

Partial and General Equilibrium Analysis

Frank van Tongeren

Overview of the session

- Trade tools in a partial equilibrium setting
- Geometry of PE analysis
 - Assignment 1: first analysis of a policy
- Mathematics of a perfect substitutes PE model
- Spreadsheet implementation
 - Assignment 2: quantitative analysis of a policy
- Imperfect substitutes: The Armington model

Tools for analyzing trade

- analytical tools:
 - stylized partial equilibrium models
 - stylized general equilibrium models
- statistical tools:
 - gravity models
 - growth regressions
- numerical tools:
 - partial equilibrium models
 - general equilibrium models

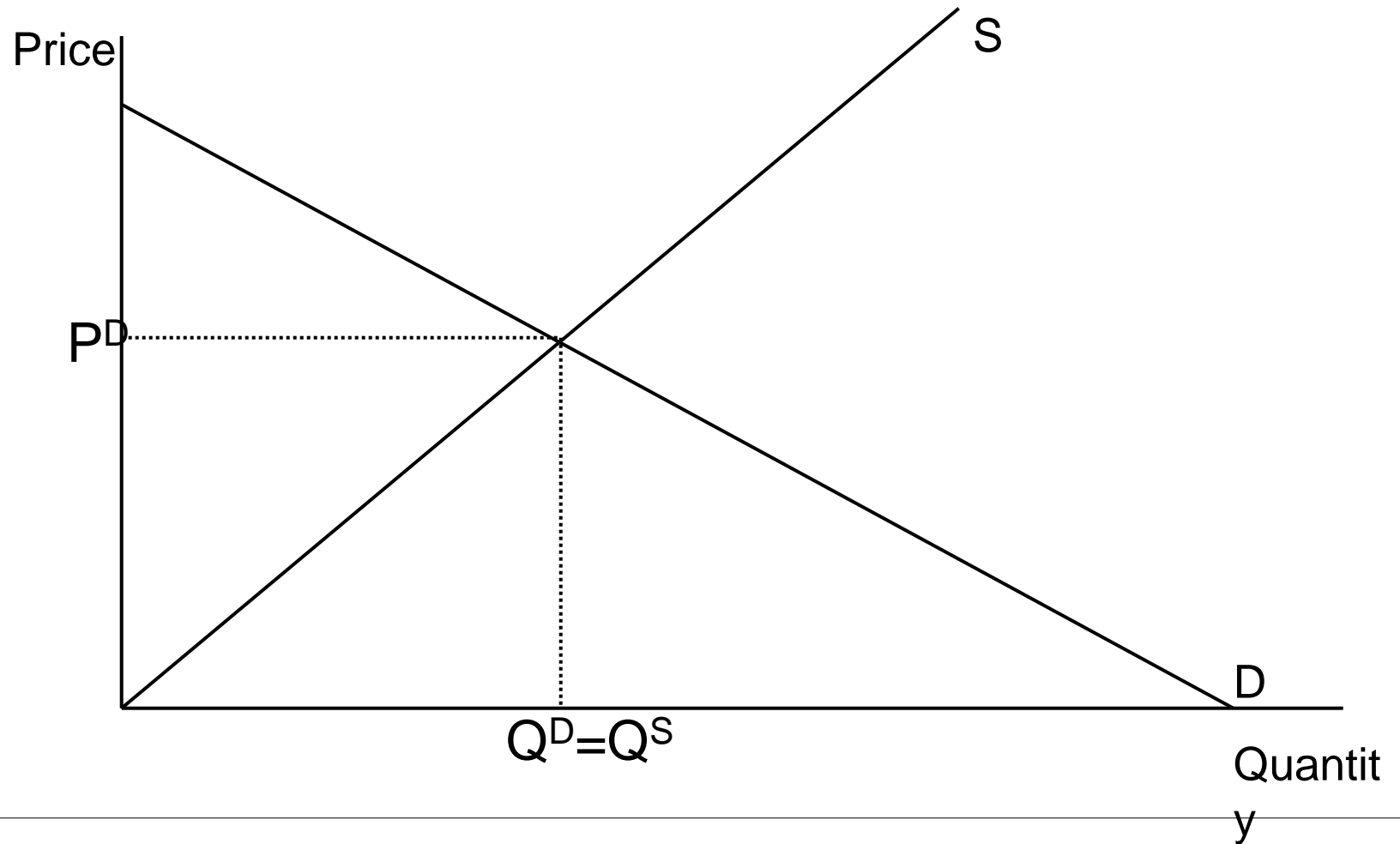
All models are wrong,
but some are useful

