Shadow Pricing, Direct Price Effects

1. Shadow Pricing

[C&B Ch. 5; DoF Ch. 3; FP Ch. 1.6, 6; S&W Ch. 8]

The NPV formula can be written as

\[ NPV = \sum_t \frac{b(t) - c(t)}{(1 + r)^t} \]

where \( b(t) = \sum_i b_i p_i = b_0 p_0 + b_1 p_1 + b_2 p_2 + \cdots \)

and \( c(t) = \sum_j c_j p_j = \cdots \)
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Now, we assume here that we have the quantities \( b_i \) benefits and \( c_j \) costs.

What of the prices \( p_i \) and \( p_j \)?
We want the true costs and benefits.

True prices reflect opportunities forgone (by suppliers, by consumers)
→ shadow prices.

A shadow price better approximates the true opportunity cost or marginal valuation of a product or resource or service.
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1. of a tax,
2. of a price change,
3. of a tax with a price change,
4. of unemployment with minimum wages,
5. of a tariff (a tax on imports).
Efficiency Cost-Benefit Analysis

To determine the true or shadow prices, use:

•
Efficiency Cost-Benefit Analysis

To determine the true or shadow prices, use:

- Willingness To Pay (demand curve) for consumption
Efficiency Cost-Benefit Analysis

To determine the true or shadow prices, use:

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But beware whether quantities increase or decrease in inputs or outputs.
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*C&B’s Pricing Rule*. [C&B p.93]

<table>
<thead>
<tr>
<th>Item to be valued</th>
<th>Valued at equilibrium point on a:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Demand Curve</td>
</tr>
<tr>
<td>Output</td>
<td>Satisfies additional demand</td>
</tr>
<tr>
<td>Input</td>
<td>Sourced from an alternative market source</td>
</tr>
</tbody>
</table>

(See also the Table on p.30 of the DoF *Handbook.*)
The Area under the Demand Curve is the Value of that Quantity

A demand curve shows the maximum the buyer is prepared to pay for each unit bought. As the price rises, buyers choose to buy less. They forgo the value to them of buying and using the forgone quantity: area = value forgone, as price $P_1 \rightarrow P_2$. 

![Diagram of demand curve]
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![Demand Curve Diagram]

Remember: the value of the last unit bought (the marginal value to the buyer) = the price of that unit.
The Area under the Supply Curve is the Cost of that Quantity

To a firm in a competitive market, its supply curve shows the cost of supplying each unit. A higher price induces more units to be offered for sale: the area under the supply curve is the total cost of supplying those units, as price $P_1 \rightarrow P_2$. 

[Diagram showing supply and demand curves with areas under the supply curve highlighted.]
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Remember: the marginal cost of supply (the cost of supplying the last unit sold) = the price of that unit.
1.1 Example 1: A Tax [C&B pp. 108–110; S&W Ch. 8.3]

Q:
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Q: A remote electricity-generation project pays $1/litre for its fuel oil, the costliest input to the project. The FA (financial appraisal) gives an NPV close to zero, but there is a tax on the fuel oil of 45¢/litre. What is the shadow price of fuel oil, to be used in the CBA NPV?
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A: Since the tax is a transfer (paying 45¢/litre for nothing), ignore it in a CBA. The shadow price is 55¢/litre, and the CBA NPV will be positive, because of the lower opportunity cost of fuel oil at the shadow price.
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A (specific) tax on a good supplied in a competitive market:

- places a wedge between the marginal cost (supply) and price (demand)
- the single (equilibrium) price \( p^S \) can no longer represent both valuation and cost
- Suppose the good is an input into a project:
A Tax (cont.) — *Infinitely elastic supply*

![Diagram showing supply and demand curves with a tax imposed.](image-url)
Because of the tax, the (tax-inclusive) demand price $p^D_1$ is greater than the (tax-exclusive) supply price $p^S_0$.

The diagram shows the Tax Revenue and the Dead-Weight Loss as the tax is imposed, pushing up the effective supply, and reducing the quantity demanded, from $q_0$ to $q_1$. 
A Tax (cont.)

\[ p^D_1 \]

\[ q_1 \]

\[ D_0 \]

\[ S_1 \]

$/\text{unit}$

quantity $q$
A Tax (cont.)

