a project) are characterized by upward sloping supply curves. In this section we first want to consider the steps in the economic evaluation of an output of a project that changes the price of the good or service. Following that we will consider how this mechanism can be used to value the economic cost of non-tradable inputs purchased by a project.

#### 11.3.1 Economic Value of a Non-Tradable Output of a Project
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For some non-tradable goods, the increase in output of a new project will lower the price of the good and hence will cause some displacement of alternative sources of supply. At the same time the lower price will create some incremental demand. This is a natural outcome of the standard supply-and-demand framework with upward-rising supply and downward-sloping demand curves.\(^3\) In this case some fraction of output of the new project will be reflected in a movement backward along the supply curve of the other sources of supply of the same goods, plus a movement forward along the total market demand curve for the good in question. The fractions applying to supply and demand (\(W^s\) and \(W^d\)) can be calculated using the price elasticity of supply (\(\varepsilon^s\)) and demand (\(\eta^d\)) for the goods\(^4\) as: 

\[
W^s = \frac{\varepsilon^s}{(\varepsilon^s - \eta^d)} \quad \text{and} \quad \frac{W^d = -\frac{\eta^d}{(\varepsilon^s - \eta^d)}}{}
\]

The economic prices associated with the changes in supply and demand as a result of a project are measured using the principles of applied welfare economics. Let \(P_x\) be the supply price per unit produced by those other than the project and \(P^d\) be the demand price per unit by domestic demanders of the good in question (project output plus other supply). The economic price (\(P^e_x\)) per unit of a non-tradable good \(x\) produced by a project can be measured by a weighted average of its supply price (\(P^s_x\)) and the demand price (\(P^d\)). The weights reflect the responsiveness of existing suppliers and demanders to changes in the price of the non-tradable good. That is:

\[
P^e_x = W^s_x P^s_x + W^d_x P^d_x \quad (11.3)
\]

where \(W^s_x + W^d_x = 1\).

\(^3\) Some of the concepts for measuring economic welfare changes are elaborated further in Appendix 11A. \(^4\) The relevant elasticities are those would characterize the markets in reaction on average over the life of the project.
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Let us now introduce distortions in the output market for the item. Suppose there is a production subsidy, $k_x$, expressed as a proportion of the net of subsidy price. In our terminology the marginal costs of production is defined as the good’s supply price, $P_x$. In addition, there is a tax levied at the rate of $t_x$ on the market price $P_x$. This is the price that the supplier receives excluding any taxes that might have been paid by final consumer. The supply and the demand prices are thus, $P^s_x = P_m (1 + k_x)$ and $P^d_x = P_m (1 + t_x)$. Equation (11.3) can then be expressed as follows:

$$P^e_x = P_m (1 + W^s_x k_x + W^d_x t_x)$$ (11.4)

The conversion factor, obtained by dividing the economic value per unit of output equation (11.4) by its financial price exclusive of tax and subsidy, is equal to one plus a weighted average of the distortions in the product in the market, i.e. $P^s_x / P_m = (1 + W^s_x k_x + W^d_x t_x)$. However, if the financial price is inclusive of tax, the conversion factor will be equal to $P^e_x / [P^m_x (1 + t_x)]$. This may seem to be similar to the tradable case, but our problem is more complicated due to the impact that the project’s output has on other distorted markets and the reallocation of resources in the economy.

In a standard supply-and-demand framework with upward-rising supply and downward-sloping demand curves, the economic price ($P_x$) of a non-tradable good $x$, can be estimated in a partial equilibrium analysis as a weighted average of the supply price ($P^s_x$) and the demand price ($P^d_x$) as expressed in equation (11.4). The supply price of the product is measured by what producers actually receive (i.e. gross of any subsidy and net of any tax). The demand price is measured by what demanders actually pay (gross of tax). Suppose the good $x$ is a telephone service produced by mobile telephones. The supply that the mobile telephone project displaces is likely to be communication services produced by the existing land-line telephones. The existing supply from all sources is

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5 If instead, and perhaps more realistic, the subsidy could be provided as a proportion, $K'_x$, of the total resource costs, then $P^s_x (1 - K'_x) = P^m_x$, hence $P^e_x = P^m_x / (1 - K'_x)$. 

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assumed to receive a direct subsidy from the government equal to a fraction \((k_x)\) of all their financial costs. Including the items discussed so far, the economic value of good \(x\) is shown by the shaded areas of Figure 11.2.

