SESSION 2.1

ESTIMATION OF PROJECT COSTS AND BENEFITS

Introductory Course on Economic Analysis of Investment Projects

Economics and Research Department (ERD)

Project Statements

- Comparison of costs and benefits
- Typically investment costs (equipment, land, buildings etc) in early years with benefits arising after one or two years
- Start year when funds are committed to project
- (e.g., year 1, sometimes year 0 if starts immediately)
- Working capital for running project e.g., stocks

Project Life

- Needs to be identified
- Can be based on technical life of main equipment or estimated economic working life
- Economic working life ends in year where running cost > additional revenue
- Where economic life < technical life need to add Terminal Value for resale of assets in final year

Constant Prices

- Inflation usually ignored on assumption that all items rise at same rate
- Constant base year prices
- Not strictly correct as fixed costs or revenues will be reduced in real terms, e.g., tax allowances or fixed interest debt
- Also relative price changes e.g., oil price

Relative Price Change

- Formula RP = ((1 + p)/(1 + i))-1

  where p is price rise for specific commodity and i is general inflation
- Approximately equal to p – i
- So if oil price rises by 10% in 2014 and inflation is 2% relative price change for oil is approximately 8%
- Also applies to exchange rate

Project Cost Estimate: Feasibility/Detailed Design

- Identify project.
- Identify individual project components.
- Classify individual project components.
- Schedule construction and operation and maintenance of individual components within the project design.
- Engage project cost estimator to begin estimating costs in financial terms.
- Engage financial analyst to provide cost estimator with the level of detail required for financial analysis.
- Engage economist to provide cost estimator with the level of detail required for economic analysis.

Project Cost Estimates

Choice of currency

- domestic currency (e.g., Som, Tenge, Tugrik)
- foreign currency (e.g., US$)

Categories of costs

- domestic currency costs (e.g., unskilled labor)
- foreign currency costs (e.g., imported equipment)
- tradables
- nontradables

Project Cost Estimates: Types of Costs

a) Investment Costs

- civil works
- electrical works
- mechanical works
- engineering and other professional services
- start-up costs
- vehicles and equipment
- labor
- other
- taxes and duties

b) Recurrent Costs

salaries

operation and maintenance costs

- salaries
- fuel
- consumables
- other

c) Salvage values

d) Financial charges

- interest during construction

Identifying Cost Items

System Costs – if project is part of a larger system, include all other system investments needed to achieve project benefits.

- Power generation project may or may not need investment in transmission and distribution
- A highway section may or may not need investment in preceding or following sections

Sunk Costs - costs that would exist without or with the project; should be excluded

Working capital

- In financial analysis, includes net current assets (inventories, securities, cash, etc.)
- In economic analysis, include only inventories
- Changes in working capital are what matter

Transfer payments

- taxes, duties, subsidies
- Included as cost in financial analysis, but not in economic analysis

Identifying Cost Items

Depreciation and amortization

- Accounting convention allows entry as expenses, for computing tax liabilities
  In financial and economic analysis, such costs amount to double-counting if already counted at time of disbursement

External costs

- Some costs may not be charged against the project, e.g., air or water pollution
- Such costs may be internalized, e.g., when pollution charges are imposed, or anti-pollution devices are installed

Base Costs

Base Costs - best estimates of project costs at a specified date, assuming:

- Quantities of works, goods and services and relevant prices are accurately known.
- Quantities and prices will not change during implementation.
- The project will be implemented exactly as planned.

Contingency Allowances

- Allowance for adverse conditions which will be in addition to the base cost estimate.
- Physical contingencies – to cover physical uncertainties beyond the base case to complete the project. Often calculated and expressed as percentages of base costs.
- Price contingencies – to cover inflation and price uncertainties

Some typical levels of Physical Contingencies:

- 5% - standard equipment designs/definable civil works, e.g., road surfacing, canal lining.
- 10% - general civil works with routine and predictable uncertainties e.g, roads, buildings, pipelines, transmission lines
- 15% - plant and civil works in difficult terrain.

Cost Scheduling - 1

- Various methodologies
- Project engineers/designers advise cost estimator on the distribution of costs over the project life.
- For example, major civil works on a hydroelectric project costing $200 million may be disbursed over a 4-5 year period, as follows:

Year	%	$ million
1	15	30
2	25	50
3	40	80
4	20	40
TOTAL:		200

Cost Scheduling-2

- Built-up for each project component in the base cost.
- Identify foreign and local currency costs separately
- Physical contingencies allotted.
- Price contingencies allotted.
- Taxes, duties, and other transfer payments quantified.
- Interest during construction calculated.
- Project cost estimate aggregated to derive total cost estimate (i.e., base costs + taxes/duties + contingencies)
- Consolidated annual cost estimate prepared (e.g., capital and O & M costs).