TRADE TOOLS IN A PARTIAL EQUILIBRIUM SETTING

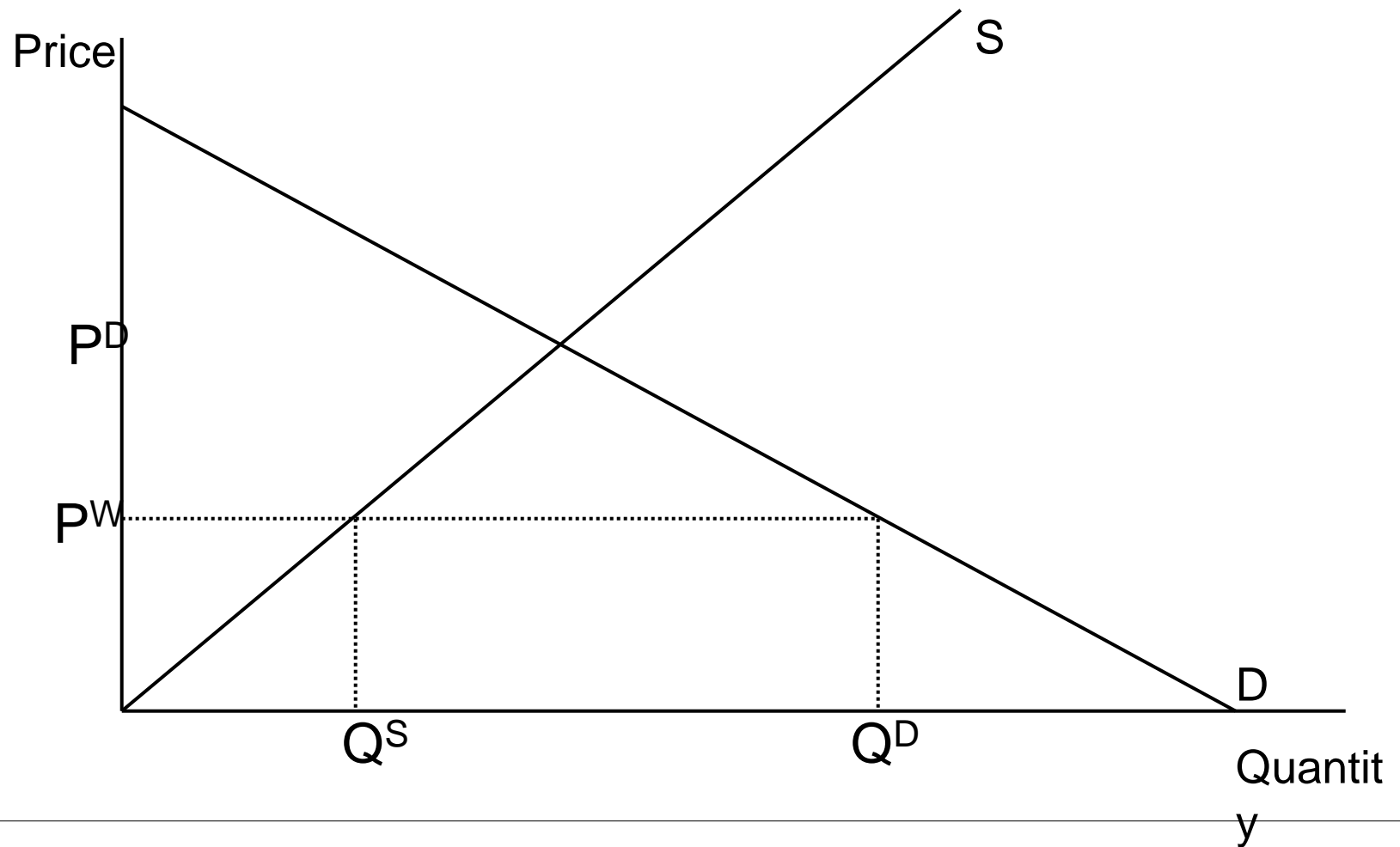
Partial equilibrium models

- Partial = only looks at part of the economy (sector)
- Limitation is strength:
 - many effects are left out of the model -> limits use
 - results are more rapid to derive and transparent
- Can be used if the effects on rest of the economy are small:
 - small sector (limited income effects)
 - limited links with other parts of economy (limited backward and forward linkages)