Let's say the project results in an expansion of demand, from $D_0$ to $D_1$. 
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- But there is no change in $p^D_1$ with the increase in demand.
Let’s say the project results in an expansion of demand, from $D_0$ to $D_1$.
- But there is no change in $p_1^D$ with the increase in demand.
- Because of the tax, the project pays the higher, tax-inclusive price $p_1^D$. 
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- Is this the shadow price?
- Does $p^D_1$ reflect the opportunity cost associated with the extra quantity?
- No, in general, but it depends on the purpose of the tax (i.e., revenue or “green” tax?).
**A Tax (cont.) —**
e.g. oil at world price plus a local excise of $t$:

![Diagram](image-url)
A Tax (cont.) —
e.g. oil at world price plus a local excise of $t$:

\[
\begin{align*}
\Delta D & \quad S_1 \\
\downarrow & \quad \uparrow t \\
\Delta D & \quad S_0 \\
\downarrow & \quad D_0 \\
\downarrow & \quad D_1 \\
q_1 & \quad q_2 \\
\text{quantity } q \\
\end{align*}
\]
A Tax (cont.) —
e.g. oil at world price plus a local excise of $t$:

Consumers value the increase in demand ($\Delta D$) at the tax-inclusive price $p^D_1$.

Suppliers' price is unchanged at $p^S_1$.

Shadow price = $p^D_1 - t = p^S_1$ = unchanging tax-exclusive price, $p^S_1$.

The tax revenue (□) is a transfer, and so changes in the tax revenue (changes in a transfer) are not changes in cost (□).
**A Tax (cont.) —**
e.g. oil at world price plus a local excise of $t$:

Consumers value the increase in demand ($\Delta D$) at the tax-inclusive price $p_1^D$.

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Shadow price = $p_1^D - t = p_1^S$ = unchanging tax-exclusive price, $p_1^S$.

The tax revenue (□) is a transfer, and so changes in the tax revenue (changes in a transfer) are not changes in cost (□).

This is only the case if there is no effect on existing purchasers of output, since there is no increase in price with perfectly elastic supply.

∴ the ex-tax price $p_1^S$ is the shadow price.
1.2 Example 2: Shadow prices and opportunity costs when prices change

[C&B pp. 92–96; FP Ch. 2.2.2, 2.3.2; DoF 3.4]

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1.2 Example 2: **Shadow prices and opportunity costs when prices change**

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**Q:** There is a local market for irrigation water. The going price is $50/megalitre. A new cotton farm is planned, but its size and thirst for water are such that the going price of water will rise to $60/megalitre, given its demand of 10,000 megalitres/year. At the lower price the NPV of the project is positive, but at the higher price negative. At the higher price the incumbent users cut their consumption by 1000 megalitres/year.

**A:**


1.2 Example 2: Shadow prices and opportunity costs when prices change

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A: The shadow price is between $50 and $60/megalitre, say $55 (assuming linear supply and demand curves). The existing users bear a cost of $55 × 1000 = $55,000/year for the water they can no longer afford (the displaced water).
1.2 Example 2: **Shadow prices and opportunity costs when prices change**

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A: The shadow price is between $50 and $60/megalitre, say $55 (assuming linear supply and demand curves). The existing users bear a cost of $55 \times 1000 = $55,000/year for the water they can no longer afford (the displaced water). The shadow cost to the new farm is $550,000/year, which includes $55,000 to outbid the exiting users for 1000 megalitres/year, and the opportunity cost of $495,000 to induce the increased supply of 9000 megalitres of water (the incremental water).
**Prices Change (cont.)**
(Not to scale.)

Diagram showing the effect of price changes on supply and demand. The graph illustrates the shift in demand from $50/ML to $60/ML, indicating a decrease in quantity demanded from $Q_1 - 1000$ to $Q_1 + 9000$. The supply curve remains unchanged.
**Prices Change (cont.)**

(Not to scale.)

\[ P \]

\[ \begin{align*}
\text{value of displaced water} &= $55,000 \\
\text{cost of supplying incremental water} &= $495,000 \\
\therefore \text{total cost} &= $550,000 \rightarrow P_S = $55
\end{align*} \]

For a FA, cost = $60 \times 10,000 = $600,000

For a CBA, cost = $55 \times 10,000 = $550,000
Prices Change (cont.)