**Figure 11.2: Economic Costs of a Project:**

-- When a production subsidy is present --

On the demand side of equation (11.4), the amount of income spent on the incremental increase in the quantity of \(x\) demanded, measured by \(W_x p^d_x\), will no longer be spent on other goods and services in the economy. In general, we would expect that some taxes would have been paid on these goods and services no longer being purchased. This effect should be captured by adding an economic cost (reducing the benefit) as the taxes associated with purchases of those goods and services are now forgone. Since we don’t know precisely where those goods and services would be forgone, an average indirect tax distortion rate \((d^*)\) on these items is assigned. Hence, the offsetting loss in taxes due to the diversion of demand toward good \(x\) will be \(W_x p^m_x d^*\). The second term on the right hand side of equation (11.4) now becomes \(W_x p^m_x (1 + t_x - d^*)\).
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If we did know that the additional quantity demanded of our non-tradable good was being drawn from a specific substitute good or service, y, then we would want to subtract the tax $t_y$ lost due to the reduction in the purchase of this good from that of the additional tax paid of $t_x$. In this case the second term on the right hand side of equation (11.4) becomes

$$W_x^d \frac{m}{P_x} (1 + t_x - t_y).$$

Adjustments must also be made to the supply price of producing the good x. However, due to different adjustments required for different types of intermediate inputs used to produce the good x, we will deal with them in the following subsections.

**A. Intermediate Inputs with Infinite Supply Elasticity**

Two further adjustments need to be made to the market price of the supply price of this good x in order to derive the value of the resources released by the non-project suppliers of the project output x. First, the supply price in equation (11.4), \( \frac{m}{P_x (1+k_x)} \), does not take into consideration any tax distortions (d_i) levied on the intermediate inputs used to produce the existing supply of x that is being partially replaced by our project. These inputs will now go elsewhere in the economy to produce other goods and services. The value, however, of these resources saved should not include the taxes that will no longer be paid by the non-project suppliers. The composition of these intermediate inputs may differ depending upon whether the replaced supply of x was using an identical technology. Often the technology will be different than that used by our project.

Certainly the inputs released do not need to be of the same composition as those used by our project (i.e., \( \sum a_{ix} P_{im} \)). Suppose they are \( \Sigma a_{ixo} P_{im} \). In the case where there are many such intermediate inputs, the adjustment made to the supply side of the economic price of
good $x$ of equation (11.4) is $W_x [\sum a_{\text{exc}} P_{\text{im}} d_i]$. This adjustment\(^6\) is shown in the lower part of the shaded area as $\sum a_{\text{exc}} P_{\text{im}} d_i$ in Figure 11.3.

**Figure 11.3: Economic Benefits of a Project:**

-- When a production subsidy is present --

The second adjustment that has not been accounted for is the foreign exchange premium and the premium for non-tradable outlays associated with tradable and non-tradable components, respectively, of the non-tradable good. The sources of these premia are due to the fact that with the reduction in the production of the non-tradable suppliers of this good the resources released will reduce the demand for tradable inputs, and hence there is a saving of the foreign exchange premium associated with this component the resources saved. The same sort of externality arises when the non-tradable inputs released by the nontradable sources of the supply of the good. In this case it is the externality measured by the premium associated with our estimated value of SPNTO.

\(^6\) The value of this tax adjustment, $W_x \sum a_{\text{exc}} P_{\text{im}} d_i$, is exactly correct only if the tax and subsidy distortions are on tradable inputs or on non-tradable inputs that are in perfectly elastic supply. This issue will be taken up again later in the chapter.
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It is likely that when the final equilibrium is re-established after the project is implemented, the ultimate uses of tradable and non-tradable components of intermediate inputs would not be the same as the initial purchases of the intermediate inputs employed to produce the non-tradable good x. However, it is difficult to foresee the final usages of tradable and non-tradable components of intermediate inputs. For all intents and purposes, we assume the composition of tradable and non-tradable components of intermediate inputs remains unchanged. We would then adjust the economic value of the non-tradable good produced by increasing the cost of the tradable component of the non-tradable intermediate inputs required to produce the good x by the foreign exchange premium (FEP) and the cost of the non-tradable component of the non-tradable intermediate inputs by the premium of non-tradable outlays (NTP). That is,

\[ + (P^n_x \times T_x \times FEP) + (P^n_x \times NT_x \times NTP) \quad (11.5) \]

