Public Goods

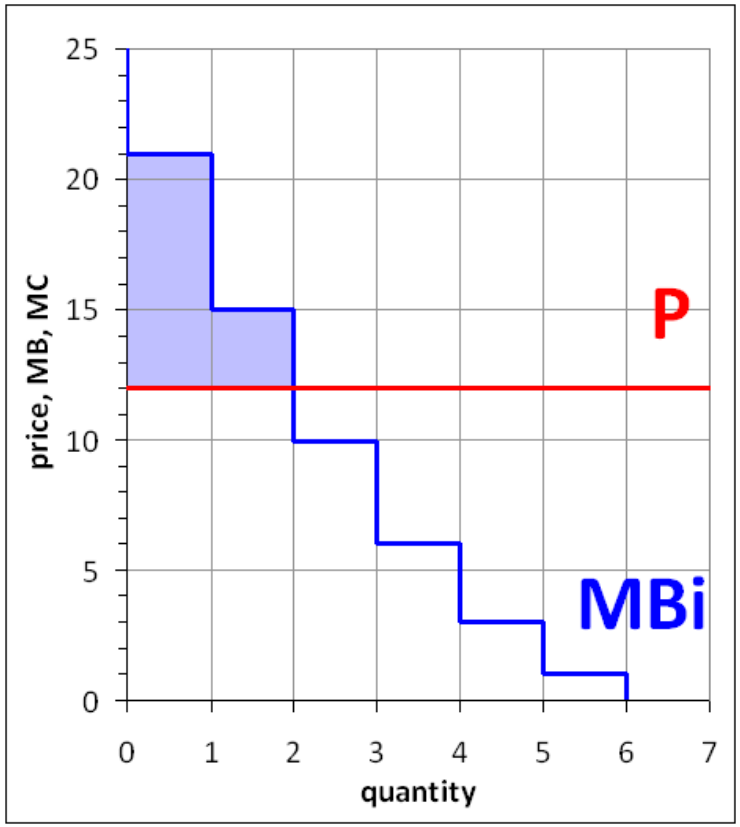
Tuesday, February 7

RIVALNESS AND EXCLUDABILITY

excludable? \ rival?	yes	no
yes	**private good** (e.g. a sandwich)	**natural monopoly** (e.g. cable television)
no	**common resource** (e.g. fish in the ocean)	**public good** (e.g. national defense)

INDIVIDUAL BENEFIT AND DEMAND

Q	TB_i	MB_i
1	21	21
2	36	15
3	46	10
4	52	6
5	55	3
6	56	1
7	56	0



CS = TB – TC
= 36 – 2×12
= 12

or

CS = Σ(MB–MC)
= (21–12)+(15–12)
= 12

Suppose that I live in a house with 4 other people, and we're deciding how many paintings to buy for the common room wall. My individual benefit from different numbers of paintings are as given above. If no one else bought any at all, and the price of a painting was $12, then I'd buy 2 paintings and get a consumer surplus of 12, as shown above.

SOCIAL BENEFIT

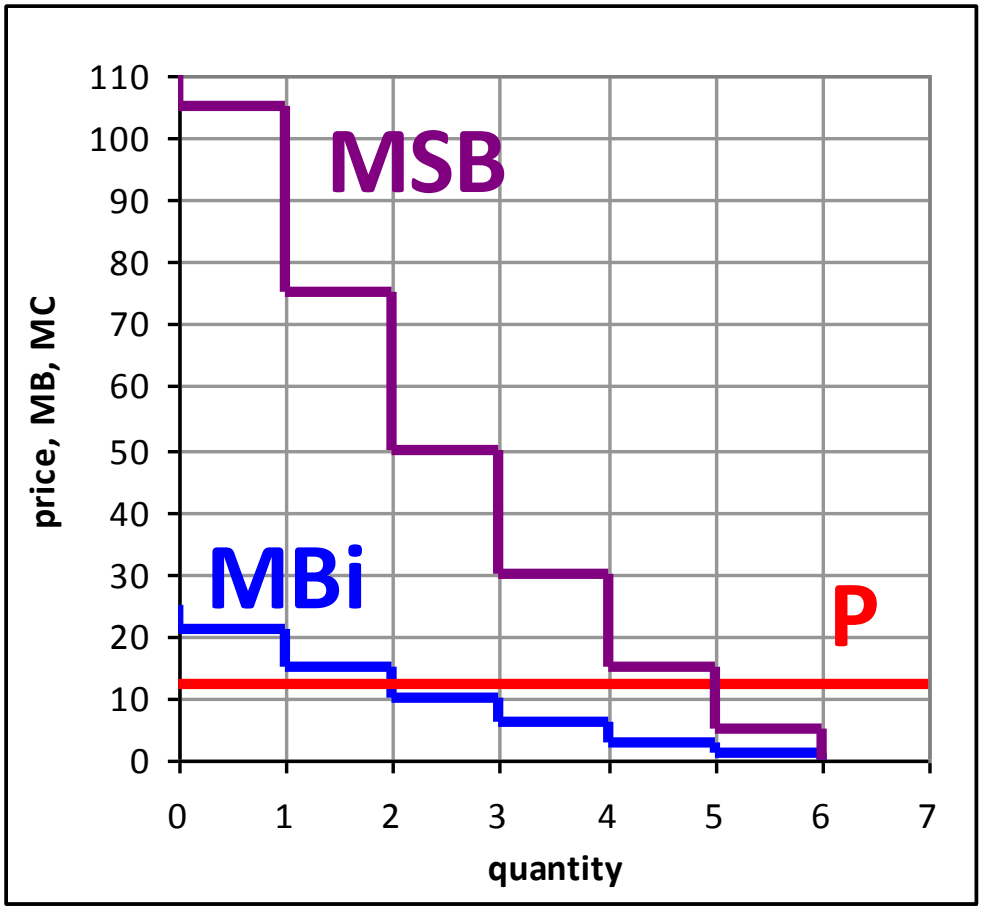
Q	TB_i	MB_i	TSB	MSB
1	21	21	105	105
2	36	15	180	75
3	46	10	230	50
4	52	6	260	30
5	55	3	275	15
6	56	1	280	5
7	56	0	280	0

Suppose (for simplicity) that all 5 residents of the house have exactly the same benefit-for-paintings schedule as I do. Suppose also that all paintings in the common room are non-rival and non-excludable (which makes sense).

In that case, multiplying the total benefit that each individual gets from any given number of paintings by 5 will give us a measure of the total social benefit that we get collectively. Likewise, multiplying the marginal benefit by 5 will give a measure of the marginal social benefit that each additional painting produces.

SOCIAL BENEFIT: GRAPH

Q	TB_i	MB_i	TSB	MSB
1	21	21	105	105
2	36	15	180	75
3	46	10	230	50
4	52	6	260	30
5	55	3	275	15
6	56	1	280	5
7	56	0	280	0

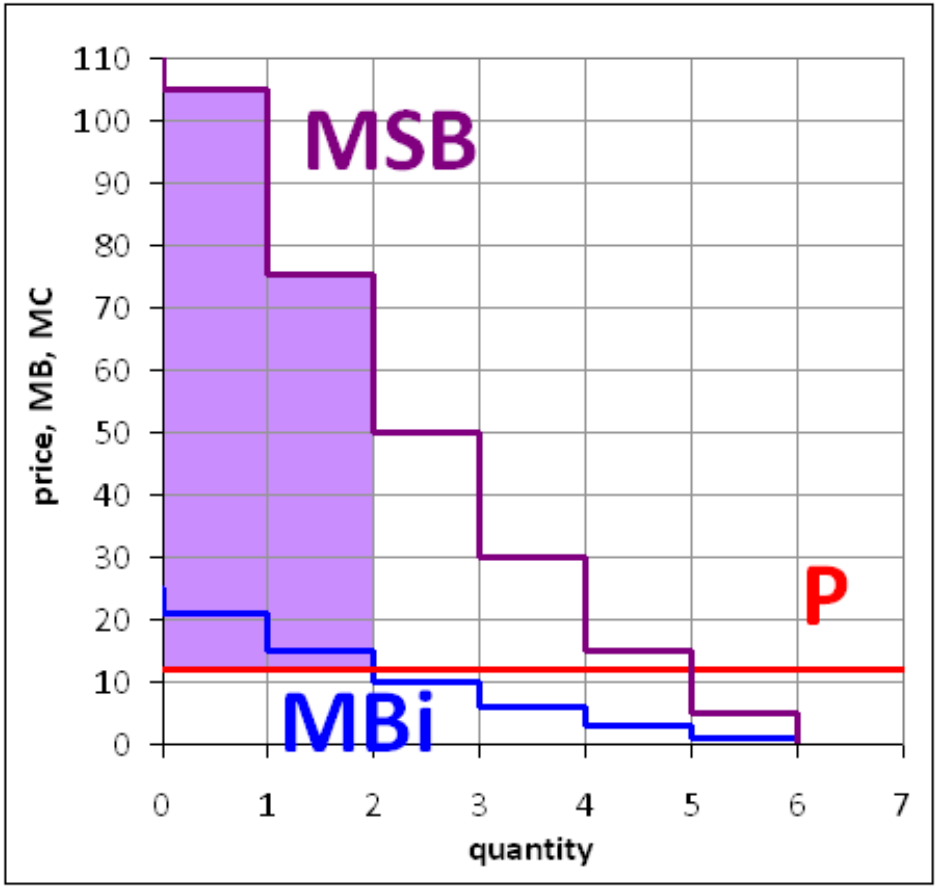


If all of us are completely self-interested, and incapable of any kind of collective bargaining, then how many paintings will end up being bought for the house?