Case 2.1
(No price change)
\textit{Prices Change} (cont.)

Case 2.1: (No price change)
resource opportunity cost = total social costs for increased factor supply (2)
\[ = P_1 \cdot \Delta G \]
Case 2.2: (Price change)

resource opportunity cost = total social costs

\[ P_1 \cdot \Delta G \] for increased factor supply (2)

+ value of reduced use of inputs in the rest of society as a response to higher prices, or opportunity costs. (1)

\[ P_1 \cdot \Delta G < \text{Area } [(1) + (2)] < P_2 \cdot \Delta G \]

\[ \therefore P_1 < P_s < P_2 \]

→ \( P_s \) is the “effective or shadow price”:

\( P_s \cdot \Delta G \) is the resource cost = area (1) + area (2)
Prices Change (cont.)

Note: be conservative

if NPV > 0 with \( P_2 \sim \text{cost} \) then \text{GO}
**Prices Change (cont.)**

Note: be conservative

\[
\begin{align*}
\text{if } \text{NPV} > 0 \text{ with } P_2 \sim \text{cost} & \quad \text{then GO} \\
\text{if } \text{NPV} < 0 \text{ with } P_1 \sim \text{cost} & \quad \text{then STOP}
\end{align*}
\]
Prices Change (cont.)

Note: be conservative

if $\text{NPV} > 0$ with $P_2 \sim \text{cost}$ then **GO**
if $\text{NPV} < 0$ with $P_1 \sim \text{cost}$ then **STOP**

\[
\begin{cases}
\quad \text{NPV} (P_2) < 0 \\
\quad \text{NPV} (P_1) > 0 \\
\quad \text{NPV} (P_s) ?
\end{cases}
\]

The point is so avoid the cost and effort of deriving a better estimate of
the shadow price $P_s$ *if it won’t make any difference to the decision.*
Some Equations and Harberger’s Method

*Area under Demand Curve*

\[
\text{area} \approx \eta^P Q_D \Delta P
\]

\( \eta^P \): price elasticity of demand

\[& \bar{Q}_D = \frac{Q_D + Q_1}{2} \]

Diagram:
- \( Q_D \)
- \( \bar{Q}_D \)
- \( Q_1 \)
- \( \Delta Q \)
- \( \Delta P \)

Equation (1)
Some Equations and Harberger’s Method

**Area under Demand Curve**

\[
\text{area} \approx \eta^P Q_D \Delta P
\]

(\(\eta^P\): price elasticity of demand)

\[Q_D \quad \tilde{Q}_D \quad Q_1\]

\[\Delta P \quad \tilde{Q}_D \quad \Delta Q\]

\[Q_D = \frac{Q_D + Q_1}{2}\]

**Area under Supply Curve**

\[
\text{area} \approx \kappa^P \tilde{Q}_S \Delta P
\]

(\(\kappa^P\): price elasticity of supply)

\[Q_1 \quad \tilde{Q}_S \quad Q_S\]

\[\Delta P \quad \tilde{Q}_S \quad \Delta Q\]

\[\tilde{Q}_S = \frac{Q_1 + Q_S}{2}\]
**Case 2.2: Prices change.** (NFX: Not For Exam)

From above, social cost \((1) + (2) = P_s \cdot \Delta G\)

\[
\Delta P (\eta \bar{Q}_D + \kappa \bar{Q}_s)
\]

\[
\therefore P_s = \frac{\Delta P (\eta \bar{Q}_D + \kappa \bar{Q}_s)}{\Delta G} \quad \text{shadow price}
\]

\[
\Delta P \left( \eta \frac{Q_1 + Q_D}{2} + \kappa \frac{Q_1 + Q_S}{2} \right)
\]

\[
\frac{\Delta P \eta \left( Q_1 + \frac{Q_D}{2} + \frac{Q_S}{2} \right)}{\Delta G} \quad \text{(if } \eta = \kappa)\]

— a means of obtaining the shadow price \(P_s\) from \(Q_1, \Delta P, \eta, \kappa, Q_D, Q_S,\) and \(\Delta G.\)
The Project’s Output Drives Prices Down

The project produces an output which is sold: FA benefit = revenue = selling price \times quantity. With no change in price, same with CBA. If the output price falls, some marginal producers cut back or cease: a benefit. **FA revenue** is too low.
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\[ P_1 < \text{shadow price} < P_2 \]
1.3 Example 3: Prices change with a tax wedge. [DoF 3.5]

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Q: In the cotton-farm example, assume that the prices of $50 (before) and $60/megalitre (after) include a tax of $4/megalitre, to raise revenue. What now is the shadow cost of water to the new farm?

