When we do a benefit-cost analysis, we have to value a range of commodities which are either inputs to or outputs of the project. Some of these commodities are traded (i.e. can be bought or sold on international markets) and some are non-traded (are not bought or sold in international markets but are only traded domestically).

Examples:
- traded goods - cotton, wool, computers etc.
- non-traded goods - gravel, haircuts etc.

What determines whether a good is traded or non-traded?

We need to define the prices at which goods can be exported or imported:
- the export price is the price received at the border as the good leaves the country - it is called the f.o.b. price ("free on board");
- the import price is the price when the good is landed in the country - it is called the c.i.f. price (cost, insurance and freight).

A good or service will not be exported if:
- f.o.b. price < domestic price

A good or service will not be imported if:
- c.i.f. price > domestic price

Hence, a commodity will be non-traded if:
- f.o.b. price < domestic price < c.i.f. price

If we wanted to allow for the effect of tariffs and export taxes, we could amend the condition for non-tradeability to:
- f.o.b. price less export tax < domestic price
- c.i.f. price plus tariff > domestic price

Consider a simple example which does not involve currencies or exchange rates:

• suppose food and clothing exchange on a 1:1 basis on international markets i.e. 1 unit of food exchanges for 1 unit of clothing;
• suppose that the country has a 100% tariff on imports of clothing i.e. in the domestic market 1 unit of food exchanges for 0.5 units of clothing;
• suppose the economy is competitive with no distortions other than the tariff, and that labour is the only factor of production. The VMPL will be the same in food and clothing production, and, hence, the MPP_L will be 1 unit of food or 0.5 unit clothing.
Now suppose a company proposes the following import-replacing project which just breaks even:

It will transfer a unit of labour from food production to clothing production. The opportunity cost of the project is 1 unit of food and the benefit is 0.5 units of clothing.

The project breaks even because the benefit (0.5 units of clothing) has the same value as the cost (1 unit of labour costing 1 unit of food).

If the economy wishes to maintain its level of food consumption, it will have to cut food exports by 1 unit, and, hence, cut clothing imports by 1 unit (a net loss of 0.5).

If the economy wishes to maintain its level of clothing consumption, it can export the extra 0.5 unit of clothing and import an extra 0.5 unit of food (a net loss of 0.5).

More generally, the economy can respond to the import replacing project by reducing food consumption by \( \alpha/2 \) units and reducing clothing consumption by \( (1-\alpha)/2 \) units, where \( 0 < \alpha < 1 \).

Why is \( 0 < \alpha < 1 \)?

Because food and clothing are both normal goods.

The proposed project breaks even at domestic prices, but if it is undertaken, the economy is worse off. Clearly we need a way of appraising import replacing projects that accurately values their contribution to the economy.

Now let’s introduce currencies.

The domestic currency is the rupee and the foreign currency is the dollar.

There are two ways of expressing the Official Exchange Rate (OER):

- the price of rupees in dollars ($/R)
- the price of dollars in rupees (R/$)

We will always quote the OER as the price of the domestic currency (rupees) in dollars, but in our example we will assume that the OER is 1, i.e. 1 rupee costs 1 dollar in foreign exchange markets.

We saw that, while the proposed import-replacing project broke even from a private viewpoint, it would actually lead to a decline in consumption by \( \alpha/2 \) units of food and \( (1-\alpha)/2 \) units of clothing, where \( \alpha \) lies between zero and 1. (Why does \( \alpha \) lie between 0 and 1?) e.g. if \( \alpha = 0 \), the loss is 0.5 unit of clothing, and if \( \alpha = 1 \), the loss is 0.5 units of food.

Suppose the price of food is 1000 rupees per unit in the domestic market. This means that the price of clothing must be 2000 rupees per unit (since 1 unit of food exchanges for 0.5 units of clothing in the domestic economy, because of the tariff on clothing).

At domestic prices, the value of the consumption goods forgone as a result of the import-replacing project is:

\[
\text{value at domestic prices} = 1000\alpha/2 + 2000(1-\alpha)/2
\]

At international prices, the value of the consumption goods forgone as a result of the import-replacing project is:

\[
\text{value at international prices} = 1000\alpha/2 + 1000(1-\alpha)/2
\]

The ratio of the value at domestic prices to the value at international prices is:

\[
[a + 2(1-a)] \geq 1.
\]

This ratio can be used to calculate the shadow-exchange rate:

\[
\text{SER} = \text{OER}/[a + 2(1-a)]
\]
Suppose that $a = 0.5$; then $(a + 2(1-a)) = 1.5$, and $\text{SER} = \text{OER}/1.5$. Since, in the example, the $\text{OER}($$/R) = 1$, $\text{SER}($$/R) = 0.67$. In other words, the SER attaches a lower dollar value to the rupee than the OER.