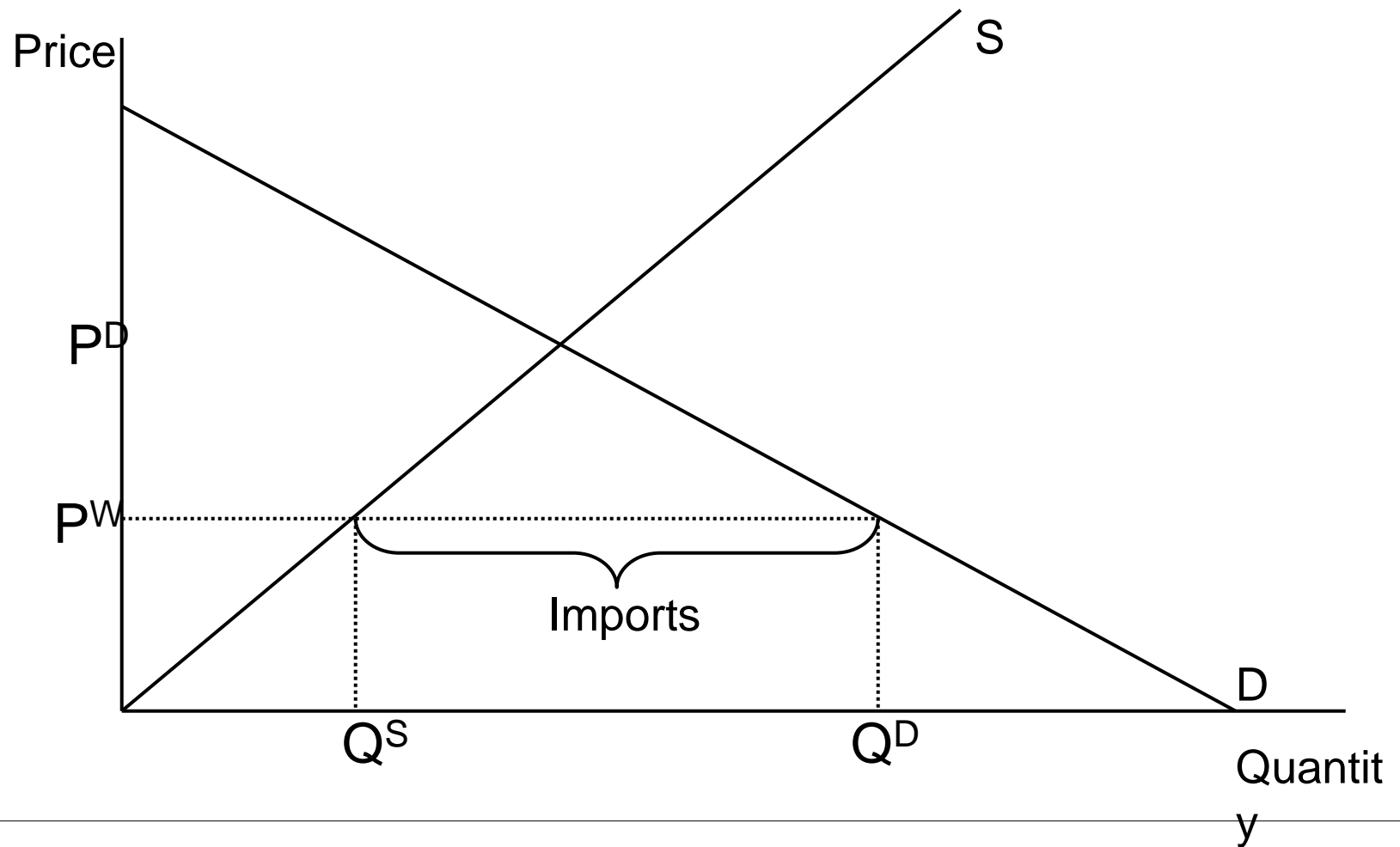
Autarky



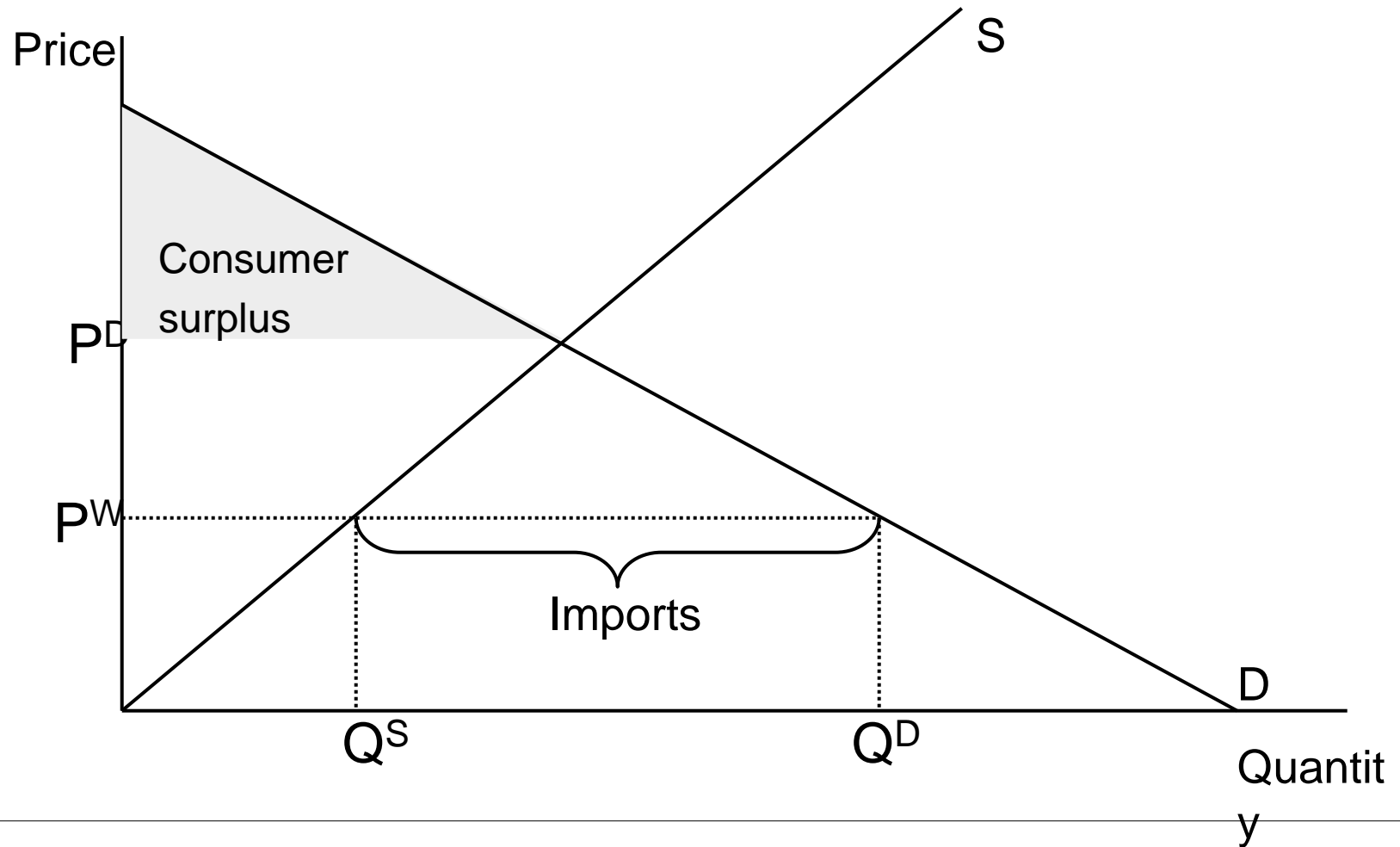