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A: We have to adjust for both the induced price increase and the tax wedge between suppliers of water and users of water.

The value of the displaced 1000 megalitres of water for the existing farmers who cannot afford to pay $60/megalitre is still $55,000 year: we use the tax-inclusive price of $55/megalitre because they evidently value this water at $50/megalitre at least, but not at $60/megalitre.
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A: We have to adjust for both the induced price increase and the tax wedge between suppliers of water and users of water.

The value of the *displaced* 1000 megalitres of water for the existing farmers who cannot afford to pay $60/megalitre is still $55,000/year: we use the tax-inclusive price of $55/megalitre because they evidently value this water at $50/megalitre at least, but not at $60/megalitre.

The shadow cost of the *incremental* water is between $46 and $56/megalitre (the tax-exclusive prices), since that’s what the suppliers of water receive to induce them to increase supply; say $51 \times 9000 \text{ megalitres/year} = $459,000/year.

∴ Total shadow cost = $55,000 + $459,000 = 514,000/year.
∴ Shadow price = $51.40/megalitre
Price Change & Tax (cont.)

(Not to scale.)
Price Change & Tax (cont.)

(Not to scale.)

\[ Q_1 - 1000 \quad Q_1 \quad Q_1 + 9000 \]

\[ \text{value of displaced water} = \$55,000 \text{ (still)} \]
\[ \text{cost of supplying incremental water} = \$459,000 \]
\[ \therefore \text{total cost} = \$514,000 \rightarrow P_S = \$51.40 \]

For a FA, cost = \$60 \times 10,000 = \$600,000
For a CBA, cost = \$51.40 \times 10,000 = \$514,000
Price Change & Tax (cont.)

Elastic supply

\[ p_0 \]

\[ q_0 \]

\[ D_0 \]

\[ S_0 \]
Elastic supply

$\$/unit

$p^D_1$

$p_0$

$p^S_1$

$q_1$

$q_0$

quantity $q$

Figure 1
Price Change & Tax (cont.)

In Figure 1 above:

•
Price Change & Tax (cont.)

In Figure 1 above:

- $p_0, q_0$ is the initial price at A
Price Change & Tax (cont.)

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- $p_0, q_0$ is the initial price at A
- A specific tax of $p_1^D - p_1^S = t$ is imposed
Price Change & Tax (cont.)

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Price Change & Tax (cont.)

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• \( p_0, q_0 \) is the initial price at A
• A specific tax of \( p_1^D - p_1^S = t \) is imposed
• This is perceived by consumers as a shift in supply from \( S_0 \) to \( S_1 \)
∴ buyers pay (tax-inclusive) \( p_1^D \) and producers receive (tax-exclusive) \( p_1^S \)

**Price Change & Tax (cont.)**

In Figure 1 above:

- $p_0, q_0$ is the initial price at $A$
- A specific tax of $p^D_1 - p^S_1 = t$ is imposed
- This is perceived by consumers as a shift in supply from $S_0$ to $S_1$
- ∴ buyers pay (tax-inclusive) $p^D_1$ and producers receive (tax-exclusive) $p^S_1$
- The tax revenue is $(p^D_1 - p^S_1)q_1 = tq_1$
Price Change & Tax (cont.)

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- Consumption falls from $q_0$ to $q_1$ (by $b$)
- The tax revenue is a transfer from consumers of the product to consumers in general (via tax receipts and government expenditure)
Price Change & Tax (cont.)

$/unit

quantity q

$p_1^D$

$q_1$

$D_0$

$S_1$
Price Change & Tax (cont.)

Figure 2
Price Change & Tax (cont.)

In Figure 2:

•
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Price Change & Tax (cont.)

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- The gain to the taxpayer is simply a transfer. ∴ ignore it.
Price Change & Tax (cont.)