A) 0 B) 1 C) 2 D) 3 E) 5

SOCIAL BENEFIT AND PRIVATE DEMAND

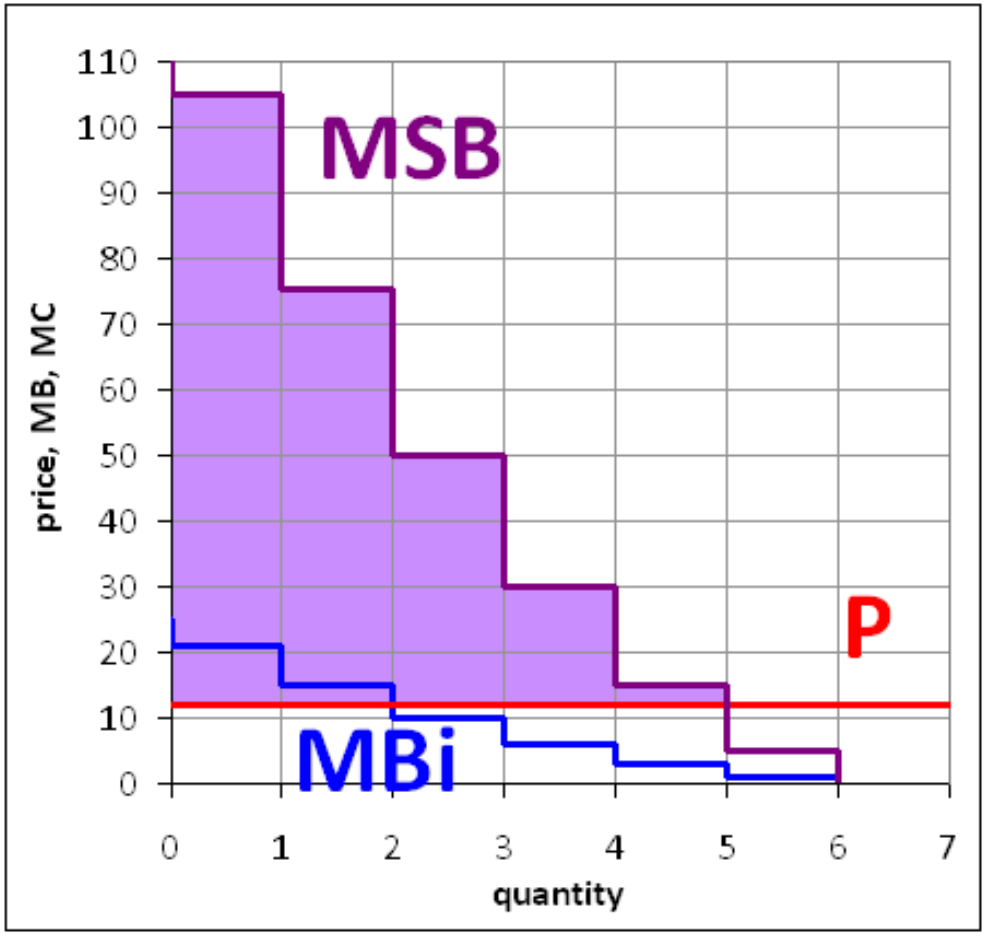
Q	TB_i	MB_i	TSB	MSB
1	21	21	105	105
2	36	15	180	75
3	46	10	230	50
4	52	6	260	30
5	55	3	275	15
6	56	1	280	5
7	56	0	280	0



When the number of paintings is less than 2, then it is in *someone*'s private interest to buy an additional painting. However, the private marginal benefit of the 3rd painting for anyone (which is $10) is less than the marginal cost ($12), so only 2 will be bought. The purple area shows the total consumer surplus for everyone in the house combined, i.e. the total social benefit minus the cost of the paintings, or TSB(2) – 2×12 = 156.

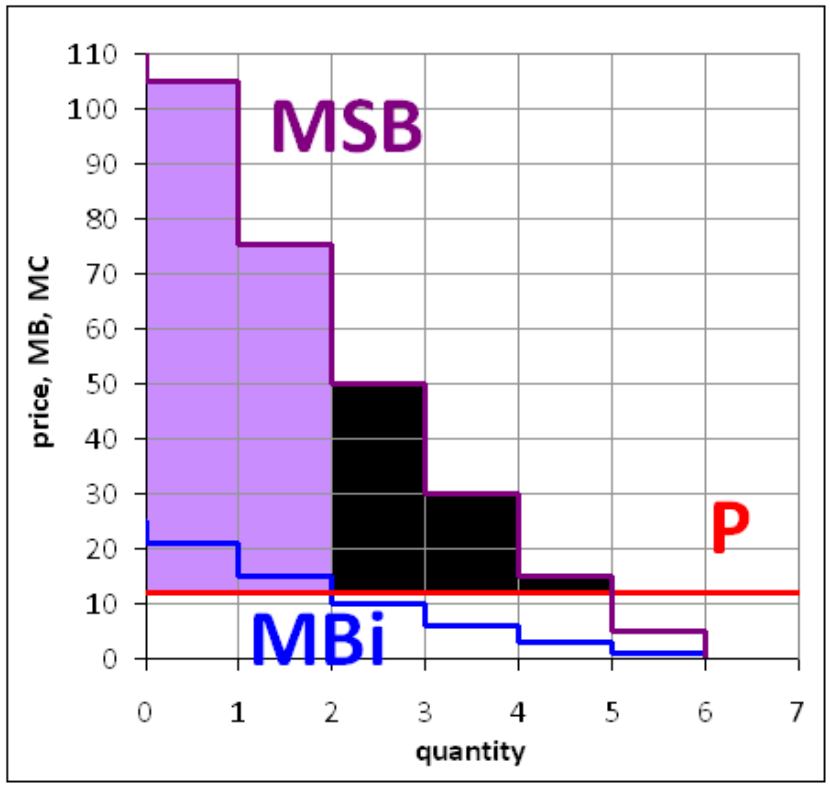
SOCIALLY OPTIMAL PROVISION

Q	TB_i	MB_i	TSB	MSB
1	21	21	105	105
2	36	15	180	75
3	46	10	230	50
4	52	6	260	30
5	55	3	275	15
6	56	1	280	5
7	56	0	280	0

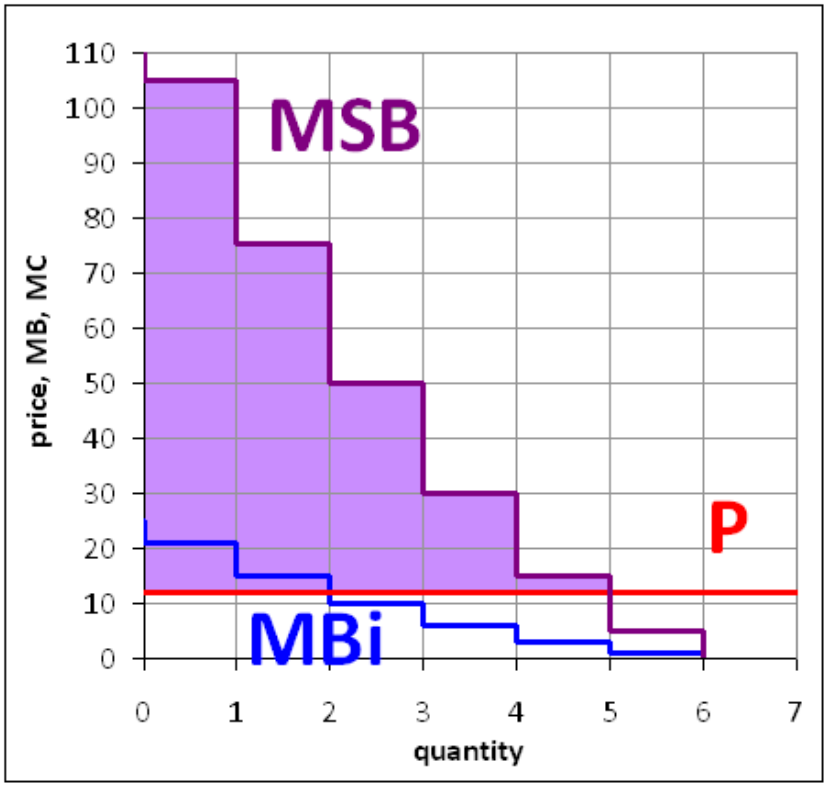


The socially optimal choice of paintings occurs where the marginal social benefit intersects the marginal cost. All paintings have a marginal cost of 12. The 5th paintings has a marginal social benefit of 15, and the 6th has a marginal benefit of 5. So, only the first 5 are worth buying.

GAIN FROM COLLECTIVE ACTION



TSB
105
180
230
260
275
280
280



TSB = 180
TC = 2×12 = 24
TES = 180 – 24 = 156

TSB = 275
TC = 5×12 = 60
TES = 275 – 60 = 215

Thus, the gain from collective action (or the deadweight loss from the lack of collective action) is 215 – 156 = 59.

QUESTION 1 (individual demand)

Q	TB_i	MB_i
1	13	13
2	21	8
3	26	5
4	29	3
5	31	2
6	32	1
7	32	0

Suppose that I live in a society of 10 people. My individual benefit from a public good is given in the table to the left. (TB = total benefit; MB = marginal benefit). If the price of the good is $20, and no one else has bought or provided any of the good, how many will I choose to buy? Assume that my choice is based solely on self interest, and there is no possibility for collective agreements.

A) 0 B) 1 C) 2 D) 3 E) 4

answer to question 1

Q	TB_i	MB_i
1	13	13
2	21	8
3	26	5
4	29	3
5	31	2
6	32	1
7	32	0

My individual marginal benefit is never greater than $20 (the price or marginal cost of the good), so it is not in my individual interest to buy any at all.

A) 0 B) 1 C) 2 D) 3 E) 4

QUESTION 2 (marginal social benefit)

Q	TB_i	MB_i
1	13	13
2	21	8
3	26	5
4	29	3
5	31	2
6	32	1
7	32	0

Again, there are 10 people in this society, and each has a total benefit and marginal benefit schedule for the public good as given in the table.