Free trade for a small country



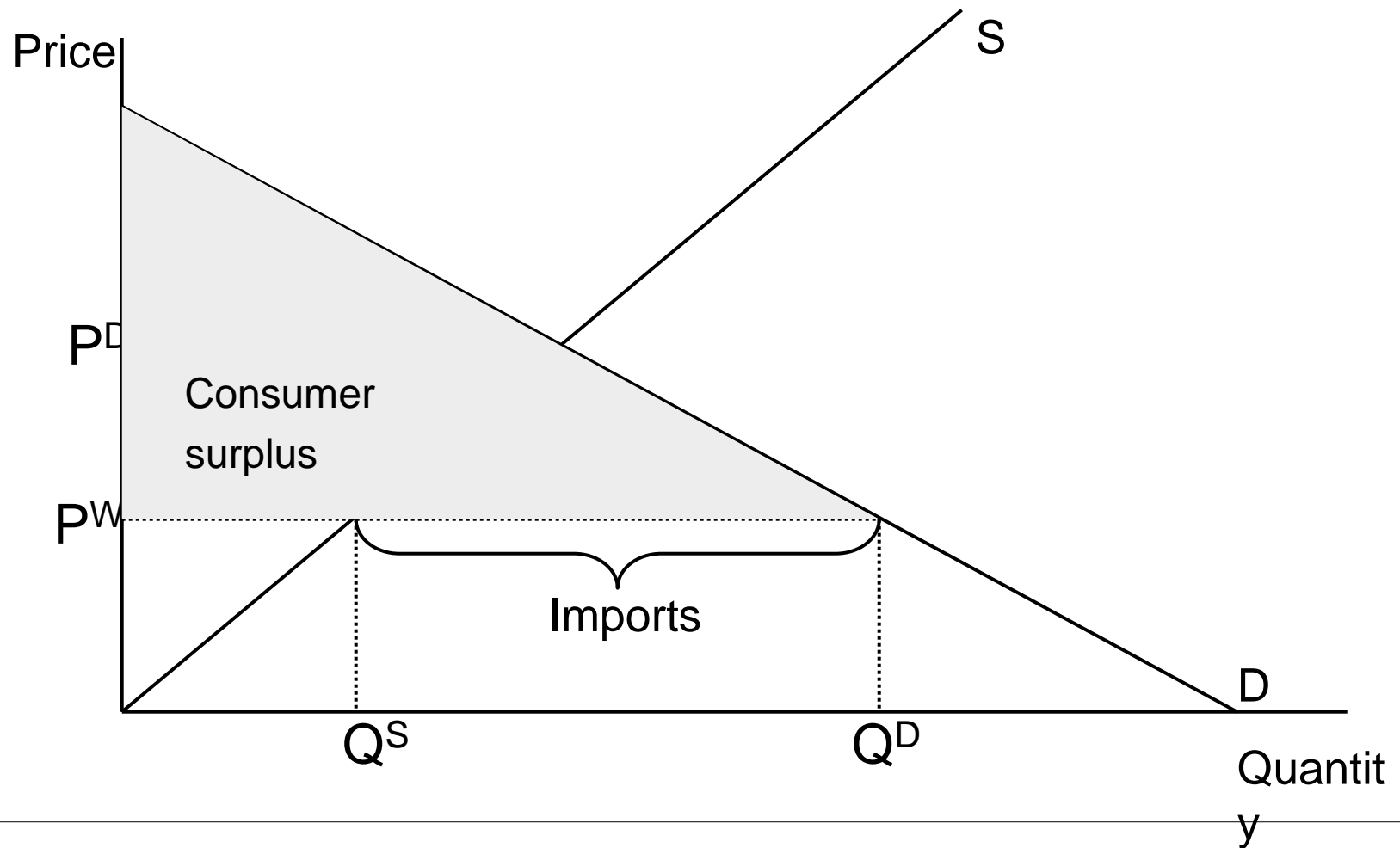
Free trade for a small country