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  - Existing consumers value the reduction in $a$ at the tax-inclusive price $p^D_2$ that they pay
  $\therefore$
Price Change & Tax (cont.)

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- The gain to the taxpayer is simply a transfer ∴ ignore it.
- Existing consumers value the reduction in $a$ at the tax-inclusive price $p_2^D$ that they pay

∴ unit social cost = $a$ (gross-of-tax price) + $(1 - a)$ (net-of-tax price)

= $a p_2^D + (1 - a)(p_2^D - t)$ = shadow price

Hence shadow price = a weighted average of the tax-inclusive and tax-exclusive prices, $p_2$ and $p_2 - t$, respectively.
Price Change & Tax (cont.)

How do we calculate the weights $a$ and $1 - a$?

$\eta_D =$
Price Change & Tax (cont.)

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Price Change & Tax (cont.)

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= \% change in quantity \( \div \) \% change in price
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**Price Change & Tax (cont.)**

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Similarly:

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\kappa_S = \text{supply elasticity} = \frac{(1-a)/q_1}{(p_2 - p_1)/p_1}
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Hence \( \frac{\eta_D}{\kappa_S} = \frac{a}{1-a} \)

and \( \therefore a = -\frac{\eta_D}{\kappa_S - \eta_D} \)

and Shadow Price = \( ap_2 + (1-a)(p_2 - t) \):
**Price Change & Tax (cont.)**

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Price Change & Tax (cont.)

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and Shadow Price $= ap_2 + (1 - a)(p_2 - t)$:

- for an increased demand for the input
- also for an increase in supply of the good if the project results in more of the good
Price Change & Tax (cont.) — Figure 3

$/$unit

$q_1$

quantity $q$

$p_1^D$

$p_1^S$

$t$

$S_1$

$S_0$

$D_0$
Price Change & Tax (cont.) — Figure 3

\[ \Delta D = 1 \]

\[ p_2^D \]

\[ p_1^D \]

\[ p_1^S \]

\[ a \]

\[ 1 - a \]

\[ q_1 \]

\[ q_2 \]

\[ t \]
Price Change & Tax (cont.) — Figure 3

- Valuation of the increased supply $1 - a$ depends on $S_0$ (tax-exclusive)

\[
\Delta D = 1 - a
\]
Price Change & Tax (cont.) — Figure 3

- Valuation of the increased supply $1 - a$ depends on $S_0$ (tax-exclusive)
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Price Change & Tax (cont.) — Figure 3

- Valuation of the increased supply $1 - a$ depends on $S_0$ (tax-exclusive)
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- Figure 3 adds the tax-exclusive supply curve $S_0$ to Figure 2
Price Change & Tax (cont.) — Figure 3

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- Valuation of the demand shifted to the project $a$ depends on the shaded area under $D_1$
- Figure 3 adds the tax-exclusive supply curve $S_0$ to Figure 2
- So $\Delta D \times p_S = \text{the sum of the two areas}$
1.4 Example 4: **Shadow pricing of labour** [C&B pp. 96–98; FP Ch. 6.4.1, Ch. 10; DoF 3.9]
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- In a competitive labour market the shadow price of labour is simply the market wage:

\[
\frac{\$}{\text{unit employment}}
\]

\[
S
\]

\[
D_1
\]

\[
w_1^*
\]

\[
n_1^*
\]

employment \( n \)
1.4 Example 4: **Shadow pricing of labour** [C&B pp. 96–98; FP Ch. 6.4.1, Ch. 10; DoF 3.9]

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![Diagram showing the relationship between shadow price and market wage](image)
1.4 Example 4: **Shadow pricing of labour** [C&B pp. 96–98; FP Ch. 6.4.1, Ch. 10; DoF 3.9]

- In a competitive labour market the shadow price of labour is simply the market wage:

  ![Diagram showing supply curve (S) and demand curves (D1 and D2) with shadow prices at w1 and w2.]