After taking into account all the repercussions as a result of producing the non-tradable good x in the economy, the economic price of the non-tradable good x can be measured as:

\[
P^e_x = W^n_x P^m_x (1+k_x) + W^d_x P^m_x (1 + t_x - d^*) - W_x (\sum_{i=1}^x P^{m}_{im} d_i + (m \times T_x \times FEP) + (m \times NT_x \times NTP)) \quad (11.6)
\]

Since the financial receipts of the non-tradable good x are \(P^e_x (1 + t_x)\), the conversion factor of this product will be:

\[
CF_x = P^e_x / P^m_x (1 + t_x). \quad (11.7)
\]

**B. Intermediate Inputs with Finite Supply Elasticity**
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To this point we have been assuming that the only distorted inputs being used in the production of good x by its non-project suppliers were either internationally traded or if non-tradable they were in perfectly elastic supply. For those intermediate inputs that are neither internationally traded nor in perfectly elastic supply, a different adjustment is required to eliminate the value of the input distortion from the value of the resources released. Now the price of the input will be lower as the demand for the input is decreased. As a consequence, the demand and supply of the input j will both be affected and our objective here is to measure any distortions associated with the supply and demand sides of the non-tradable intermediate inputs j caused by the additional supply of the project’s non-traded good x.

As our project produces more good x, the other producers of x will reduce their supply and hence their purchases of input j. The financial cost of the input j will be \( P_j (1 + d_j) \).

Following the standard supply-and-demand framework with upward-rising supply and downward-sloping demand curves, because their price of j is now allowed to change the effect of this will be a cutback in the supply of j. The economic cost of the input j due to its supply response will be measured by the response of the input supply \( W_{js} \) times the price of the input \( p_j^m \) or \( W_j^s (a_{jxo} p_j^m) \) where \( a_{jxo} \) is the input-output coefficient of the input, j, used to produce a unit of x. In the case there is a subsidy on the production of j, the economic cost will be measured by \( W_j^s [a_{jxo} p_j^m (1 + k_j)] \) where \( k_j \) stands for the subsidy rate.

At the same time due to the drop in the price more of the input j will be demanded by other users of the input. We therefore want to estimate the economic value of the input j in the demand response as \( W_j^d [a_{jxo} p_j^m (1 + t_j)] \). At the same time there will be an offsetting adjustment due to the diversion of j to other demanders. If these new purchasers of j pay the same tax \( t_j \), there will be no net distortion to be deducted due to the diversion of the demand for j. However, it might be more appropriate to assume the average rate of distortion of \( d' \) is paid by the new demanders of this input since we do not
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know precisely where those inputs would be finally used. With this adjustment, the net economic value of the input \( j \) in the demand response should be measured by

\[
W^d_j \left[ a_{jx0} P^m_j (1 + t_j - d^*) \right].
\]

From the above discussion, one can summarize that when the non-tradable input \( j \) with a finite supply elasticity is used to produce a non-traded good \( x \), the adjustment to the supply side for the distortions on input \( j \) can be measured by the excess of the financial cost of the input \( j \) over and above its corresponding economic cost. That is,

\[
W^s_x \{ a_{jx0} [P^m_j (1 + t_j) - W_j^d P^m_j (1 + t_j - d^*)] \}\]

Simplifying equation (11.8) by substituting \( P^m_j (1 + t_j - d^*) \) with \( P^m_j (1 + t_j - d^*) \), the total distortion of tax and subsidy on non-tradable input \( j \) will become:

\[
-W^s_x \{ a_{jx0} [P^m_j (t_j - k_j) + W_j^d P^m_j d^*] \}\]

Both \( t_j \) and \( d^* \) are positive, their effect will be to reduce the economic cost of the final non-tradable good \( x \) while \( k_j \) is a subsidy on non-tradable supply of input \( j \) which is negative and will thus increase the economic cost of the final non-tradable good \( x \).