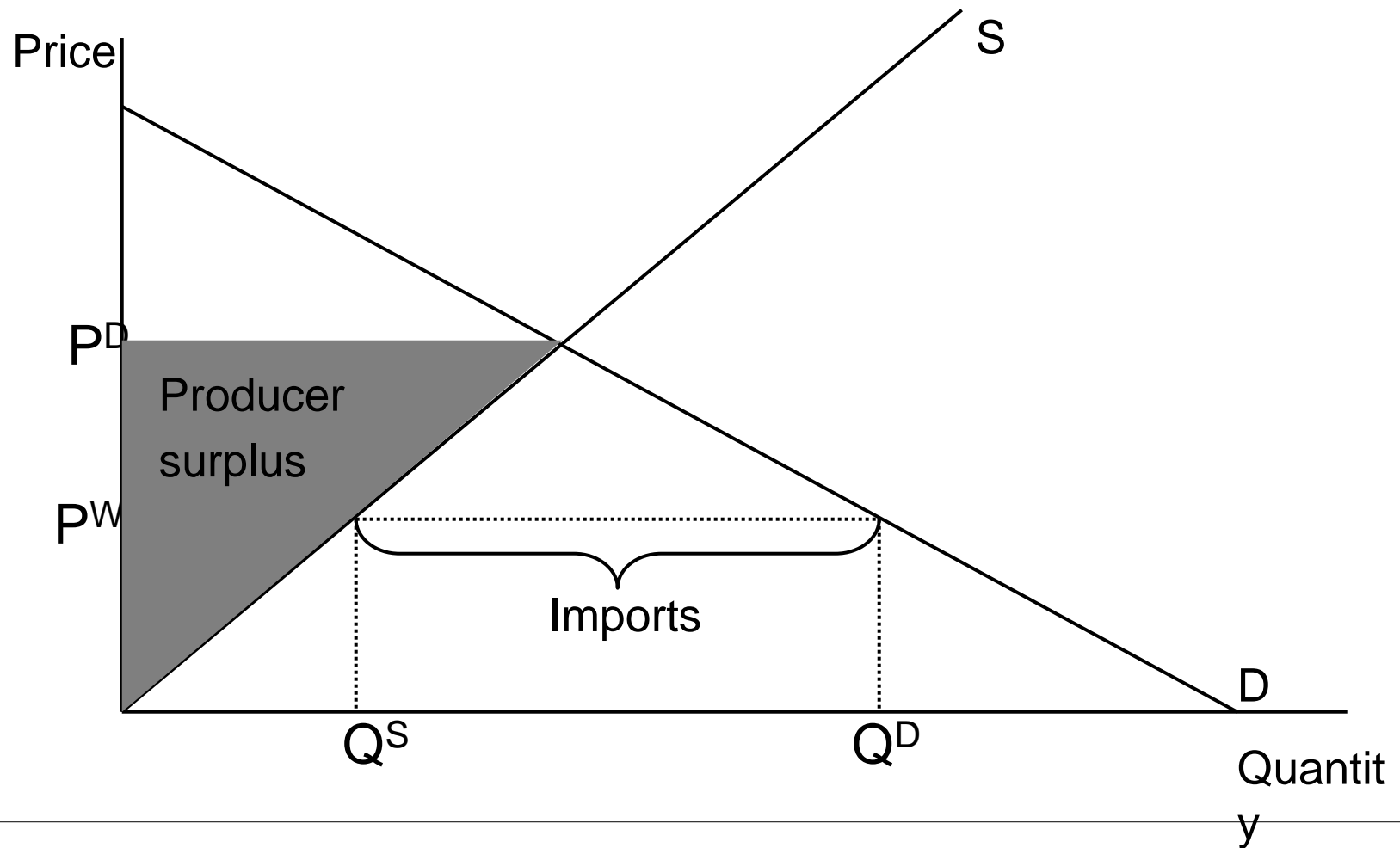
Free trade: consumers gain