- But the project shifts the demand for labour from D1 to D2.
1.4 Example 4: Shadow pricing of labour [C&B pp. 96–98; FP Ch. 6.4.1, Ch. 10; DoF 3.9]

- In a competitive labour market the shadow price of labour is simply the market wage:

  ![Graph showing shadow pricing of labour](image)

  - But the project shifts the demand for labour from \( D_1 \) to \( D_2 \)
  - more jobs are “created” \((n_2^* - n_1^*)\)
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\[ w^* \]

- But the project shifts the demand for labour from \( D_1 \) to \( D_2 \)
- more jobs are “created” \( (n_2^* - n_1^*) \)
- workers move from lower-paid to higher-paid jobs

\[ w_1^* \quad w_2^* \]

\[ \Delta D \]
1.4 Example 4: Shadow pricing of labour [C&B pp. 96–98; FP Ch. 6.4.1, Ch. 10; DoF 3.9]

- In a competitive labour market the shadow price of labour is simply the market wage:

\[ \frac{\text{$/unit}}{n} \]

- But the project shifts the demand for labour from \( D_1 \) to \( D_2 \)
- more jobs are “created” \( (n_2^* - n_1^*) \)
- workers move from lower-paid to higher-paid jobs
- and there is no “involuntary” unemployment
Labour (cont.) — Suppose there is a minimum wage $\bar{w}$ for labour set by the IRT. Then the employment level $n_1$ will be less than the competitive level, $n^*_1$.
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[Diagram showing wage $w$ in units on the y-axis and employment $n$ on the x-axis. The curve $S$ represents the supply of labour, and the curve $D_1$ represents the demand for labour. The minimum wage $\bar{w}$ is above the competitive wage $w_1^*$, and the supply price $w_1^{SP}$ is below $w_1^*$, indicating the impact of the minimum wage on employment.]
Labour (cont.) — Suppose there is a minimum wage $\bar{w}$ for labour set by the IRT. Then the employment level $n_1$ will be less than the competitive level, $n_1^*$. 

![Diagram showing the impact of a minimum wage on employment.](image-url)
Labour (cont.) — Suppose there is a minimum wage \( \bar{w} \) for labour set by the IRT. Then the employment level \( n_1 \) will be less than the competitive level, \( n_1^* \).

- The projects shifts out demand for labour from \( D_1 \) to \( D_2 \).
Labour (cont.) — Suppose there is a minimum wage $\bar{w}$ for labour set by the IRT. Then the employment level $n_1$ will be less than the competitive level, $n^*_1$.

- The projects shifts out demand for labour from $D_1$ to $D_2$
- If the additional workers who receive jobs value leisure at $w_1^{SP}$, then $w_1^{SP}$ is their shadow wage
Labour (cont.) — Suppose there is a minimum wage $\bar{w}$ for labour set by the IRT. Then the employment level $n_1$ will be less than the competitive level, $n^*_1$.

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If the additional workers who receive jobs value leisure at $w_1^{SP}$, then $w_1^{SP}$ is their shadow wage

New employed workers may have a higher value of leisure $w_2^{SP}$ than $w_1^{SP}$

$\therefore$
Labour (cont.) — Suppose there is a minimum wage $\bar{w}$ for labour set by the IRT. Then the employment level $n_1$ will be less than the competitive level, $n_1^*$.

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∴ this higher average value $w_{2}^{SP}$ should be used for them
Labour (cont.) — Suppose there is a minimum wage $\bar{w}$ for labour set by the IRT. Then the employment level $n_1$ will be less than the competitive level, $n_1^*$. 

- The projects shifts out demand for labour from $D_1$ to $D_2$.
- If the additional workers who receive jobs value leisure at $w_{1SP}$, then $w_{1SP}$ is their shadow wage.
- New employed workers may have a higher value of leisure $w_{2SP}$ than $w_{1SP}$.
- This higher average value $w_{2SP}$ should be used for them.
- The average social cost (shadow price) is lower than the market price $\bar{w}$.
Labour (cont.) — Suppose there is a minimum wage \( \bar{w} \) for labour set by the IRT. Then the employment level \( n_1 \) will be less than the competitive level, \( n^*_1 \).

\[
\text{wage } w \text{ }$/unit\]

- The projects shifts out demand for labour from \( D_1 \) to \( D_2 \)
- If the additional workers who receive jobs value leisure at \( w^{SP}_1 \), then \( w^{SP}_1 \) is their shadow wage
- New employed workers may have a higher value of leisure \( w^{SP}_2 \) than \( w^{SP}_1 \)
- this higher average value \( w^{SP}_2 \) should be used for them
- The average social cost (shadow price) is lower than the market price \( \bar{w} \)
- Why? Because there is unemployment at minimum wage \( \bar{w} \).
Labour (cont.)