We can use the symbol \( d_j \) to stand for \( t_j - k_j \), which is equivalent to the distortions \( (d_i) \) associated with the tradable intermediate input \( i \). Thus, equation (11.9) can be written as:

\[
-W^s_x \{ a_{jx0} [P^m_j (d_j) + W^d_j P^m_j d^*] \}\]

That being said, in a more generalized form one would assume that the production of good \( x \) by our project leads to the release of some intermediate inputs \( i_s \) by the non-project producers of which are in perfectly supply elasticity, along with the release of other intermediate inputs \( j_s \) with finite supply elasticities. After making all the above
adjustments including the distortions in the markets for intermediate inputs i and j, the measurement of $P_x$ for equation (11.6) will be modified to become,

$$
P^e_x = W^s_x P^m_x (1+kx) + W^d_x P^m_x (1+tx-d^*)
- W^s_x [\sum_i a_{ix0} P^m_{im} d_i + \sum_j a_{jx0} (W^s_j P^m_{jx} d_j + W^d_j P^m_{jd}\ d^*)]
+ (P^m_x \times T_x \times FEP) + (P^m_x \times N^x_T \times NTP)
$$

The input-output coefficients in equation (11.11) relate to the factors and factor mix used by the non-project producers of x whose markets are being affected by our project.

### 11.3.2 Economic Value of a Non- Tradable Input Purchased by a Project

Figure 11.4 illustrates a situation of the market for an input $z$ that is used to produce the good $x$. This input receives a direct subsidy equal to $k_z$ of its production cost and when it is sold, this input is subject to a tax of $t_z$. When our project demands more of this input, its market demand curve will be shifted from $ND_n$ to $CD_{n+p}$. This will stimulate additional supply of $(Q_1 - Q_0)$ and will cause the previous consumers of $z$ to reduce their purchases by $(Q_0 - Q_{1d})$. 

22
The first step in the estimation of the unit economic cost (\( e_z \)) of this non-tradable input \( z \) that is purchased by our project is to consider cost from the value of the additional resources used by producers to supply more of \( z \) and the value placed on the demand by others that has been given up because the price of \( z \) has been raised. These two costs are measured by a weighted average of its supply price (\( P^s_z \)) and the demand price (\( P^d_z \)), respectively. The weights reflect the responsiveness of existing suppliers and demanders to changes in the price of the non-tradable input. That is:

\[
P^e_z = W^s_z P^s_z + W^d_z P^d_z
\]

(11.12)

where \( W^s_z + W^d_z = 1 \).

If we account for the market distortions explicitly then \( P^m_z = P_m (1 + k_z) \) and
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\[ P^d_z = P^m_z (1 + t_z) \], hence equation (11.12) can be written as:

\[
P^e_z = W^s_z P^m_z (1 + k_z) + W^d_z P^m_z (1 + t_z)
\]  

(11.13)

The adjustments to account for the distortions on the prices of the additional inputs used to supply \( z \) or on the price of \( z \) when it was being previously purchased elsewhere are of the same form as in the case of an output \( x \) in equation (11.11). Similarly, the adjustments are made for the generalized distortions of the foreign exchange premium, when there is an impact on the demand or supply of tradable goods, and for the premium on non-tradable goods. That is, the term \( (P_z \times T_z \times FEP) \) measures the additional cost associated with the additional tradable inputs that are now demanded because our project demands for the input \( z \). Likewise, the term \( (P_z \times NT_z \times NTP) \) measures the additional cost arising from the increased use of non-tradable inputs as a consequence of our project’s purchase of this non-tradable input. The final expression for estimation of the economic price of input \( z \) in its generalized form is identical in form as in the estimation of the economic price of an output. It is shown as follows:

\[
P^e_z = W^s_z P^m_z (1 + k_z) + W^d_z P^m_z (1 + t_z - d^*) \\
- \sum_s [\sum d_i P^m_z x_{iz} + \sum d^* j a_{jz}] \\
+ (P^m_z \times FEP) + (P^m_j \times P^d_j \times NTP)
\]  

(11.14)

It is important to note that exactly the same structure and terms are present in equation (11.14) as in equation (11.11). It does not matter if a particular good is an input being purchased or an output being produced, its economic value is the same.