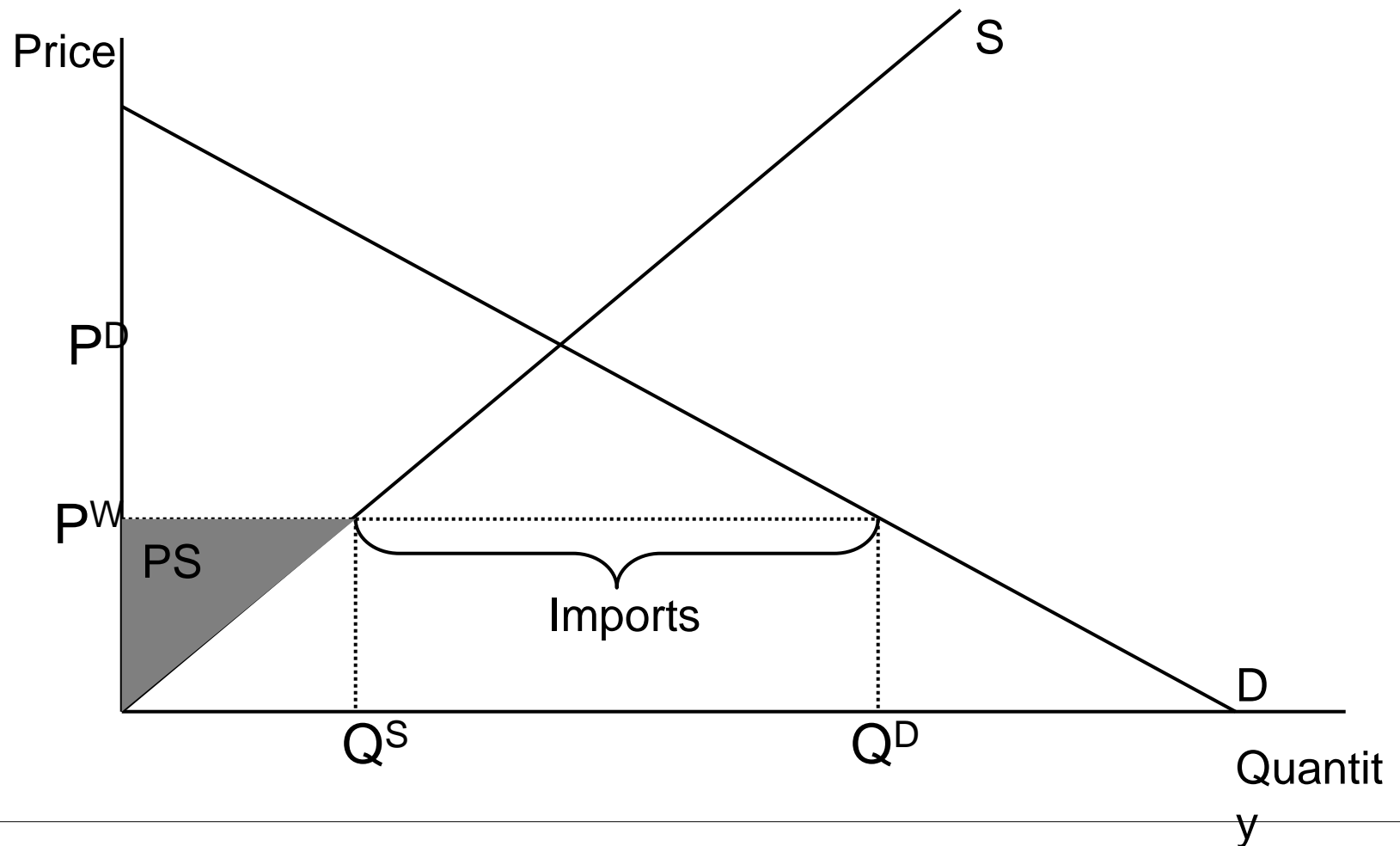
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