If 1 unit of the public good has already been provided, then what is the marginal social benefit of the second unit?

A) 0 **B) 21** **C) 8** **D) 210** **E) 80**

answer to question 2

Q	TB_i	MB_i	TSB	MSB
1	13	13	130	130
2	21	8	210	80
3	26	5	260	50
4	29	3	290	30
5	31	2	310	20
6	32	1	320	10
7	32	0	320	0

What is the marginal social benefit of the second unit?

A) 0 B) 21 C) 8 D) 210 **E) 80**

QUESTION 3 (optimal quantity)

Q	TB_i	MB_i	TSB	MSB
1	13	13	130	130
2	21	8	210	80
3	26	5	260	50
4	29	3	290	30
5	31	2	310	20
6	32	1	320	10
7	32	0	320	0

If the marginal cost of the public good is $40, then what is the socially optimal quantity of the public good?

A) 1 B) 2 C) 3 D) 4 E) 5

answer to question 3

Q	TB_i	MB_i	TSB	MSB
1	13	13	130	130
2	21	8	210	80
3	26	5	260	50
4	29	3	290	30
5	31	2	310	20
6	32	1	320	10
7	32	0	320	0

If the marginal cost of the public good is $40, then what is the socially optimal quantity of the public good?

A) 1 B) 2 **C) 3** D) 4 E) 5

QUESTION 4 (total surplus)

Q	TB_i	MB_i	TSB	MSB
1	13	13	130	130
2	21	8	210	80
3	26	5	260	50
4	29	3	290	30
5	31	2	310	20
6	32	1	320	10
7	32	0	320	0

If the marginal cost of the public good is $40, and the optimal quantity of 3 is chosen, then what is the total economic surplus (total social benefit minus total cost)?

A) 140 **B) 260** **C) 26** **D) 50** **E) 40**

answer to question 4

Q	TB_i	MB_i	TSB	MSB
1	13	13	130	130
2	21	8	210	80
3	26	5	260	50
4	29	3	290	30
5	31	2	310	20
6	32	1	320	10
7	32	0	320	0

MC = 40

Q = 3

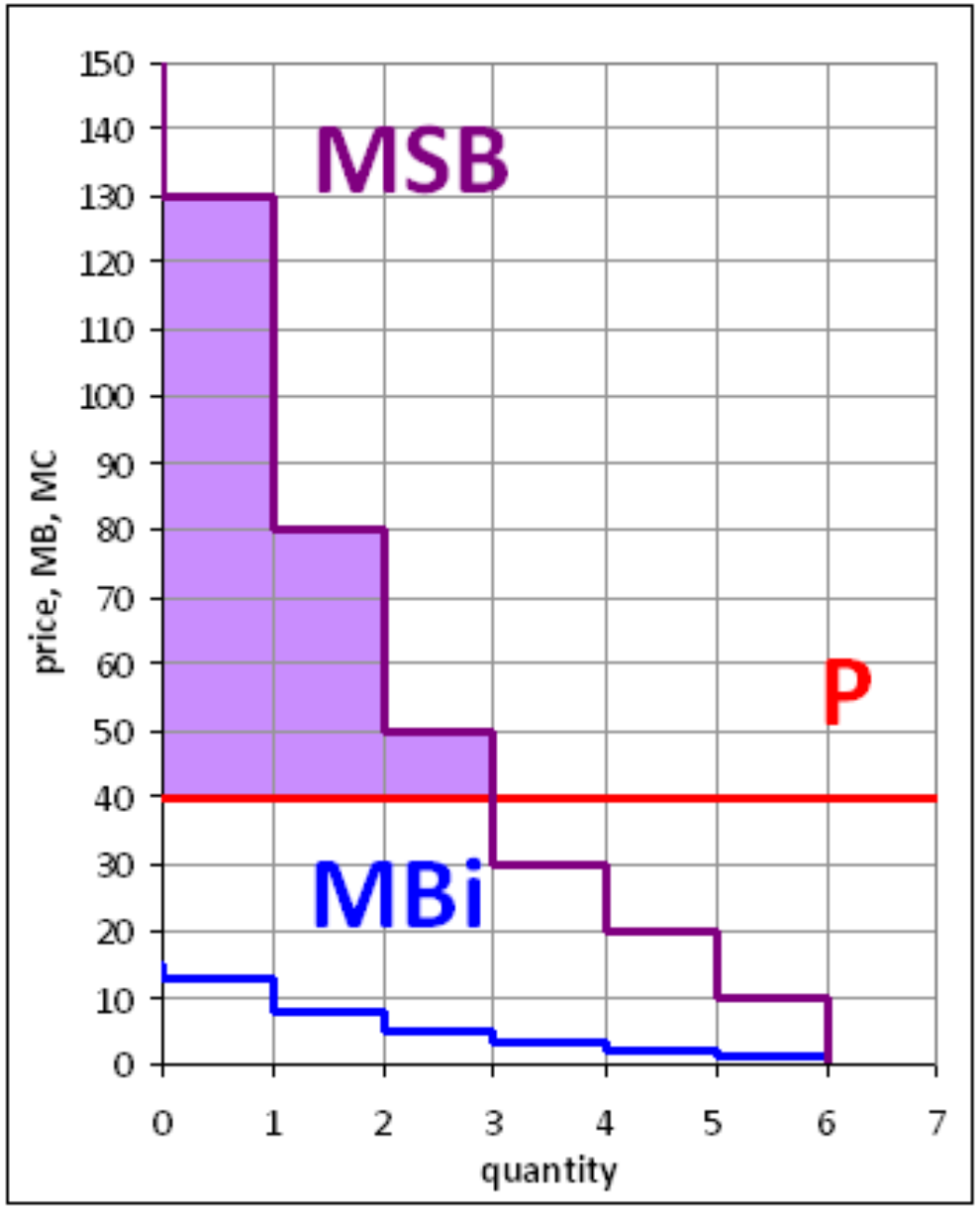
TES = TSB – TC
= 260 – 3×40
= 140

or

TES = (130 – 40)
+ (80 – 40) + (50 – 40)
= 90 + 40 + 10 = 140

A) 140 B) 260 C) 26 D) 50 E) 40

GAIN FROM COLLECTIVE ACTION: GRAPH



In the absence of collective action, the quantity of the public good is zero, and so the total economic surplus from the public good is also zero.

The optimal quantity of the public good is 3, which brings total economic surplus to 140. This is the gain from collective action, or the deadweight loss from its absence.

PUBLIC GOODS: CONTINUOUS

Suppose that, in some society, individual total and marginal benefits from a public good are given by the functions:

$$TB_i = 100Q - Q^2$$

$$MB_i = 100 - 2Q$$

If there are 5 people in the society, then the social total and marginal benefit functions are:

$$TSB = 500Q - 5Q^2$$

$$MSB = 500 - 10Q$$

PRIVATE DEMAND

$TB_i = 100Q - Q^2$ $MB_i = 100 - 2Q$

$TSB = 500Q - 5Q^2$ $MSB = 500 - 10Q$

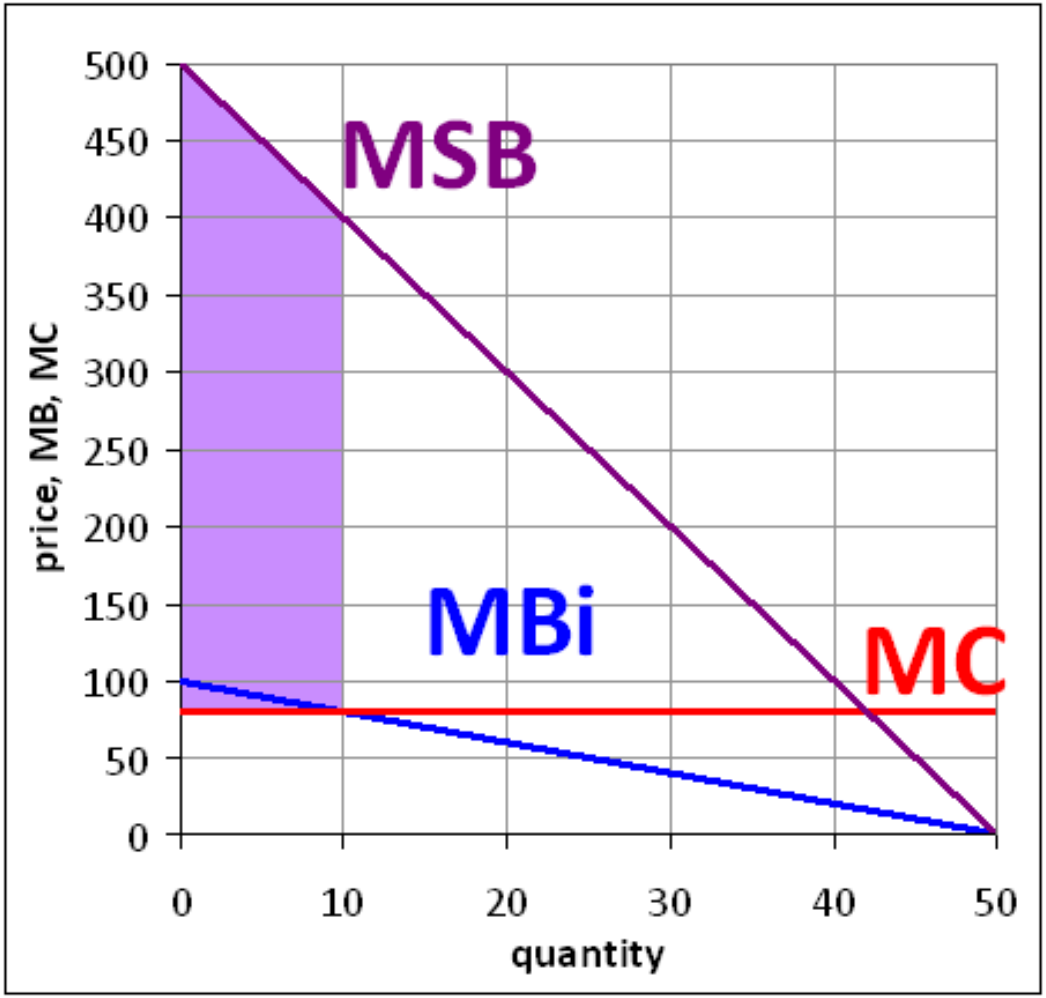
$MC = 80$

If there is no collective action, then people will only buy the public good up to the point where $MB_i = MC$