11.4 Application of Economic Prices to Estimate the Economic Net Benefits of a Project
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Where the nature of the market distortions are taxes and subsidies that are expressed as a proportion of a price, the natural way to introduce this conversion of financial values into economic values is through the use of commodity specific conversion factors. In such case, if the rates of distortion do not change then there is a fixed relationship between the real or nominal unit economic value of an item and its financial unit cost to the project. For example, consider a project input such as electricity or construction services that will be used over and over again in many projects. If the distortions in the output and input markets can all be expressed as a proportion of either $P^m$, $P^d$, or $P^s$ then any one of these prices can be expressed as in terms of one of the other prices and the relevant distortions that make them not equal. Hence, it is also the case that we see from equation (11.11) that the economic price $P^e$ of any good $i$ can be expressed simply as a constant factor times the financial demand price of the same item. The constant factor will be a function of all the distortions and weights that determine the economic price of the item. This commodity specific conversion factor, $CF_i$, is the ratio of the economic price of $i$ to its tax inclusive financial price, or its demand price,

$$CF_i = \frac{P^e_i}{P^m_i (1 + t_i)}$$ (11.15)

For inputs and outputs where these conditions hold, the economic benefits and costs can be estimated period by period by simply multiplying the financial line items of financial analysis from the total investment point of view by the corresponding commodity specific conversion factor for that line item. The result is the value of the economic benefit or the value of the cost item for that period. When all the line items of a financial cash flow analysis are converted into their economic values then it is a relatively simple procedure of subtracting the costs from the benefits to derive the periodic economic net benefits and the economic net present value of the project.

Of course when there are distortions such as rationing, quantitative restrictions, consumer surplus arising from new market entrants, then the economic value of the additional consumption will be divorced from the particular financial prices charged. The value of
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the output of a road, when no tolls are being charged is a classic example where the output of the road has to be evaluated based on the fundamental items that measure the consumers’ willingness to pay and the economic value of the resources saved, and in this case these values are completely divorced from what the user of the road pays for the service.

The items where conversion factors can not be used are usually associated with the outputs of projects. Examples include the benefits from improving a road, the benefits from providing access to potable water supplies, and the benefits of improving the reliability of the electricity service. In all these cases the engineers and sector specialists will often have the professional training on how to measure the economic value of the output produced by the project.

A major hurdle to the widespread implementation of economic cost-benefit analysis is the dozens, and sometimes hundreds of inputs for a single project for which the sector specialist has little idea, or the time, to go about making an estimation of the economic prices of each of these commodities and services. The major advantage of expressing the relationship between the unit economic value and the unit financial value as a conversion factor is that for as long as the rates of the distortions do not change, then the same conversion factor can be used for the same good across many projects in the country. In addition, the conversion factor is not affected by the rate of inflation. Hence, it can be applied to either the nominal financial values of a particular item over time to obtain its nominal economic values through time, or it can be applied to the real values of the same item and the result will be the real economic value of the item over time.

Furthermore, the nature and magnitudes of the distortions that determine the size of the conversion factor for a particular good or service can be clearly written as a formula using the relationship shown in equations (11.11) and (11.14). Hence, when it is known that the rate of tax or subsidy has changed then the conversion factors for the items affected can be readily updated.
11.5 An Illustrative Example

Consider a project in South Africa using bricks as an input where there are distortions in the markets of bricks, and in the markets two inputs, clay and furnace oil, are used to produce brick.

Assume that the market for bricks is competitive, the market price is subject to a 14% general sales tax without any tax credit and brick producers receive a 15% subsidy ($k_z$) on their total production cost. In this case, the supply price is expressed as 

\[ P_z = \frac{P_n}{1 - k_z} \]

because the subsidy is the fraction of the supply price. Without the project, the quantity demanded and supplied in the market is 7 million bricks per month at a market price ($P_z$) of R0.2 per brick. Now introduce a project that requires 300,000 bricks per month. Two of the inputs used in the production of bricks have distortions in their markets: (a) clay, a non-tradable good, has a 14% sales tax levied on its market price ($P_{\text{clay}}$) of R7 per ton, (b) furnace oil, an import good, has a subsidy ($k_{\text{oil}}$) of 20% on its cif price of US $240 per ton. The input-output coefficient for furnace oil ($a_{oilz}$) is 180 kilograms of oil per 1000 bricks and that of clay ($a_{clayz}$) is 3.5 tons of clay per 1000 bricks. The market exchange rate is R9.85 per US dollar.

The weighted average excise and other indirect tax rate on tradable and non-tradable goods and services in the economy ($d^*$) is 9%.

The economic cost per brick can be estimated using equation (11.14). Data requirements for the estimation of the economic price ($P_z$) of a brick used by the project as an input are described below.