Project Cost Estimates ($ million)

	Base Cost[a]			Physical Contingency[b]			Price Contingency[c]			Total		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
A. Preliminary Works	0	4.7	4.7	0	0.2	0.2	0	0.1	0.1	0	5.0	5.0
B. Civil Works												
Lot C1 (Dam and Desanders)	75.7	12.6	88.3	7.6	1.3	8.8	5.7	1.0	6.7	89.0	14.9	103.8
Lot C2 (Tunnel)	54.6	6.4	61.0	5.5	0.6	6.1	2.8	1.9	4.7	62.9	8.9	71.8
Lot C3 (Powerhouse)	36.2	11.6	47.8	6.5	2.1	8.6	2.9	0.9	3.8	45.6	14.6	60.2
C. Electromechanical												
Lot 4 (Hydraulic Steel Work)	21.6	0.9	22.5	1.2	0.1	1.3	1.4	0.4	1.8	24.2	1.4	25.6
Lot 5 (Electrical Equipment)	31.1	1.0	32.1	1.7	0.1	1.8	2.2	0.5	2.7	35.0	1.6	36.6
Lot 6 (Mechanical Equipment)	19.5	0.8	20.3	1.1	0	1.1	1.1	0.3	1.4	21.7	1.1	22.8
Lot 7 (Transmission System)	10.5	2.9	13.4	0.6	0.2	0.8	0.7	1.3	2.0	11.8	4.4	16.2
D. Other Project Costs												
Construction Engineering	13.0	2.1	15.1	0.7	0.1	0.8	0.9	0.1	1.0	14.6	2.3	16.9
Project Management	2.1	6.1	8.2	0.1	0.3	0.5	0.2	0.4	0.6	2.4	6.8	9.3
Environmental Mitigation	2.3	3.0	5.3	0.1	0.2	0.3	0.2	0.2	0.4	2.6	3.4	6.0
Loss Reduction Component	2.3	0.9	3.2	0.1	0.1	0.2	0.2	0.1	0.3	2.6	1.1	3.7
Total (A+B+C+D)	268.9	53.0	321.9	25.3	5.2	30.5	18.3	7.2	25.5	312.5	65.4	377.9
E. Taxes and Duties												
Contract Tax										0	16.8	16.8
Customs Duties										0	1.5	1.5
F. Interest during Construction										7.9	1.6	9.5
Total										**320.4**	**85.3**	**405.7**

[a] Base cost is based on January 1996 prices.

[b] Physical contingency: Lot C1 – 10%; Lot C2 – 10%; Lot C3 – 18%; Preliminary works – 4%; other items – 5.6%.

[c] Price contingency: 2.7% for foreign exchange costs (FC) and 6% for local currency costs (LC).

Annual Project Cost Estimates ($ million)

Fiscal Year	Capital Costs	Operation & Maintenance Costs	Salvage Value	Total Costs
1999	1.45			1.45
2000	64.91			64.91
2001	93.38			93.38
2002	165.39			165.39
2003	57.83			57.83
2004	22.74	3.46		26.2
↓		↓		↓
2012		3.46		3.46
2013		15		15
2014		3.46		3.46
↓		↓		↓
2022		3.46		3.46
2023		3.46	-81.14	-77.68
Total	405.70	80.74	-81.14	405.30

Construction Period: 5 years (overlap in years 1 and 6)
Project Operating Life: 20 years
Salvage Value: 20% of Investment Cost

Zhengzhou – Xi'an Railway Project
COST ESTIMATES AND FINANCING PLAN
($ million)

	Cost Estimates			Financing Plan	
Item	FX	LC	TC	ADB	MOR, HPG,SPG, CDB
A. Base Cost[a]					
1. Civil Works	604.54	1,410.60	2,015.14	0.00	2,015.14
2. Railway Track Work[b]	120.79	134.47	255.26	105.85	149.41
3. Buildings and Facilities	3.78	66.16	69.64	0.00	69.64
4. Signaling and Communications	190.84	138.71	329.55	156.17	173.38
5. Electric Power and Traction	76.47	106.32	182.79	49.89	132.90
6. Safety Component	26.29	23.29	49.58	20.47	29.11
7. E-Governance and MIS	41.89	37.09	78.98	32.61	46.37
8. Land Acquisition and Resettlement	0.00	181.43	181.43	0.00	181.43
9. Other Equipment and Facilities	16.23	14.38	30.61	12.64	17.97
10. Administration, Consulting Services, and Miscellaneous	32.28	178.41	210.69	0.80	209.89
11. Environmental Protection Mitigation and Monitoring	0.0	31.97	31.97	0.00	31.97
12. Temporary Facilities and Transitional Works	0.0	56.11	56.11	0.00	56.11
Subtotal (A)	1,112.81	2,378.94	3,491.75	378.43	3,13.32
B. Contingencies					
1. Physical Contingency[c]	144.30	96.20	240.50	0.00	240.50
2. Price Contingency[d]	58.50	87.75	146.25	21.57	124.68
Subtotal (B)	202.80	183.95	386.75	21.57	365.18
C. Interest[e]	49.00	204.43	253.43	0.00	25343
Total	**1,364.61**	**2,767.32**	**4,131.93**	**400.00**	**3,731.93**