$\text{$/unit}
tilde{w}

\begin{align*}
W_1^{SP} \\
n_1 \\
\text{employment } n
\end{align*}
Labour (cont.)

$$/unit
\bar{w}
W_2^{SP}
W_1^{SP}
\Delta D
D_1
D_2
n_1
n_2
employment n
Labour (cont.)

![Graph showing labor market dynamics with supply (S) and demand (D1, D2) curves, depicting wage rates (W1^SP, W2^SP) and employment levels (n1, n2).]
Labour (cont.)

The change in the wage bill = \( \bar{w} \times (n_2 - n_1) \); in F.A. it was the “rectangle” (brown + green).

•
Labour (cont.)

- The change in the wage bill = $\bar{w} \times (n_2 - n_1)$; in F.A. it was the “rectangle” (brown + green).
- The change in the social cost = $\frac{w_{1}^{SP} + w_{2}^{SP}}{2} \times (n_2 - n_1)$: brown area.
Labour (cont.)

\[ \text{The change in the wage bill} = \bar{w} \times (n_2 - n_1); \text{ in F.A. it was the} \]
\[ \text{“rectangle” (brown + green).} \]

\[ \text{The change in the social cost} = \frac{w_1^{SP} + w_2^{SP}}{2} (n_2 - n_1): \text{ brown area} \]

\[ \text{The opportunity cost of getting a job is less than } \bar{w}, \text{ which is} \]
\[ \text{reflected in the supply curve. } w^{SP} = \frac{1}{2} (w_1^{SP} + w_2^{SP}) \]
1.5 Example 5: **Foreign exchange** [C&B Ch. 8; FP Ch. 9.2; DoF 3.8]

![Diagram of foreign exchange with demand and supply curves for exports and imports, showing a change in demand ($\Delta D$) and traded goods ($q$).]
Foreign Exchange (cont.)

In the figure:

•
Foreign Exchange (cont.)

In the figure:

- the vertical axis shows the real price of traded goods = the inverse of the exchange rate.

-
Foreign Exchange (cont.)

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- the supply and demand for foreign currency is initially in balance at $q_1, e_1$. 


Foreign Exchange (cont.)

In the figure:

- the vertical axis shows the real price of traded goods = the inverse of the exchange rate.
- the supply and demand for foreign currency is initially in balance at \( q_1, e_1 \).
- if the demand for imports by Australians goes up by \( \Delta D \), the real price of traded goods will cost more.
Foreign Exchange (cont.)

In the figure:

- the vertical axis shows the real price of traded goods = the inverse of the exchange rate.
- the supply and demand for foreign currency is initially in balance at \( q_1, e_1 \).
- if the demand for imports by Australians goes up by \( \Delta D \), the real price of traded goods will cost more.
- the $A will devalue in terms of foreign currency as the real price of imports rises (and \( e \) rises).
Foreign Exchange (cont.)

In the figure:

- the vertical axis shows the real price of traded goods = the inverse of the exchange rate.
- the supply and demand for foreign currency is initially in balance at $q_1, e_1$.
- if the demand for imports by Australians goes up by $\Delta D$, the real price of traded goods will cost more.
- the $\$A$ will devalue in terms of foreign currency as the real price of imports rises (and $e$ rises).
- Australian exporters will gain more revenue in $\$A$ terms, to encourage additional exports.

$\therefore$
Foreign Exchange (cont.)

In the figure:

• the vertical axis shows the real price of traded goods = the inverse of the exchange rate.
• the supply and demand for foreign currency is initially in balance at $q_1, e_1$.
• if the demand for imports by Australians goes up by $\Delta D$, the real price of traded goods will cost more
• the $\$A$ will devalue in terms of foreign currency as the real price of imports rises (and $e$ rises)
• Australian exporters will gain more revenue in $\$A$ terms, to encourage additional exports
∴ an upwards sloping supply curve $S$. 
Foreign Exchange (cont.)

A tariff (tax) of $t$ is now imposed on imports.
Foreign Exchange (cont.)