---

7 It is assumed that the change in the market price of clay on account of the project’s demand is relatively small, hence justifying the use of without-the-project prices, rather than an average of the prices with and without the project.
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**Brick**

*Step 1: Price Estimation*

Since $P_{zn} = R0.2$, thus $P_{z} = P_{zn} / (1 - k_z) = 0.2 / (0.85) = R0.2353$,

and $P_{z} = P_{zn} \times (1 + t_z) = 0.2 \times (1.14) = R0.2280$.

*Step 2: Estimation of the Supply and Demand Weights ($W_z$ and $W^{*}_{z}$)*

For such a production activity, the expected supply response will be small in the short run as most brick making kilns are usually operating close to capacity. Although the supply response will be larger in the longer run, it will still not be as large as the demand response. In other words, a larger proportion of the bricks required by the project will be obtained at the expense of existing demanders who will divert to other things, rather than from new production. Hence, assigning a weight of 0.33 to the demand side ($W_z$) and a weight of 0.67 to the supply side ($W^{*}_{z}$) seems plausible.

*Step 3: Tradable, Non-tradable Good Component in Brick Production*

By examining the cost components used in the production of bricks, we are given that the tradable good component and non-tradable good component account for 60% and 40%, respectively, of the market price of bricks. The foreign exchange premium is equal to 6% and the premium on the purchase or sale of non-tradable goods and services is 1%.

*Step 4: Product Distortions*

The supply price on the newly stimulated supply of brick, as was calculated above, is equal to,

$$P_{z} = P_{zn} / (1 - k_z) = 0.2 / (0.85) = R0.2353,$$

On the demand side, the tax on good $t_z$ that other demanders will not be paying because they are now buying other goods is partially offset by the taxes they will now pay $d^*$. Hence, the opportunity cost of the forgone consumption of others is equal to,

$$P_{z} [1 + (t_z - d^*)] = 0.2 (1 + 0.14 - 0.09) = R0.21.$$
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**Furnace Oil**

Since furnace oil enjoys a subsidy, its financial market price is different from its economic price and so an adjustment for this input will have to be made when estimating the economic cost of bricks.

*Step 1: Estimating the Market Price*

\[
P_{oil} = \text{cif price} \times E_m \times (1 - s_{oil})
\]

\[
= 240 \times 9.85 \times (1 - 0.2)
\]

\[
= R1,891 \text{ per ton}
\]

*Step 2: The Economic Cost of Furnace Oil (p_{oil})*

\[
P_{oil} = \text{cif price} \times E_m
\]

\[
= 240 \times 9.85
\]

\[
= R2,364 \text{ per ton}
\]

The value of the subsidy per ton of furnace oil is estimated below.

The value of the subsidy = \( p_{oil} - p_{oil} \)

\[
= - \text{cif price} \times E_m \times s_{oil}
\]

\[
= - 240 (9.85) (0.2)
\]

\[
= - R472.8 \text{ per ton}
\]

Thus, the value of the distortion per brick is - R0.0851

\[ (= - a_{oil}z \times R472.8/1,000 = - 0.18 \times R0.4728). \]

**Clay**

As clay is subject to 14% of the sales tax, its demand price is different from its market price and an adjustment for this input is necessary when estimating the economic cost of bricks.

*Step 1: Estimating the Demand and Supply Prices for Clay*

Since \( p_{clay} = R7 \text{ per ton} \), thus \( p_{clay} = p_{clay} \times (1 + t_{clay}) = 7 \times (1 + 0.14) = R7.98 \text{ per ton} \)

and \( p_{clay} = p_{clay} \times (1 - k_{clay}) = 7 \times (1 - 0) = R7 \text{ per ton} \)
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**Step 2: Estimation of the Supply and Demand Weights (W_{clay} and W_{clay})**

If clay is not in short supply, one can reasonably assert that the demand for clay derived from the project’s demand for bricks will be mostly met from additional supply. Accordingly, a demand weight (W_{clay}) of 0.33 and a supply weight (W_{clay}) of 0.67 are assigned.