ADB= Asian Development Bank, CDB = China Development Bank, HPG=Henan Provincial Government, MOR = Ministry of Railways, SPG= Shaanxi Provincial Government

a At 2005 prices. Import taxes and duties are waived

b Including rails, sleepers, ballast, bridge beams, track laying and bridge construction

c At 8% of civil works cost, including land acquisition

d At 3% per annum of local currency costs and 2% per annum for foreign exchange cost during 2006-2011

e This is based on the prevailing US$ 5-year swap rate plus a spread for the ADB loan and the prevailing interest rate for the China Development Bank

Economic Cost Estimate

- Economist advises cost estimator on the breakdown of costs required for the economic analysis.
- Level of detail contingent upon availability of conversion factors and choice of numeraire.
- Include base cost.
- Include physical contingencies.
- Exclude price contingencies
- Exclude relevant taxes, duties, subsidies, and other transfer payments.
- Classify project components as tradable or non-tradable.

Economic Cost Estimate

- **Tradable inputs and outputs** -- goods and services where production or consumption affects a country's level of imports or exports.

- **Nontradable inputs and outputs** -- goods and services that are not imported or exported by the country in which the project is located, because by their nature, they must be produced or sold within the domestic economy, e.g., products with no international market due to their quality and/or cost.

Economic Cost Estimate

- Apply shadow pricing
- For example, $200 million civil works on a hydroelectric project including physical contingencies (10%) using **world price numeraire**; standard conversion factor of 0.90 and no other conversion factors.
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	Total	Traded	Nontraded			Total Economic
Year	Civil Works	(35%)	65%	SCF	Economic Cost	Cost
1	33	11.6	21.4	0.9	19.3	30.9
2	55	19.2	35.8	0.9	32.2	51.4
3	88	30.8	57.2	0.9	51.5	82.3
4	44	15.4	28.6	0.9	25.7	41.1
Total	220	77.0	143.0		128.7	205.7

- In the above example, non-traded goods and services were adjusted by the standard conversion factor.
- Step repeated for each project component and then presented in the economic resource statement.

Economic Cost Estimate

If domestic price numeraire used for project, result is as follows.

Shadow Exchange Rate Factor = 1.11 (i.e. 1/SCF = 1/0.9)

	Total	Traded			Nontraded	Total Economic
Year	Civil Works	(35%)	SERF	Economic Cost	65%	Cost
1	33	11.6	1.11	12.9	21.4	34.3
2	55	19.2	1.11	21.3	35.8	57.1
3	88	30.8	1.11	34.2	57.2	91.4
4	44	15.4	1.11	17.1	28.6	45.7
Total	220	77.0		85.5	143.0	228.5

Economic costs are different with different numeraire. Shows importance of ensuring numeraire is defined clearly and used consistently.