$100 - 2Q = 80$

$2Q = 20$

$Q^* = 10$ **is the equilibrium quantity.**



SOCIALLY OPTIMAL PROVISION

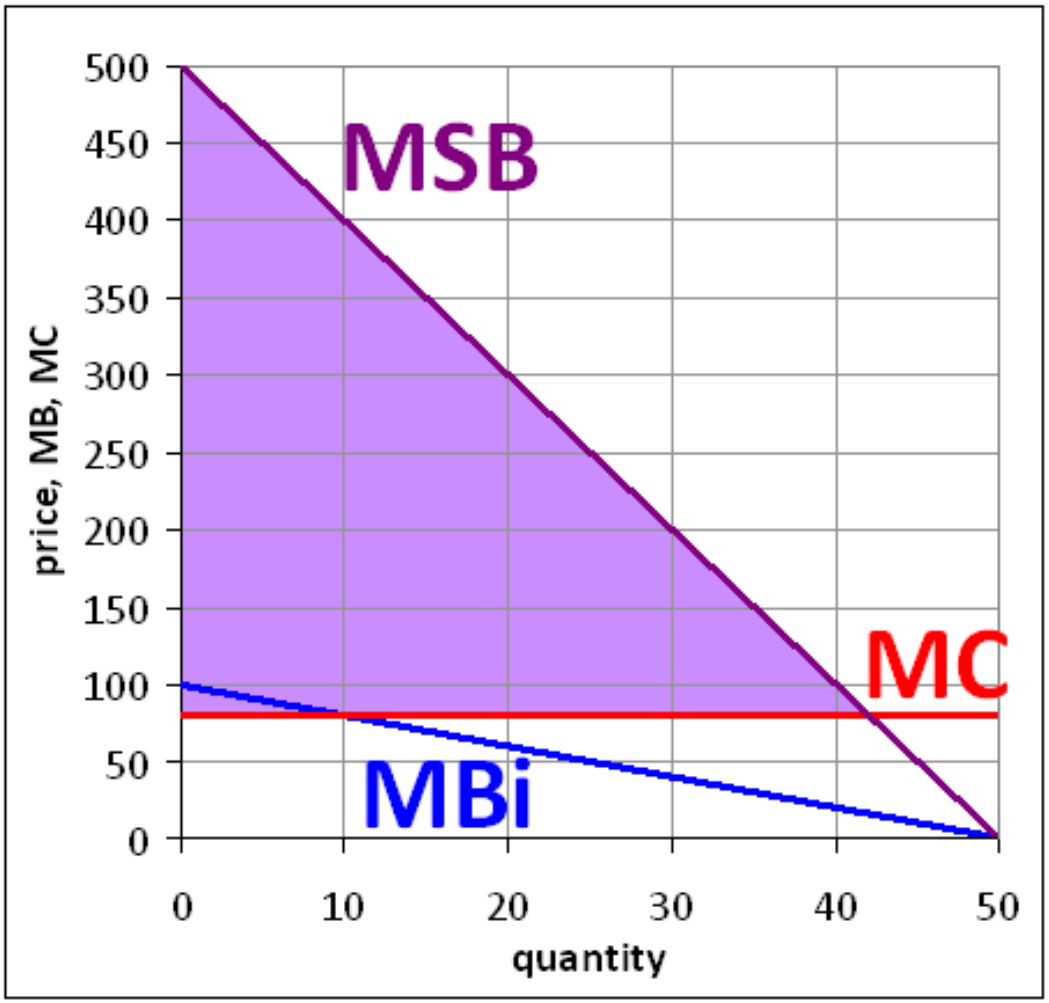
$TB_i = 100Q - Q^2$ $MB_i = 100 - 2Q$

$TSB = 500Q - 5Q^2$ $MSB = 500 - 10Q$

$MC = 80$

Total economic surplus from the public good will be maximized at the point where MSB = MC

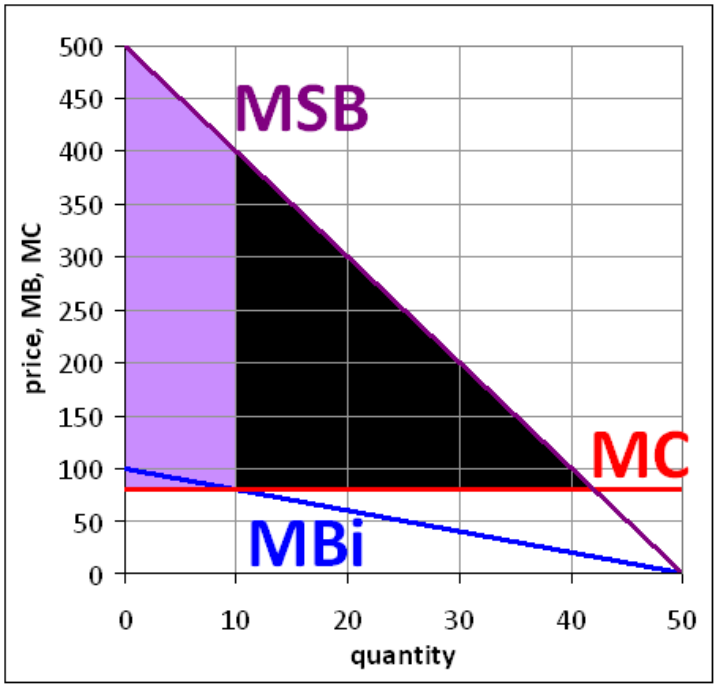
$500 - 10Q = 80$
$10Q = 420$
$Q^o = 42$ is the socially optimal quantity.

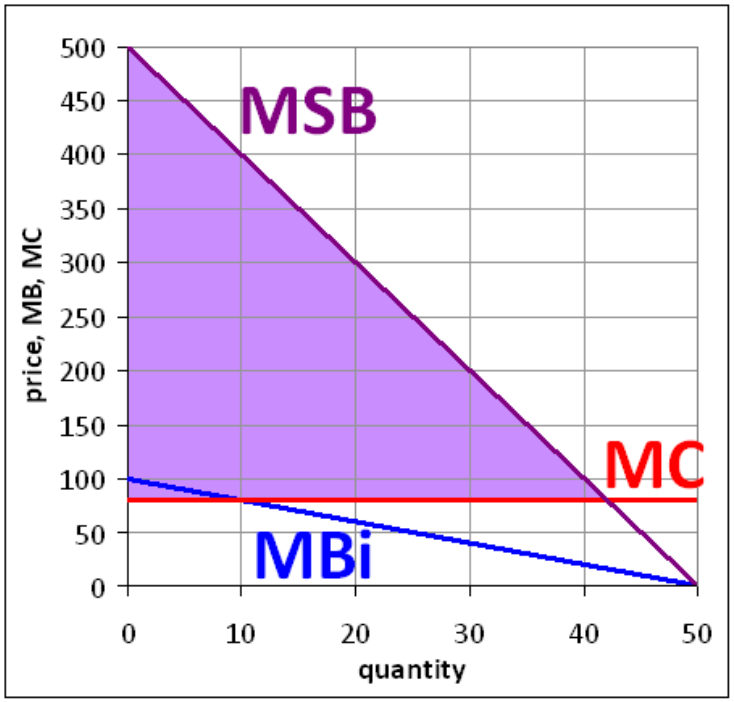


GAIN FROM COLLECTIVE ACTION (GEOMETRIC)