**Step 3: The Economic Cost of Clay (P_{clay})**

Using clay as an input will lead to additional supply as well as displaced demand for some existing demand, the value of the distortion created after taking into account all the repercussions of the demand for clay in the economy can be estimated as:

\[
P_{mclay} \{a_{clay}(W_{clay}(d_{clay} - k_{clay}) + W_{clay}d^{*})\}
\]

\[
= 7\{0.0035 \times (0.67 \times (0.14 - 0) + 0.33 \times 0.09)\} = 0.0245 (.1235) = 0.0030\text{R/brick}
\]

Taking into account the distortions in the product and input markets, the economic price per brick by substituting in equation (11.14) repeated below:

\[
P^e_z = W^s_z P^m_z/(1 - k_z) + W^d_z P^m_z (1 + t_z - d^{*}) - W^s_z \sum^m_{j} W^d_j P^m_j d_j + \sum^m_{j} W^d_j P^m_j d^{*})
\]

\[
= 0.67(0.2353) + 0.33(0.2100) - 0.67(-0.0851 + 0.0030) + 0.2 \times 0.6 \times 0.06 + 0.2 \times 0.4 \times 0.01 = 0.1577 + 0.0693 + 0.0550 + 0.0080
\]

\[
= 0.2900\text{R/brick}
\]

To estimate the commodity-specific conversion factor for bricks used by the project, we divide the economic price by the financial demand price. Recall that the demand price is inclusive of sales tax. That is,
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\[ CF = \frac{0.2900}{0.228} = 1.27 \]

The same methodology can be used to estimate the conversion factors for a series of non-
tradable goods and services involved in projects. In the case of project supply or project
demand for tradable goods, it often requires non-tradable services such as truck
transportation services and handling charges in order to move the goods between the port
and the project site. The financial costs for these services must be converted using the
respective conversion factors to the economic costs in the economic appraisal.

As was mentioned in Chapter 10, for example, the irrigation project in Visayas of the
Philippines is required to import pesticides to improve the farm’s productivity. The project
will also incur handling charges, dealers’ margin, and transportation costs in order to move
pesticides from the port to the farm. Thus, in addition to 4,239 pesos paid for the duty-paid
value of the item, the project will also pay a total of 1,140 pesos for handling and port
charges, 475 pesos for transportation costs from the port to the farm gate, as well as 200
pesos for dealers’ services. Each of these non-tradable service costs presented in the
financial cash flow statement must be converted to the economic costs in the economic
resource flow statement using their corresponding conversion factors calculated as
outlined in this chapter.

11.6 Conclusion

This chapter has described the analytical framework how the economic prices of
nontradable goods and services can be estimated. Unlike the case of tradable goods, there
will be no direct world price, but an equivalency to the world market can be derived. The
analysis began with the case in which a project produces non-tradable outputs where its
market supply function is perfectly elastic and then moved to the standard case with
upward-rising supply and downward-sloping demand curves. The analysis takes into
account all repercussions of the project in the economy by capturing all distortions in the direct
product and indirect input markets.
This appendix provides readers with the basic toolbox concerning very basic supply-and-demand relationships. We start with a commodity that is subject to both an excise tax and a value added tax. We assume that the posted market price is inclusive of VAT (as is the practice in most VAT countries), and that the excise tax is added to the market price, as an extra item on the buyer’s bill. In short, in this presentation we assume that the VAT is institutionally paid by the supplier, where the excise tax is paid by the demander. The ultimate incidence of these taxes is another issue.

This yields the supply-and-demand picture shown in Figure 11A. In the Figure, the value added tax is 25 percent (on a base price of 0.80), while the excise tax is 40 percent on a base price of 1.00. When a new demand is introduced, say by our project, 70 percent of that demand is met by displacing other demand and 30 percent by generating new increments of supply. In this case, the economic opportunity cost of meeting new demand for this good will be \((0.7 \cdot 1.40) + (0.3 \cdot 0.80) = 1.22\).
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\[ Q_{1s} - Q_{1d} = 100 \text{ units}, \ Q_{1s} - Q_{10} = 30 \text{ units}, \ Q_{10} - Q_{1d} = 70 \text{ units} \]

One way to visualize this opportunity cost is that we do not know whether our project will or will not be required to pay tax on its purchases. Perhaps, as a government project, it will be exempt from the excise tax, or maybe even from both taxes. Perhaps as a private project producing for export, it will be exempt from both taxes. The point is that as we try to establish the economic opportunity cost of the product \( Q_1 \), we do not know what taxes the buyer will be required to pay. We do know, however, that suppliers will incur a resource cost of 0.80 on the incremental supply, and that demanders will be forgoing units of \( Q_1 \) that the value at (or a bit above) 1.40 on 70 percent of the amounts that our project takes.

Thus we have unambiguously established that the economic opportunity cost of \( Q_1 \) is a weighted average of supply and demand prices.