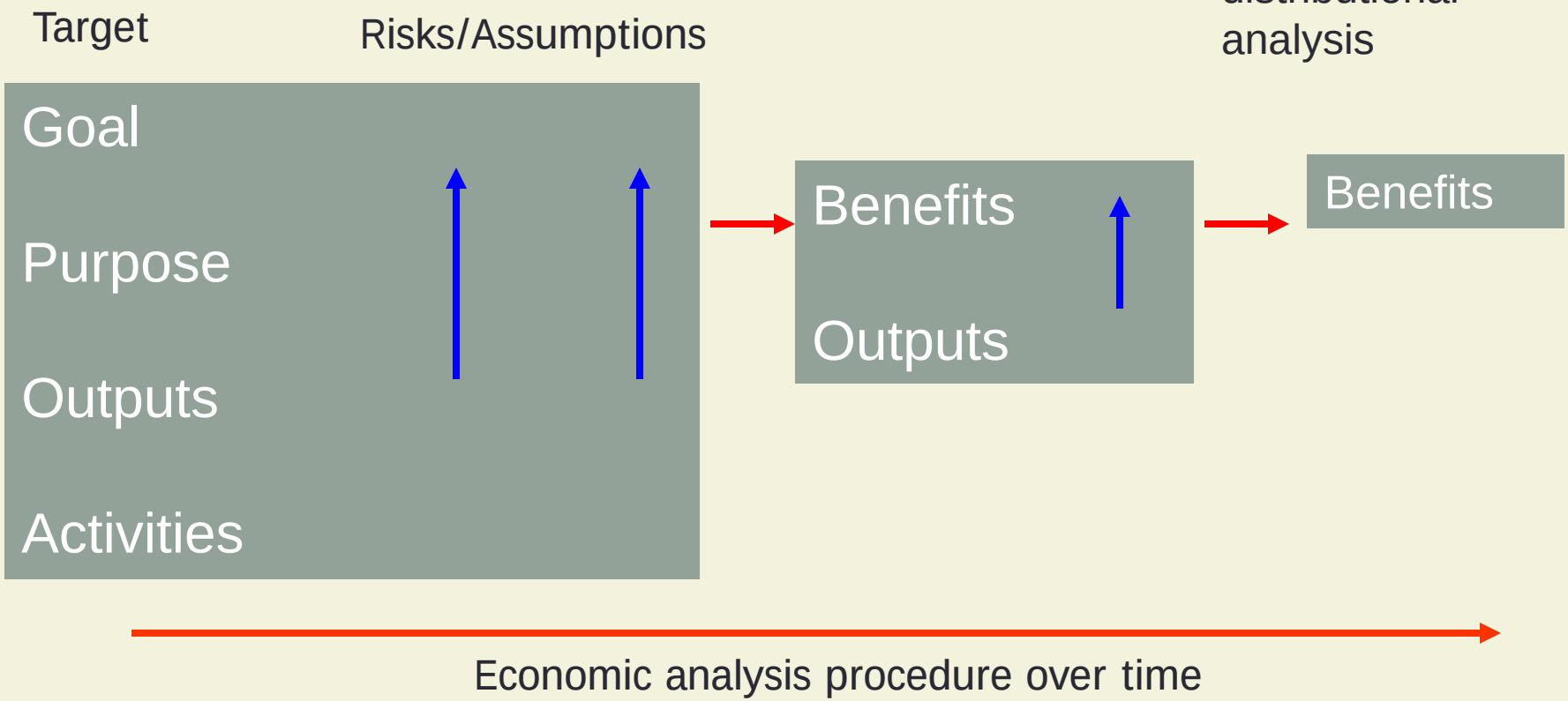
If numeraire is used consistently for costs and benefits, eventual decision on project, will not be affected by choice of numeraire.

Benefit Identification: The Project Framework and Economic Analysis

Define Targets
(from Project Framework)

Specify Outputs-to-Benefits Linkage

Value Benefits, use in EIRR calculation and distributional analysis



Specifying the Output-to-Benefit Linkage

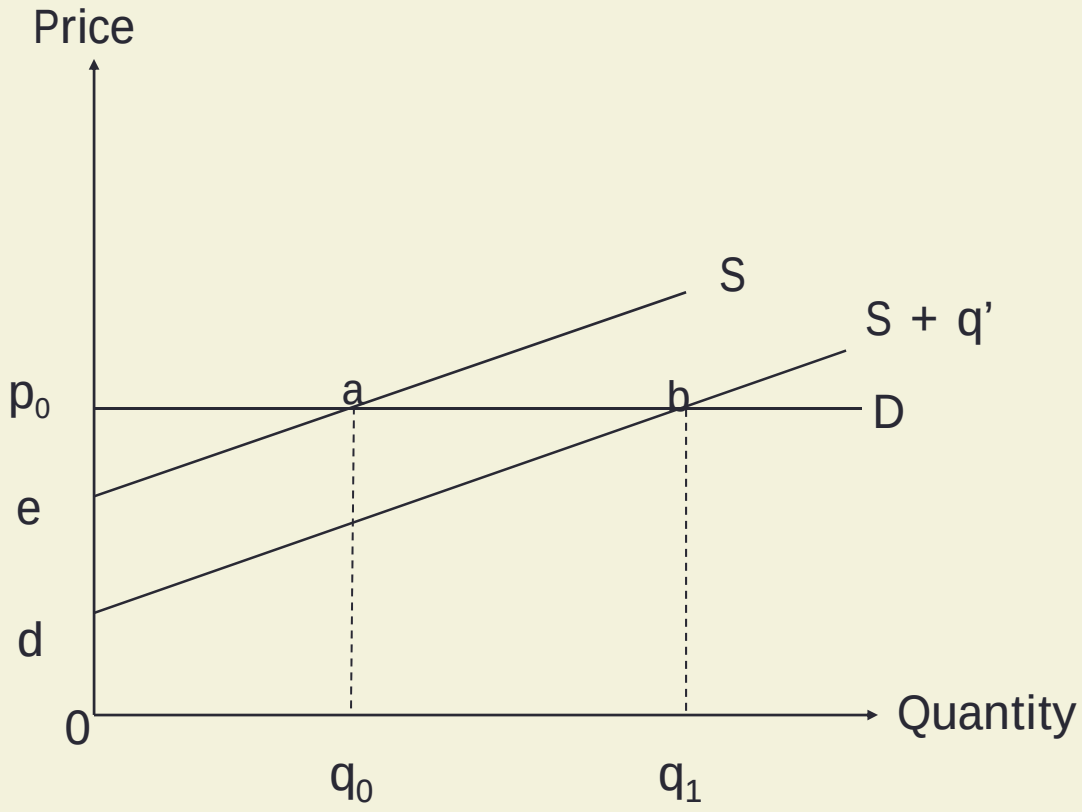
Output-to-Benefit Characteristic	Characteristic	Alternate characteristic
Type of output-to-benefit linkage mechanism	Direct (e.g., the project produces intermediate or final goods for participants)	Indirect (e.g., the project strengthens institutions or services to participants)
Basis of output valuation	Project output is sold in domestic and/or international markets	Project output is not sold in markets (domestic or international)
Types of beneficiaries	Existing participants (e.g., farmers, smallholders)	New, or new and existing participants