$TB_i = 100Q - Q^2$ $MB_i = 100 - 2Q$ $MC = 80$

$TSB = 500Q - 5Q^2$ $MSB = 500 - 10Q$





TES = (10)(420+320)/2 = 3700

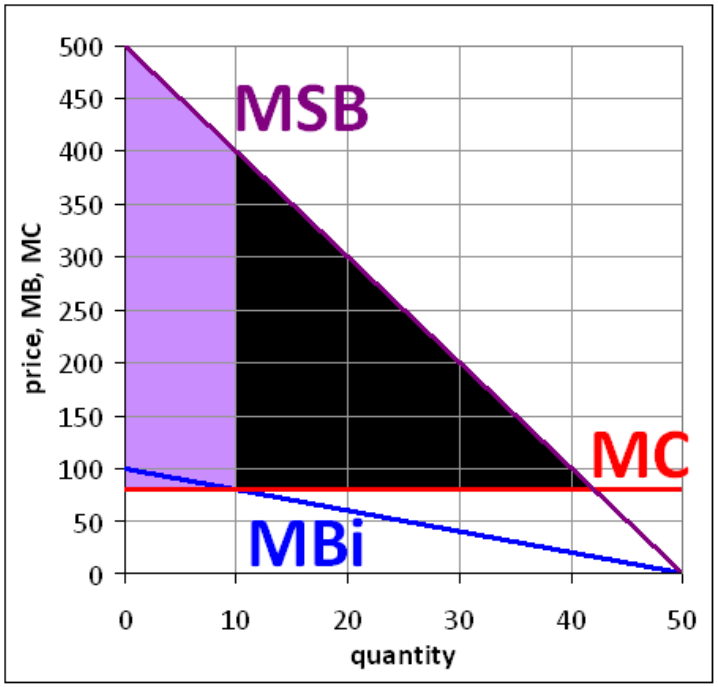
TES = (.5)(42)(420) = 8820

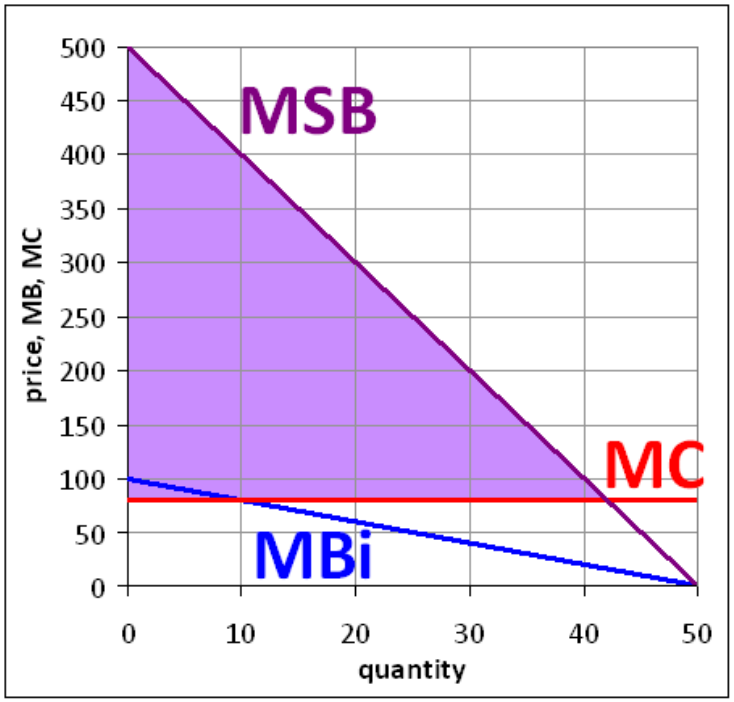
DWL = (.5)(32)(320) = 5120

GAIN FROM COLLECTIVE ACTION (USING TSB)

$TB_i = 100Q - Q^2$ $MB_i = 100 - 2Q$ $MC = 80$

$TSB = 500Q - 5Q^2$ $MSB = 500 - 10Q$





$TSB = 500(10) - 5(10)^2$
$= 5000 - 500 = 4500$
$TC = 10 \times 80 = 800$
$TES = 4500 - 800 = 3700$

$TSB = 500(42) - 5(42)^2$
$= 21000 - 8820 = 12180$
$TC = 42 \times 80 = 3360$
$TES = 12180 - 3360 = 8820$

$DWL = 8820 - 3700 = 5120$

QUESTION 5

$TB_i = 15Q - Q^2/20$ $MB_i = 15 - Q/10$

$TSB = 150Q - Q^2/2$ $MSB = 150 - Q$ (10 people)

$MC = 10$

Total and marginal benefit functions for a public good for a society of 10 identical people are given above, along with the price marginal cost of the public good (10).

If there is no possibility for collective action, how much of the public good will be bought?

A) 0 B) 20 C) 40 D) 50 E) 100

answer to question 5

$TB_i = 15Q - Q^2/20$ $MB_i = 15 - Q/10$

$TSB = 150Q - Q^2/2$ $MSB = 150 - Q$ (10 people)

$MC = 10$

$$MB_i = MC \rightarrow 15 - Q/10 = 10 \rightarrow Q/10 = 5$$

$$\rightarrow Q = 50$$

A) 0 B) 20 C) 40 **D) 50** E) 100

QUESTION 6

$TB_i = 15Q - Q^2/20$ $MB_i = 15 - Q/10$

$TSB = 150Q - Q^2/2$ $MSB = 150 - Q$ (10 people)

$MC = 20$

Same question, but the marginal cost is now 20.

If there is no possibility for collective action, how much of the public good will be bought?

A) 0 B) 20 C) 40 D) 50 E) 100

answer to question 6

$TB_i = 15Q - Q^2/20$ $MB_i = 15 - Q/10$

$TSB = 150Q - Q^2/2$ $MSB = 150 - Q$ (10 people)

$MC = 20$

Same question, but the marginal cost is now 20.

If there is no possibility for collective action, how much of the public good will be bought?

A) 0 B) 20 C) 40 D) 50 E) 100

QUESTION 7

$TB_i = 15Q - Q^2/20$ $MB_i = 15 - Q/10$

$TSB = 150Q - Q^2/2$ $MSB = 150 - Q$ (10 people)

$MC = 20$

The marginal cost is still 20.

What is the quantity of the public good that maximizes total surplus?

A) 0 **B) 50** **C) 100** **D) 120** **E) 130**

answer to question 7

$TB_i = 15Q - Q^2/20$ $MB_i = 15 - Q/10$

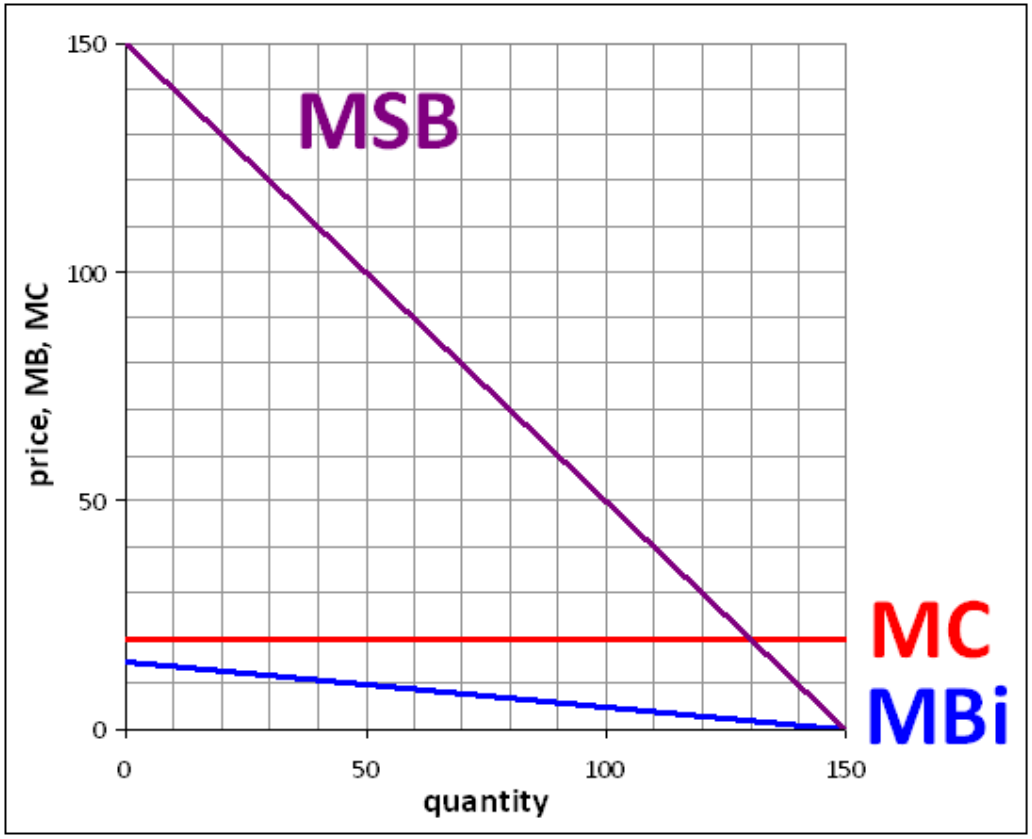
$TSB = 150Q - Q^2/2$ $MSB = 150 - Q$ (10 people)

$MC = 20$

$MSB = MC$

$\rightarrow 150 - Q = 20$

$\rightarrow Q = 130$



A) 0 B) 50 C) 100 D) 120 **E) 130**

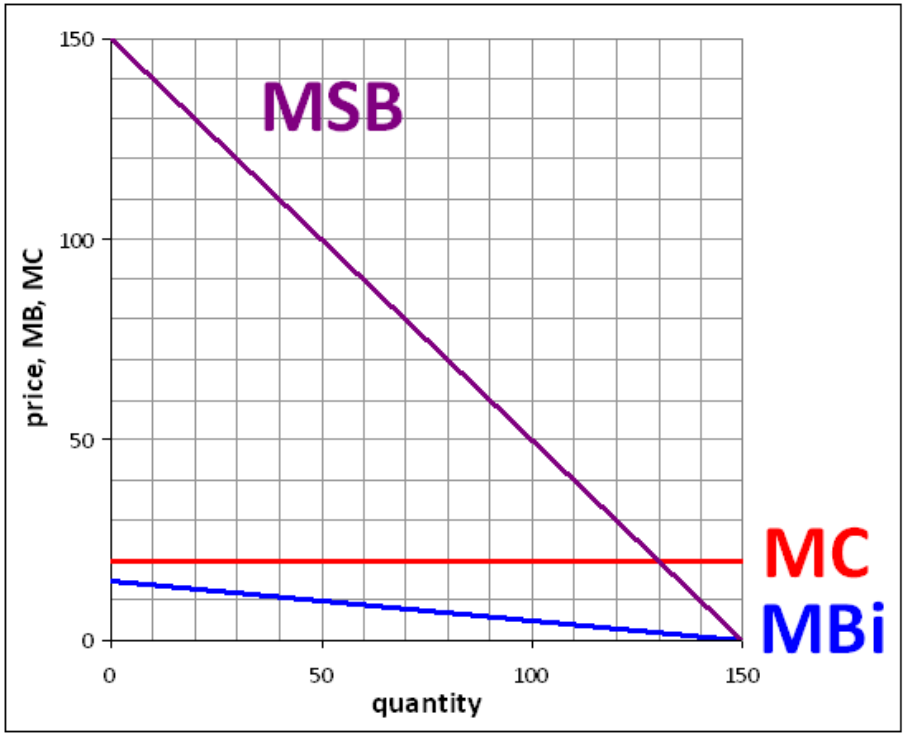
QUESTION 8

$TB_i = 15Q - Q^2/20$ $MB_i = 15 - Q/10$

$TSB = 150Q - Q^2/2$ $MSB = 150 - Q$ (10 people)

$MC = 20$ $Q^* = 0$ $Q^o = 130$

If this society chooses the optimal quantity of 130, then how much economic surplus have they gained from collective action?