Why?
Because the value of the rupee in foreign exchange markets is made artificially high by the tariff on clothing which discourages imports and, hence, reduces the quantity of rupees which people want to exchange for dollars.

‘Artificially high’ means a higher value than is warranted by the productivity of the domestic economy relative to overseas.

How is the SER used in benefit-cost analysis?
Consider the example of the import-replacing project:

• the project uses labour (a non-traded commodity) valued at 1000 rupees at domestic prices, to produce clothing (a traded commodity) valued at $500 at international prices.

To convert the $500 at border prices to a value at domestic prices, we use the SER:

\[
\text{value at domestic prices (rupees)} = 500/\text{SER}($$/R).
\]

In our example, $\text{SER} = 0.67$, so that:

\[
\text{value at domestic prices} = 500/0.67 = 750 \text{ rupees.}
\]

We can now calculate the net benefit of the project at domestic prices: Net benefit = 750 - 1000 = -250 rupees. Hence, we would reject this project.

We have found that the net benefit of the import-replacing project is -250 rupees at domestic prices.

Suppose we decided to evaluate the project in terms of international (border) prices?

The value of the output of clothing at border prices is $500, which converts to 500 rupees at the OER.

The value of the input (labour) is 1000 rupees at domestic prices. However, labour needs to be valued at border prices. This is done by converting the labour cost to dollars using the OER and then converting it back to rupees using the SER:

\[
\text{labour cost} = (1000/\text{OER})\times \text{SER} = 1000\times (0.67/1) \text{ rupees}
\]
i.e. the cost of labour at border prices is 667 rupees.

We can now calculate the net benefit of the import-replacing project at border prices: Net benefit = 500 - 667 = -167 rupees. We now have three pieces of evidence that would lead us to reject the proposed import-replacing project:

1. Without considering prices or exchange rates, we have seen that undertaking the project would result in lower domestic consumption levels;
2. The net benefit of the project at domestic prices is -250 rupees;
3. The net benefit of the project at border prices is -167 rupees.

Should it worry us that the net benefit of the project is different at domestic prices vs. border prices?
If you use different sets of prices, you will get different answers. The important point is that we have been consistent: we either valued both traded and non-traded commodities at domestic prices (UNIDO), or we valued them both at border prices (LM).

Could UNIDO and LM give conflicting results?
No, because:

\[
\text{Net Benefit UNIDO (SER/OER)} - \text{Net Benefit LM (OER/1)} = -167
\]

In other words, net benefit always has the same sign under each approach.

Example: a proposed project in PNG will use 5 kina worth of labour and $1 worth of imported goods to produce exports valued at $6.

The OER = 0.75 $/kina; the SER = 0.67 $/kina.

The shadow-wage is 60% of the market wage (i.e. the opportunity cost of 5 kina worth of labour is 3 kina).

Perform a social benefit cost analysis of this project, using the UNIDO and LM methods.
Figure 8.2 The UNIDO and LM Approaches to Project Appraisal

<table>
<thead>
<tr>
<th>UNIDO</th>
<th>LM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tradeables</td>
<td>Non-Tradeables</td>
</tr>
<tr>
<td>Use border prices in US dollars</td>
<td>Use domestic prices in domestic currency</td>
</tr>
<tr>
<td>converted to currency shadow price for domestic</td>
<td>converted to currency shadow price for domestic</td>
</tr>
<tr>
<td>using the SER distortions</td>
<td>using the OER distortions</td>
</tr>
<tr>
<td>Use border prices in US dollars</td>
<td>Use domestic prices in domestic currency</td>
</tr>
<tr>
<td>converted to currency shadow price for domestic</td>
<td>converted to currency shadow price for domestic</td>
</tr>
<tr>
<td>adjusted for FOREX market distortions using SER/OER</td>
<td></td>
</tr>
</tbody>
</table>

Example: OER: $0.75/Kina, implying that 1.3333 Kina = 1 US$
SER: $0.67/Kina, implying that 1.4925 Kina = 1 US$

<table>
<thead>
<tr>
<th>Exports</th>
<th>Imports</th>
<th>Labour</th>
</tr>
</thead>
<tbody>
<tr>
<td>$6</td>
<td>$1</td>
<td>K5</td>
</tr>
<tr>
<td>K8.96</td>
<td>K1.49</td>
<td>K3</td>
</tr>
<tr>
<td>Net Benefit = K4.47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 8.3 demonstrated that an additional $1 of foreign exchange is worth $1.5 kina to PNG, which suggested that the SER is 1/1.5 = 0.67.