Benefit Identification: Incremental and Nonincremental

Economic valuation of project outputs depends upon whether they are incremental or not to existing national output or usage:

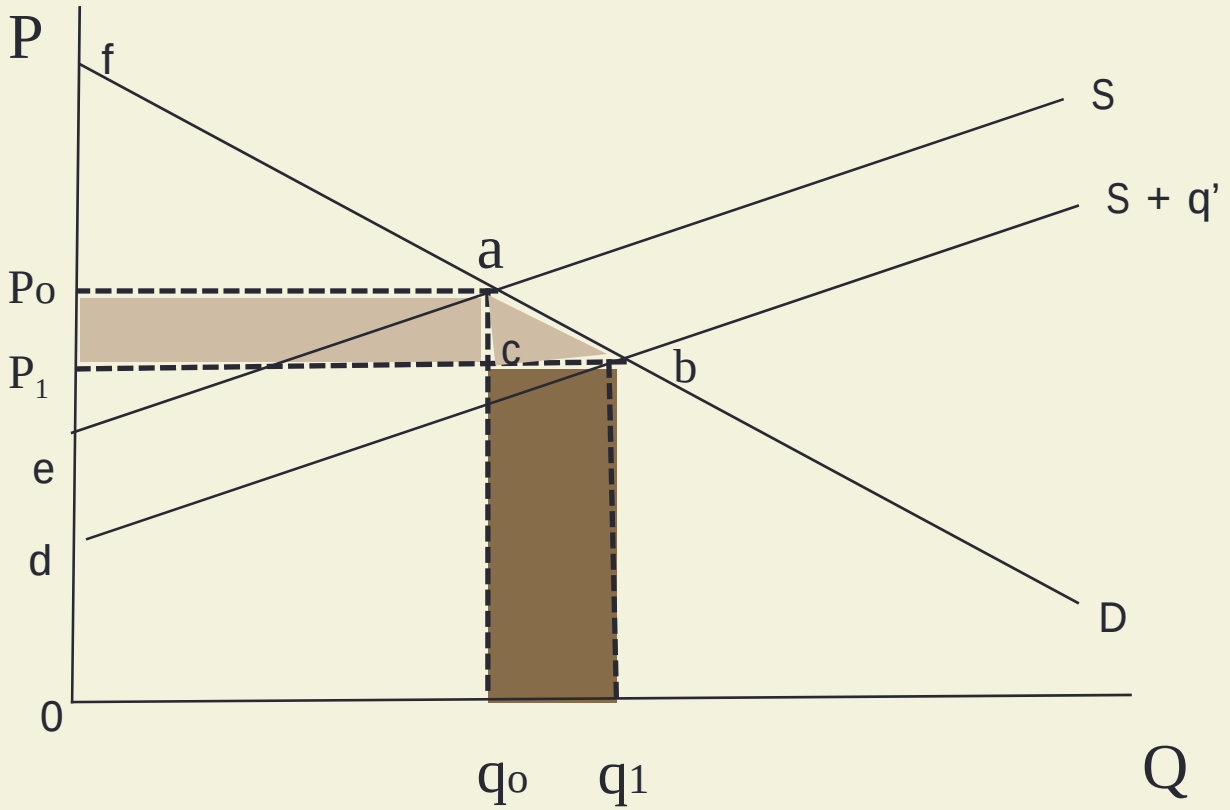
	Project Output
Incremental	the project output is additional to the case without the project
Nonincremental	the output of the project substitutes for alternative sources of supply in the economy (or imports)