A tariff (tax) of $t$ is now imposed on imports

- $A$ represents the equilibrium value of exports
Foreign Exchange (cont.)

A tariff (tax) of $t$ is now imposed on imports.
- $A$ represents the equilibrium value of exports.
- $B$ is the tariff-inclusive value of imports.
A tariff (tax) of \( t \) is now imposed on imports

- \( A \) represents the equilibrium value of exports
- \( B \) is the tariff-inclusive value of imports
- measured in terms of foreign currency, the value of imports and exports is equal.
Foreign Exchange (cont.) —
Project now increases our supply of foreign exchange $\Delta S$ via additional exports. Let $\Delta S = 1$.
Foreign Exchange (cont.) —
Project now increases our supply of foreign exchange $\Delta S$ via additional exports. Let $\Delta S = 1$.

\[ \Delta S = 1 \]

\[ $/\text{unit} \]

\[ e_1 \]

\[ \text{sold goods q} \]

\[ a \]

\[ q_1 \]

\[ \text{targ-blem~exclusive for imports} \]

\[ \text{targ-blem~inclusive} \]

\[ A \]

\[ B \]

\[ C \]

\[ S \]

\[ S' \]

\[ \Delta S = 1 \]

\[ \text{this situation is similar to the tax example (p.5-12)} \]
Foreign Exchange (cont.) —

.
Foreign Exchange (cont.) —

- increased exports facilitates increased imports valued at $e_1 + t$
  (area base $1 - a$)
Foreign Exchange (cont.) —

- increased exports facilitates increased imports valued at $e_1 + t$
  (area base $1 - a$)
- increased new exports displaces traditional exports $a$ valued at net-tax price of $e_1$
Foreign Exchange (cont.) —

- Increased exports facilitates increased imports valued at $e_1 + t$
  (area base $1 - a$)

- Increased new exports displaces traditional exports $a$ valued at
  net-tax price of $e_1$

- Shadow price =
Foreign Exchange (cont.) —

- increased exports facilitates increased imports valued at \( e_1 + t \)
  (area base \( 1 - a \))

- increased new exports displaces traditional exports \( a \) valued at
  net-tax price of \( e_1 \)
  \[ \text{shadow price} = a \text{ (post-tax price of traded goods)} + (1 - a) \text{(pre-tax price of traded goods)} \]
Foreign Exchange (cont.) —

- increased exports facilitates increased imports valued at $e_1 + t$
  (area base $1 - a$)

- increased new exports displaces traditional exports $a$ valued at
  net-tax price of $e_1$

  • shadow price = $a \text{ (post-tax price of traded goods)}$
    + $(1 - a) \text{ (pre-tax price of traded goods)}$

- shadow exchange rate will exceed market exchange rate, since
  exports are under-valued by the market exchange rate. — The
  Gregory Thesis or Dutch Disease.
Summary of Lecture 5

This lecture introduced the use of market prices — suitably adjusted to become *shadow prices* which accurately reflect the opportunity cost of the goods and services used by the project, whether produced in response to the project’s demand (*incremental*) or bid away from existing uses (*displaced*) — in CBA studies.

Remember: **No price change ∴ no displacement**
Summary of Lecture 5

This lecture introduced the use of market prices — suitably adjusted to become *shadow prices* which accurately reflect the opportunity cost of the goods and services used by the project, whether produced in response to the project’s demand (*incremental*) or bid away from existing uses (*displaced*) — in CBA studies.

Remember: **No price change:** no displacement

- How to adjust market prices for taxes (which are *transfers*, by and large).
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Summary of Lecture 5

This lecture introduced the use of market prices — suitably adjusted to become *shadow prices* which accurately reflect the opportunity cost of the goods and services used by the project, whether produced in response to the project’s demand (*incremental*) or bid away from existing uses (*displaced*) — in CBA studies.

Remember: **No price change ∴ no displacement**

- How to adjust market prices for taxes (which are *transfers*, by and large).

- How to adjust market prices for price changes caused by the project.
  
  When input prices rise, FA overstates the cost.
  When output prices fall, FA understates the benefit.
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- How to adjust market prices for regulated prices, such as minimum wages with unemployment among the workers the project will hire.
  
  Shadow wages.