However, the foreign exchange requirements of a project need not be entirely met by diverting foreign exchange from existing uses, where its value is 1.5 kina per $1. Some could come from additional supply of foreign exchange, which costs 1.33 kina per $1.

Where some foreign exchange is an addition to supply and some is diverted from alternative use, the SER will be a weighted average of the costs of foreign exchange from the two sources.

Figure 8.4 Supply and Demand for Foreign Exchange with Tariffs and Subsidies

Suppose that some foreign exchange is diverted from purchase of imports (Q0 - Q1d in Figure 8.4, which we will later denote by d_{FEM}) and some is obtained from increasing exports (Q1s - Q0 in Figure 8.4, which we will later denote by d_{FEX}).

The opportunity cost of the foreign exchange diverted from imports is measured by the before-tariff demand curve for foreign exchange (Area FEQ0Q1d under demand curve D in Figure 8.4); and the opportunity cost of foreign exchange obtained from additional supply is measured by the before-subsidy and tax supply curve of foreign exchange (Area ABQ0Q1s under supply curve S in Figure 8.4).

It is clear from Figure 8.4 that the market demand and supply curves for foreign exchange, D_t and S_t, which are net of taxes and subsidies, do not measure the opportunity cost of foreign exchange.

This means that the OER determined by the distorted market does not measure the opportunity cost of foreign exchange.

The opportunity cost of foreign exchange is higher by the amount of the tariff on imports, or by the combined effect of the subsidy and tax on exports.

Note that the value placed on imports in the domestic economy is: \(p^{M_t}_d = p_{w(1+t)}/OER\); and the cost of exports is \(p^{S_t}_s = p_{w(1-s+d) OER}\).
Using this approximation, we can express the social opportunity cost of foreign exchange (measured in domestic currency) as:

\[
SOC = \frac{d_{FEM}(1+t)}{OER} + \frac{d_{FEX}(1+s-d)}{OER}
\]

where \(t\) is the tariff on imports, \(s\) is the subsidy on exports, and \(d\) is the tax on exports.

Note also that: \(1/(1-s+d)\) is approximately equal to \((1+s-d)\). [The relationship is exact if \((s-d)² = 0\). For example, since a subsidy rate might be 0.2 (20%) and an export tax rate might be 0.1 (10%), \((s-d)²\) in this case would be equal to 0.01 (1%), which is a negligible value.]

Using this approximation, we can express the social opportunity cost of foreign exchange (measured in domestic currency) as:

\[
SOC = d_{FEM}(1+t)/OER + d_{FEX}(1+s-d)/OER
\]

where \(t\) is the tariff on imports, \(s\) is the subsidy on exports, and \(d\) is the tax on exports.

What does the SOC tell us?

It says what $1 of foreign exchange is worth in terms of domestic currency: to value $1 of foreign exchange, multiply it by (rupees per dollar): \(SOC = \frac{b(1+t) + (1-b)(1+s-d)}{OER}\) or divide it by (dollars per rupee): \(SER = \frac{OER}{b(1+t) + (1-b)(1+s-d)}\), where \(SER\) is the shadow-exchange rate.

(Remember that an exchange rate is $/rupee and when you divide a US$ amount by an exchange rate you get a value in rupees, or domestic currency.)

If \(QF\) is the total quantity of foreign exchange required for the project, and it is obtained in the proportions \(b\) and \((1-b)\) from reduced imports and additional exports respectively, then \(d_{FEM} = b QF\) and \(d_{FEX} = (1-b) QF\).

We can then express the social opportunity cost of the quantity \(QF\) of foreign exchange as:

\[
SOC = \left(\frac{b(1+t) + (1-b)(1+s-d)}{OER}\right)QF
\]

and the social opportunity cost of one unit of foreign exchange (\(QF = $1\)), measured in domestic currency, as:

\[
SOC = \frac{b(1+t) + (1-b)(1+s-d)}{OER}
\]

To calculate the \(SER\):

\[
SER = \frac{OER}{b(1+t) + (1-b)(1+s-d)}
\]

we need estimates of \(b, t, s, \) and \(d\).

Assume:

\[
b = \frac{M}{M+X}; (1-b) = \frac{X}{M+X}
\]

\(t\) = average tariff rate level
\(s\) = average subsidy rate on exports
\(d\) = average tax rate on exports

In an economy with significant tariffs and export subsidies \(OER > SER\) (i.e. the official dollar value of the currency is higher than its real value). This means that \(OER/SER > 1\).

The value \(OER/SER\) is \(1+FEP\), where \(FEP\) is the foreign exchange premium.