Measuring Benefits in an Efficient Market with No Price Effects

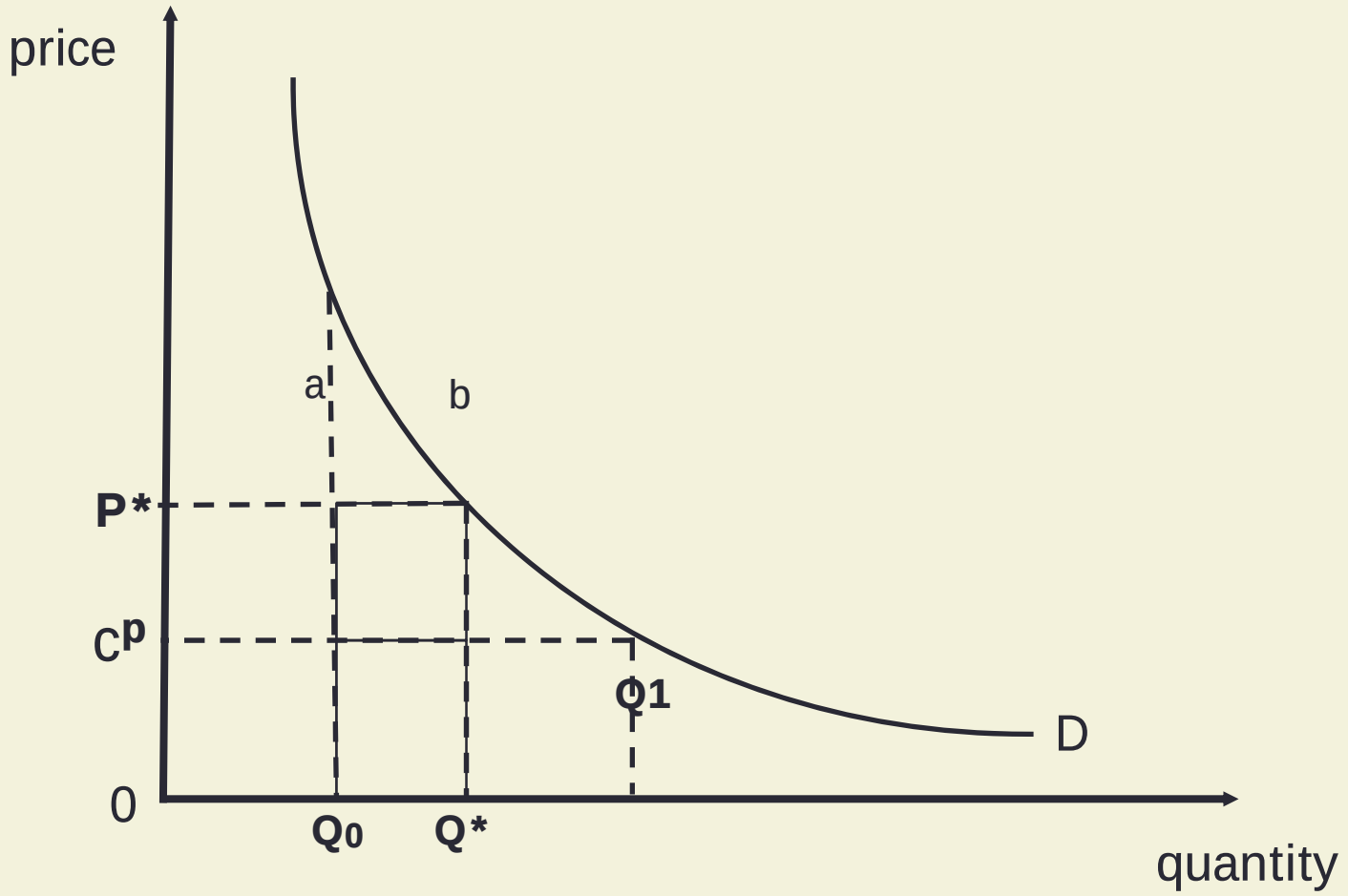


Revenues = Benefits

Measuring Benefits in an Efficient Market with Price Effects