A) 130 B) 11250 C) 16900

D) 8450 E) 22500

answer to question 8

$TB_i = 15Q - Q^2/20$ $MB_i = 15 - Q/10$

$TSB = 150Q - Q^2/2$ $MSB = 150 - Q$ (10 people)

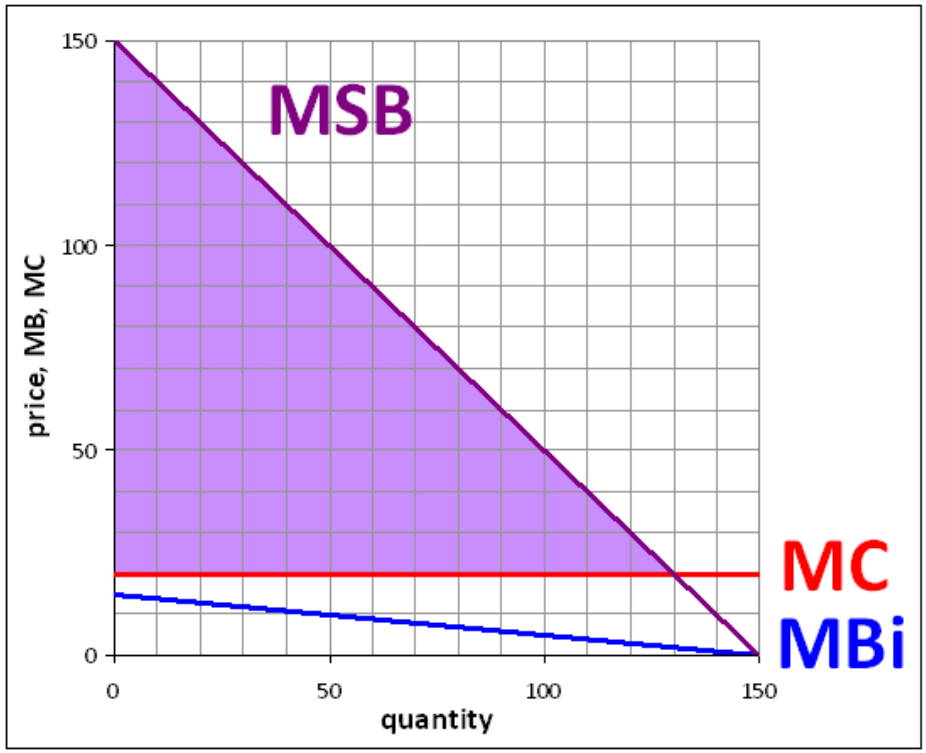
$MC = 20$ $Q^* = 0$ $Q^o = 130$

$TES = (.5)(130)(130)$

$= (.5)(16900)$

$= 8000 + 450$

$TES = 8450$



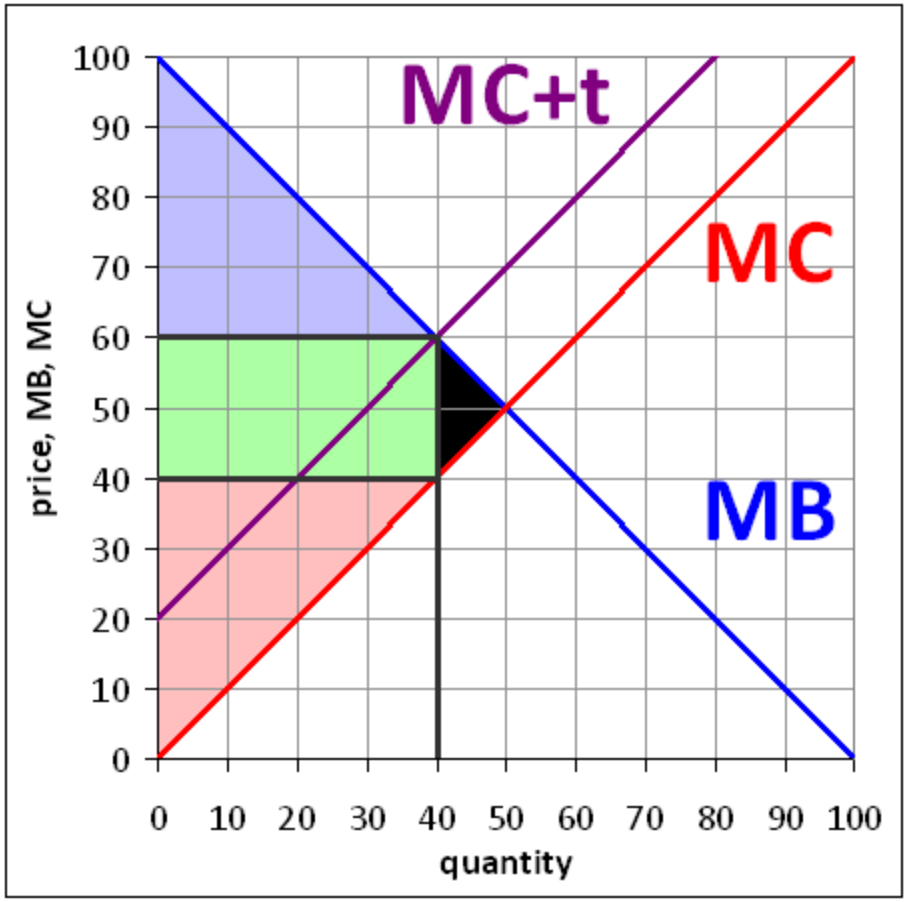
A) 130 B) 11250 C) 16900

D) 8450 E) 22500

TAXES ON EFFICIENT MARKETS

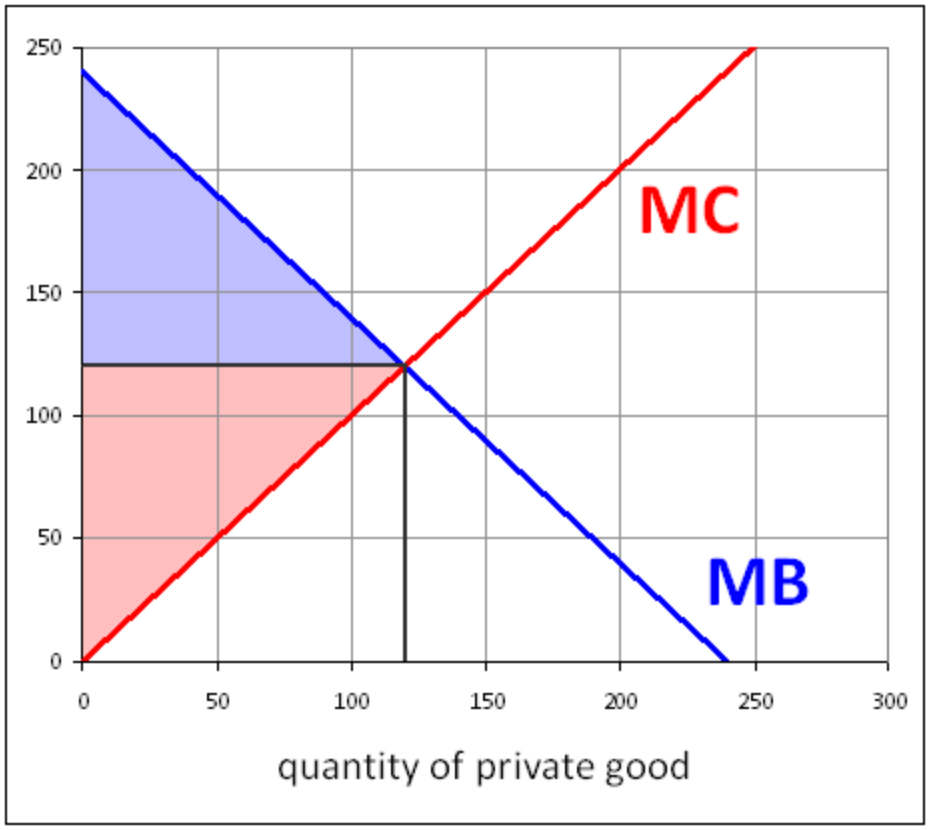
Suppose that we have an initially efficient market (perfectly competitive, with no externalities), and we apply an excise (per unit) tax.