Let us now consider another problem dealing with the same market. Our project is now in some quite different area. Its output is a non-tradable good or service, \( Q_7 \), and as a consequence of the project the total demand for \( Q_7 \) increases. A likely scenario is that the price of good falls from \( P_{70} \) to \( P_{71} \). Because good \( Q_7 \) is a substitute for \( Q_1 \), when the quantity demanded of \( Q_7 \) increases, the demand declines for \( Q_1 \).
Figure 11B illustrates this case for an induced shift in demand (away from Q₁) and toward Q₇, equal to 100 units. Note in Figure 11B, that we can still say (if we want to) that the economic opportunity cost of those 100 units of shifted demand is \((0.3 \times 0.80) + (0.7 \times 1.40) = 1.22\), as before.

But this is not a very good way to summarize what is going on. What actually happens is simply a reduction of the equilibrium quantity of Q₁ by 30 units. In the exercise of Figure 11B, certain demanders (call them the *shifte rs*) shift 100 units of demand away from Q₁. In order to buy more of Q₇, they induce a bunch of other demanders of Q₁ (call them the *stayers*) to augment their demand by 70 units. But that change of +70 units by the stayers is more than canceled by the -100 unit change produced by the shifte rs. The end result is a net reduction in demand for Q₁ of 30 units, which necessarily also equals the reduction in supply.

Figure 11C shows a better picture of what happens in the market for Q₁, as a consequence of a project-induced increase in demand in the market for Q₇ (the project good). This
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Figure allows for the induced increase in demand of 70 (by the stayers) to be fully canceled by the project-generated reduction in demand for Q1 of 100 (by the shifters). The net result is a reduction of -30 in the equilibrium quantity of Q1, to which a distortion of 0.60 (=1.40 - 0.80) applies. In this case the distortion effects are not split between a supply change in one direction and a demand change in the other, but are combined into a simple grand distortion (= demand price minus supply price), which applies to the net change in the equilibrium quantity of the good in question (here Q1).

Note that this example is relevant for all kinds of external effects that take place outside the purview of the project we are analyzing. When we deal with “our” project’s demand, we want to separately consider the distortions applying to increased supply and decreased demand (or vice versa). But in cases where we are examining induced effects in other markets, those effects are necessarily shifts (up or down) of the equilibrium quantity of good Qj, in whatever market that might be.

**Figure 11C**

\[
Q_{10} - Q_{1d} = 30 \text{ units}
\]
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Our important corollary of this simple lesson, is that when we have an increase in demand of, say 400, for the project good Q7, of which 100 came by the shifters substituting away from good 1 and toward Q7 as a consequence of our project. We do not want to assign our externality of \((1.22 - 1.00) \cdot (-100)\) of shifted demand for Q1. This would equal -22. Nor do we want to assign an externality of \((1.22 - 0.80) \cdot (-100)\), which would equal -42. The correct externality assignment is of \((1.40 - 0.80) \cdot (-30) = -18\).

It is a pity that this simple lesson is not widely understood, even among experienced project economists. It follows directly from the standard expression for measuring external effects \(\Sigma_i D_i \Delta Q_i\), where \(D_i\) is the distortion affecting activity \(i\) and \(\Delta Q_i\) is the amount by which the equilibrium quantity of \(Q_i\) changes, as a consequence of the event being analyzed (in this case “our” project in the market for Q7).

Thus when we consider increases in demand for project output, even if all the increase in demand were to come from Q1 that does not mean we should assign a Q1 distortion to that full increase of 400 in demand for Q7. In this case we would assign the full Q1 distortion of 0.60 per unit to a shift in equilibrium quantity of Q1, equal to -120 \([=0.3 \cdot (-400)]\). That is, the externality \(D_1 \Delta Q_1\) would equal \((0.60) \cdot (-120) = -72\).

In dealing with the Q7 market, we would have project output of 1,000, of which 600 would be reflected in reduced supply by others and would be assigned a distortion equal to \(d^*\) (as those resources find their new equilibrium locations elsewhere). Then we would have 400 of increased output of Q7, to which the tax \(T_7\) would apply (i.e., our project’s output would be valued at its demand price). And finally on the externality applying in the market for Q1 we would have a Q1 externality equal to \(D_1 \Delta Q_1 = -72\ (= -120 \cdot 0.60)\), plus an additional externality of +120\(d^*\), as the resources released from Q1 are absorbed elsewhere in the economy.
REFERENCES