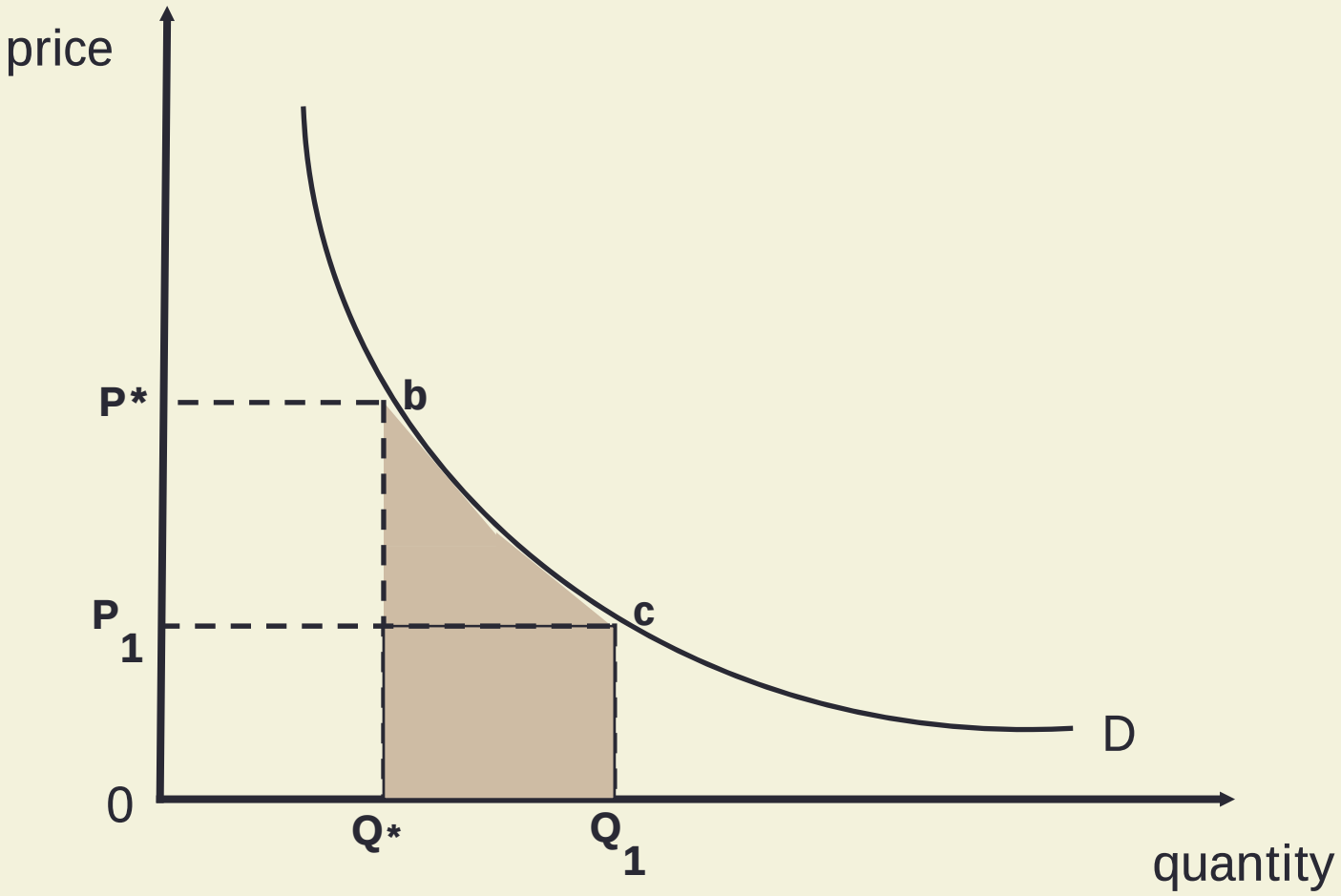


Measuring Benefits in a Distorted Market:
Non-incremental Benefits



Measuring Benefits in a Distorted Market:

Incremental Benefits



Benefit Valuation Methodology

Non-incremental Benefits

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Resource Cost Savings

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Supply Price

Incremental Benefits

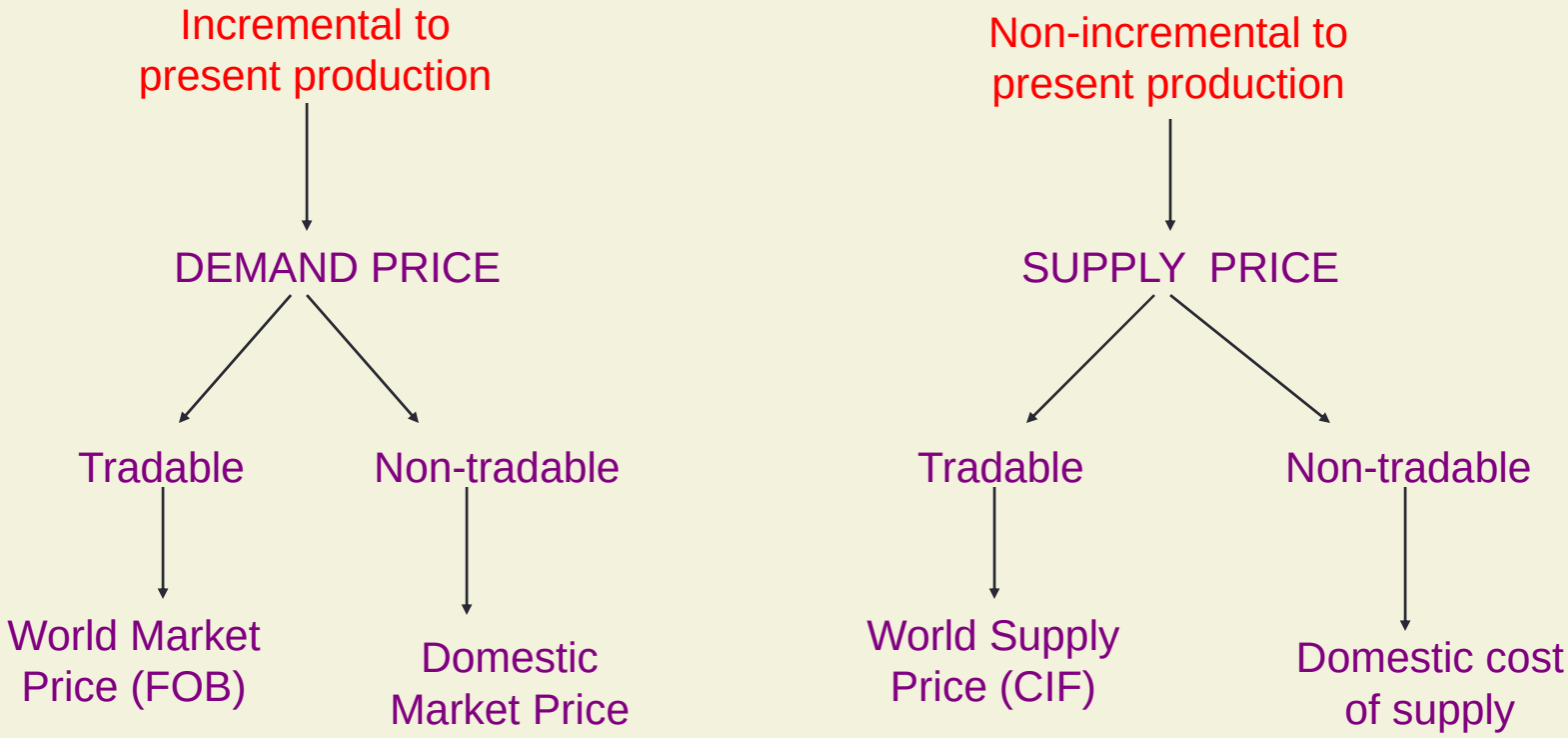
↓

Willingness-to-Pay

↓

Demand Price

Valuing Project Outputs



NB> Note that the domestic market demand price includes net taxes (i.e., it is a measure of what consumers are willing to pay for it), but that the domestic market supply price is only the cost of production (i.e., it should exclude any production taxes or surplus profits).

Benefit Identification:
Urban Infrastructure Projects

Type of Project	Potential Nonincremental Benefits	Potential Incremental Benefits
a) Piped Water Supply	i) Alternative sources of supply displaced ii) Improved quality displacing adverse health impacts iii) Improved quality resulting in efficiency gains	Improved quality Induced demand
b) Wastewater Treatment	i) Alternative sources of wastewater treatment displaced ii) Improved health through cost of illness displacement	Induced demand

Benefit Identification: Energy Projects

Type of Project	Potential Non-incremental Benefits	Potential Incremental Benefits
a) Power Generation	Displaced alternative forms of electricity/ energy generation in various sectors – all size generators	Additional or induced energy consumption valued at willingness-to-pay
b) Electricity Transmission i) Augmentation	i) Transmission loss reduction i) Reliability Improvement ii) Alternative supply displacement	Induced demand
ii) Interconnection	Alternative sources of fuel displaced	Induced demand

Benefit Identification: Transportation Sector

Type of Project	Potential Non-incremental Benefits	Potential Incremental Benefits
a) Road Improvement/ Rehabilitation	i) Reduced operating costs for existing traffic ii) Reduced operating costs for traffic diverting from alternative route iii) Travel time savings iv) Reduced road maintenance expenditures	Willingness-to-pay of new traffic generated by improved conditions of road.
b) Expressway Construction	i) Resource cost savings for traffic diverting from existing roads/railways ii) Resource cost savings for traffic remaining on existing roads (reduced congestion)	Willingness-to-pay of new traffic generated by new road.

Transport Projects

- Benefits = Vehicle Operating cost savings for Normal Traffic
- Benefits = 0.5* Vehicle Operating cost savings for Generated Traffic
- Benefits can be estimated initially in financial prices (eg via HDM model) then converted to economic prices

Non-Quantifiable Economic Benefits

- non-tangible (social / political, knowledge / information / business skills)
- tangible (inputs for processing industry, new businesses)
- exclude from economic analysis but describe textually (quantity and quality)

Thank you.