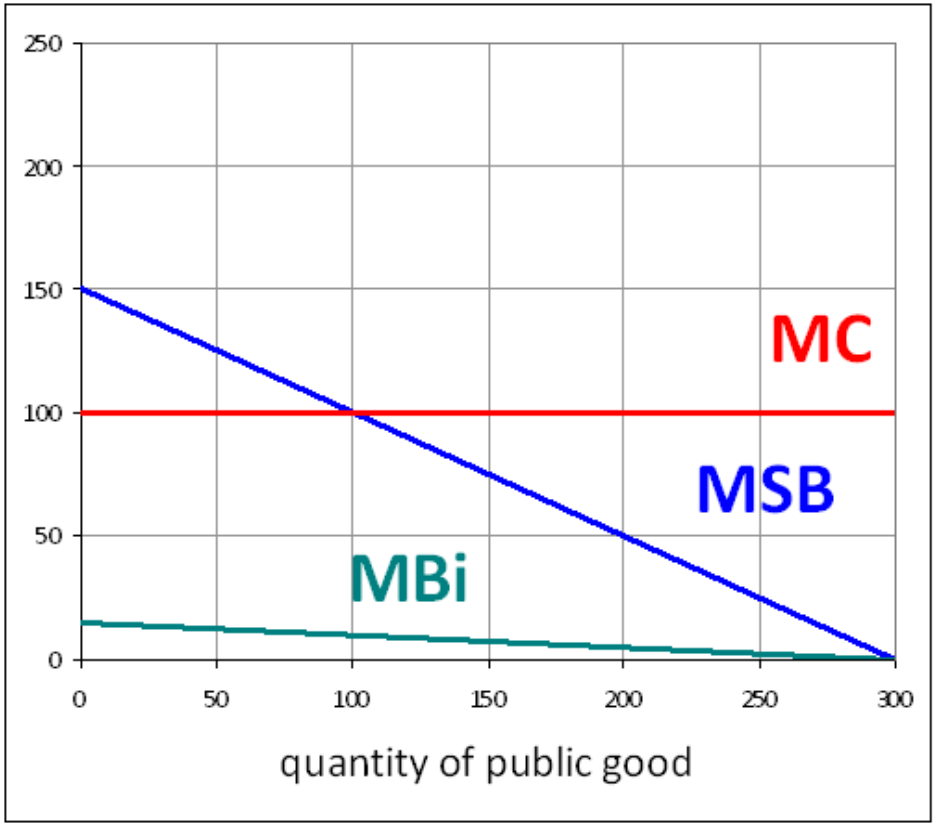
The blue area shows consumer surplus, the red area shows producer surplus, and the green area shows government revenue, G.



If t is the tax per unit, and Q is the quantity of the good sold, then G = tQ.

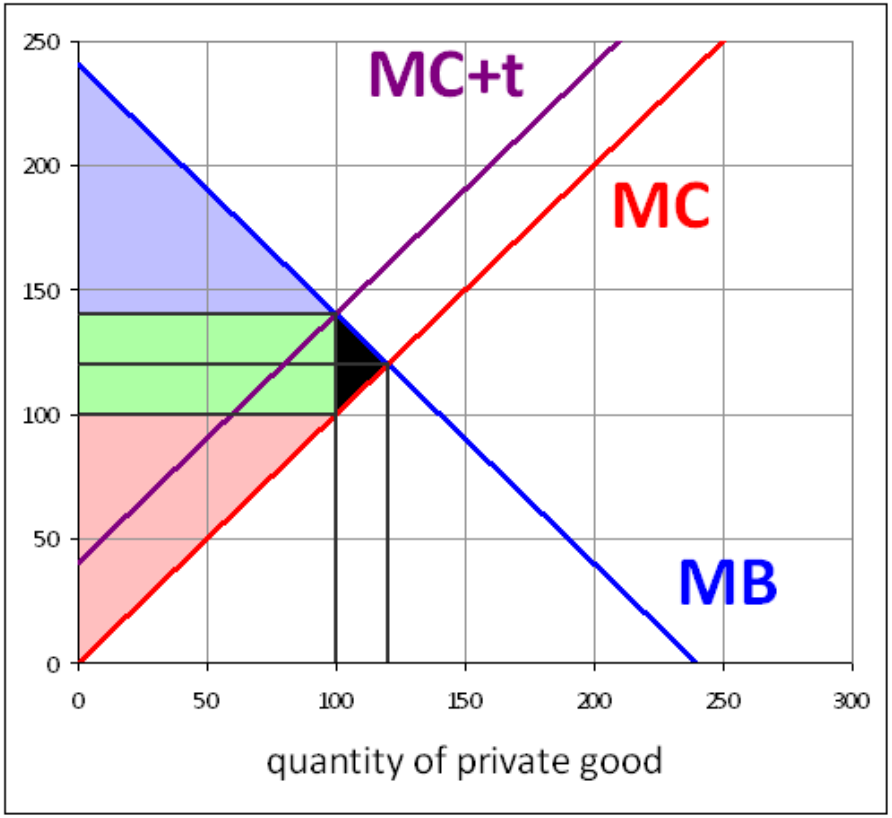
TRADEOFFS BETWEEN PRIVATE AND PUBLIC MARKETS

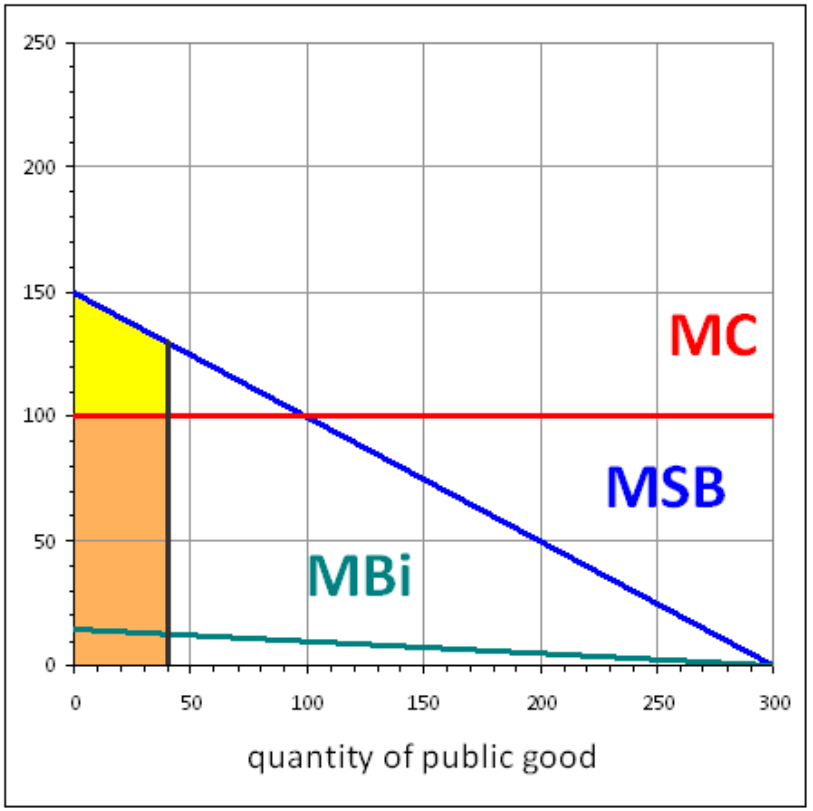




Suppose that there are two goods: a private good, and a public good. The market for the private good happens to be efficient (it is perfectly competitive and has no externalities), but in the absence of collective action, the equilibrium quantity of the public good is zero.

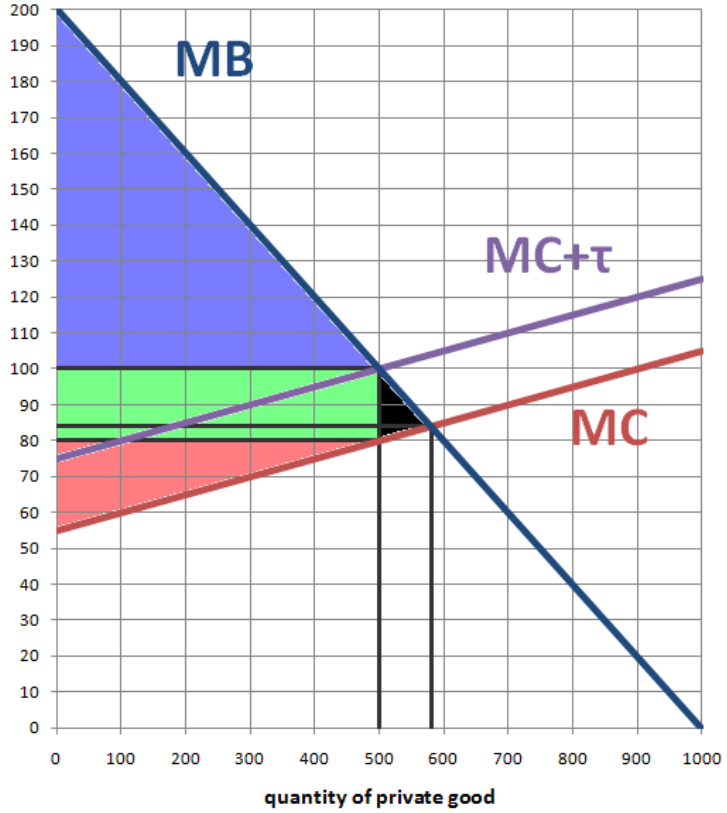
TRADEOFFS BETWEEN PRIVATE AND PUBLIC MARKETS

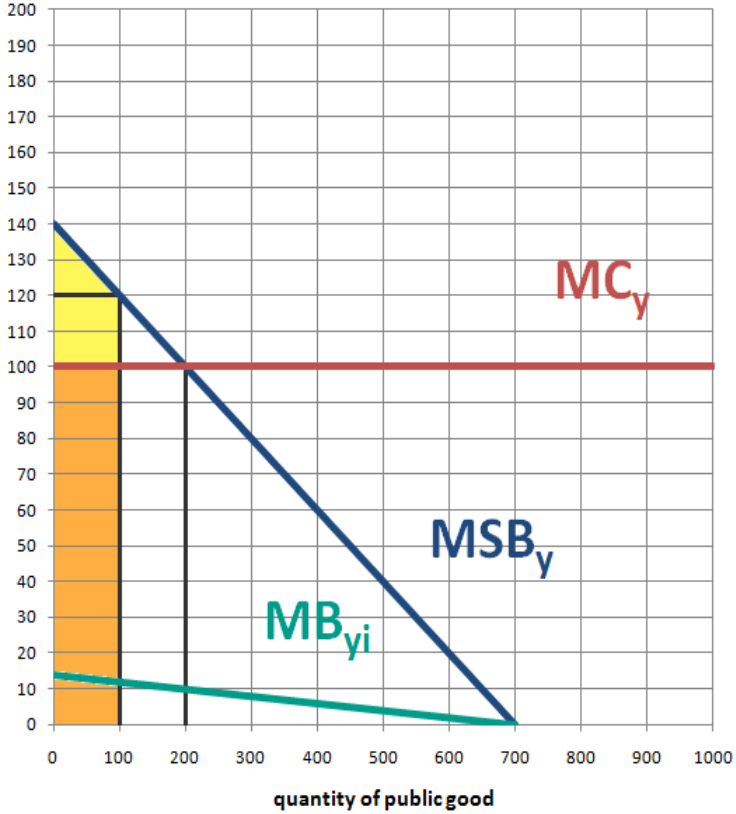




Total economic surplus can be increased overall by taxing the private market in order to finance provision of the public good.

NUMERICAL EXAMPLE





MB = 200 – x/5

MC = 55 + x/20

τ = 20

Q* = 500

G = 10,000

DWL = 800

MSB = 140 – y/5

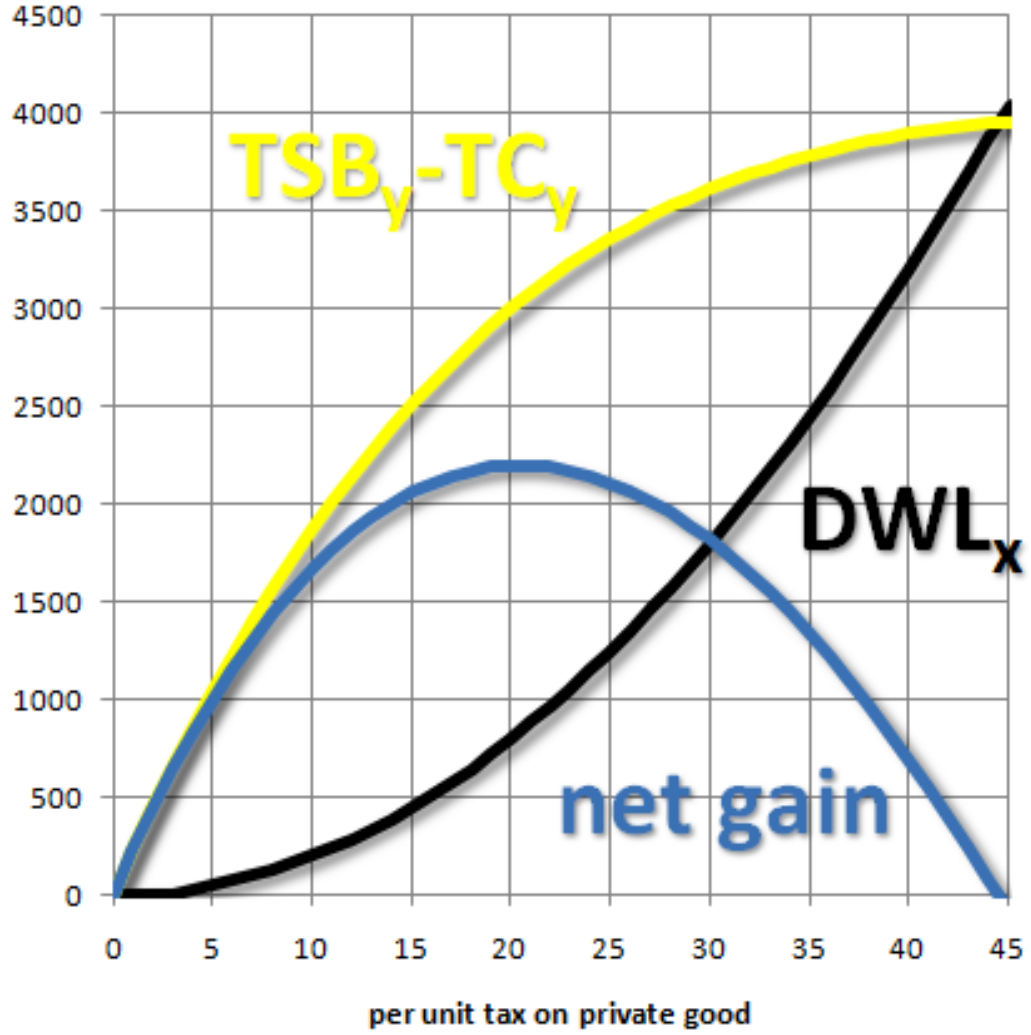
MC = 100

y = G/100 = 100

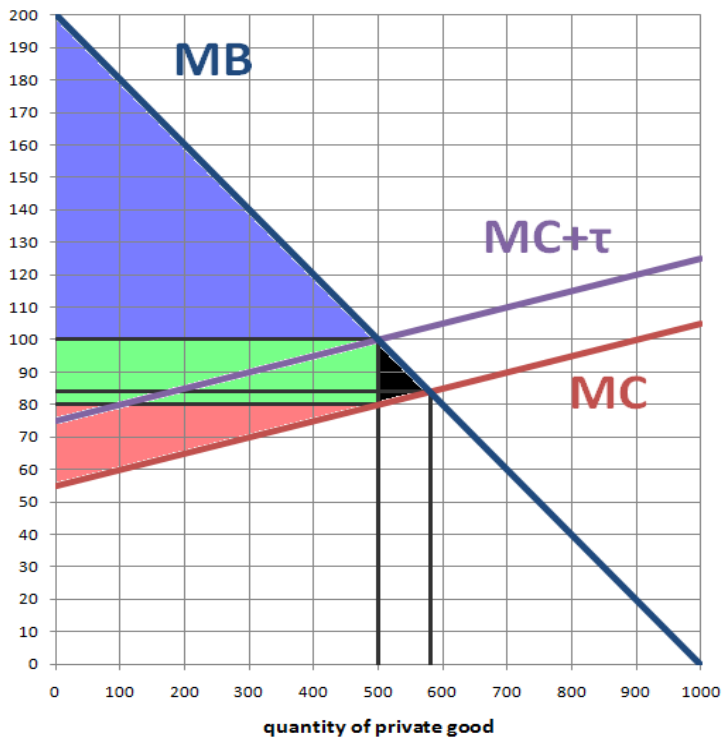
TES gain = 3000

3000 – 800 = 2200

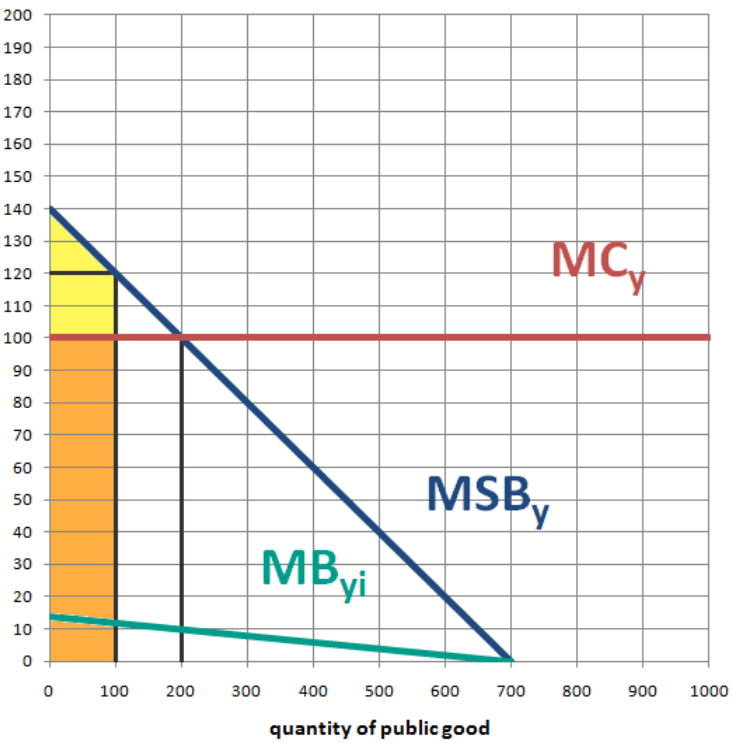
OPTIMAL TAX

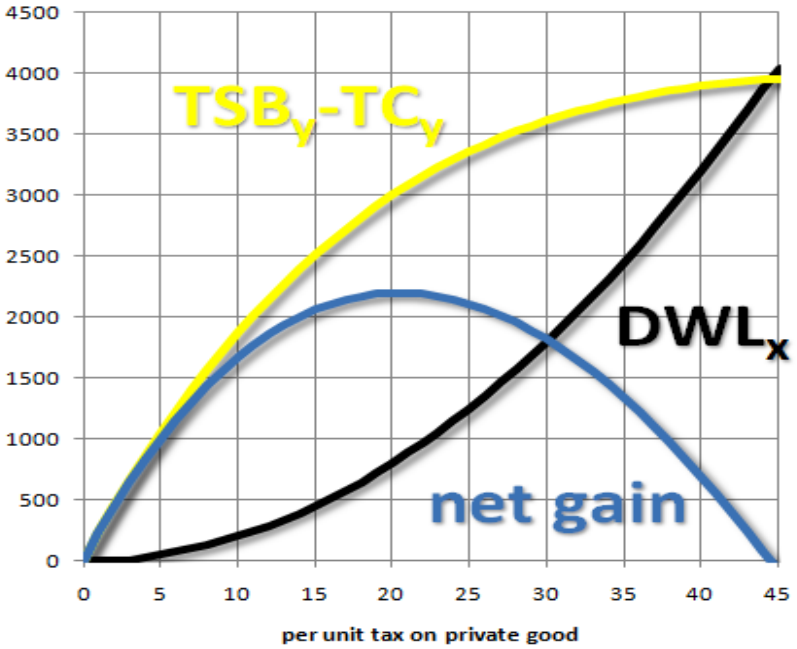


The optimal amount of tax in this situation turns out to be ≈20.44, which gives a net gain of ≈2200.89


MB
MC+τ
MC
quantity of private good

IMA


MC$_y$
MSB$_y$
MB$_{yi}$
quantity of public good


TSB$_y$-TC$_y$
DWL$_x$
net gain
per unit tax on private good