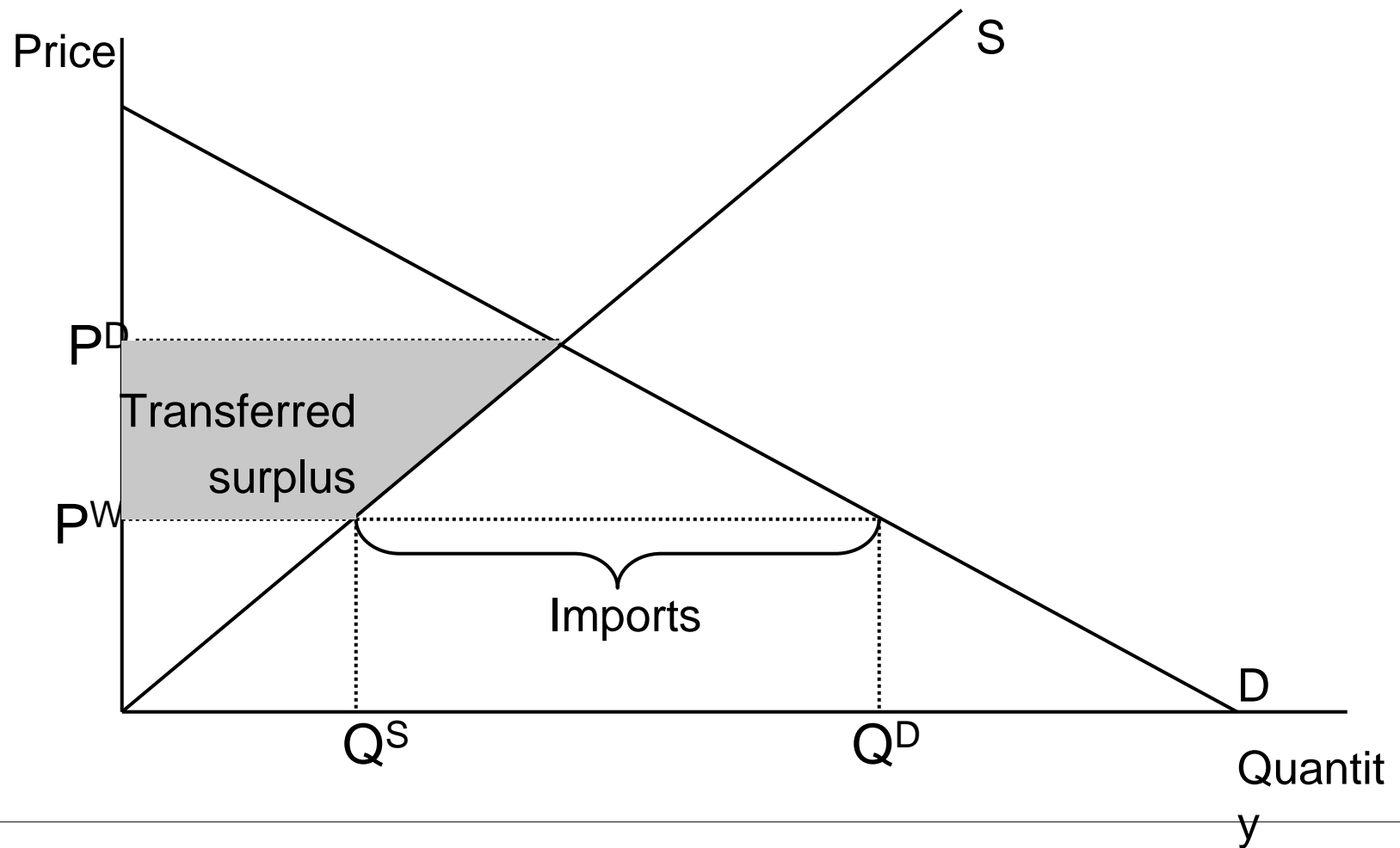
Free trade: producers loose



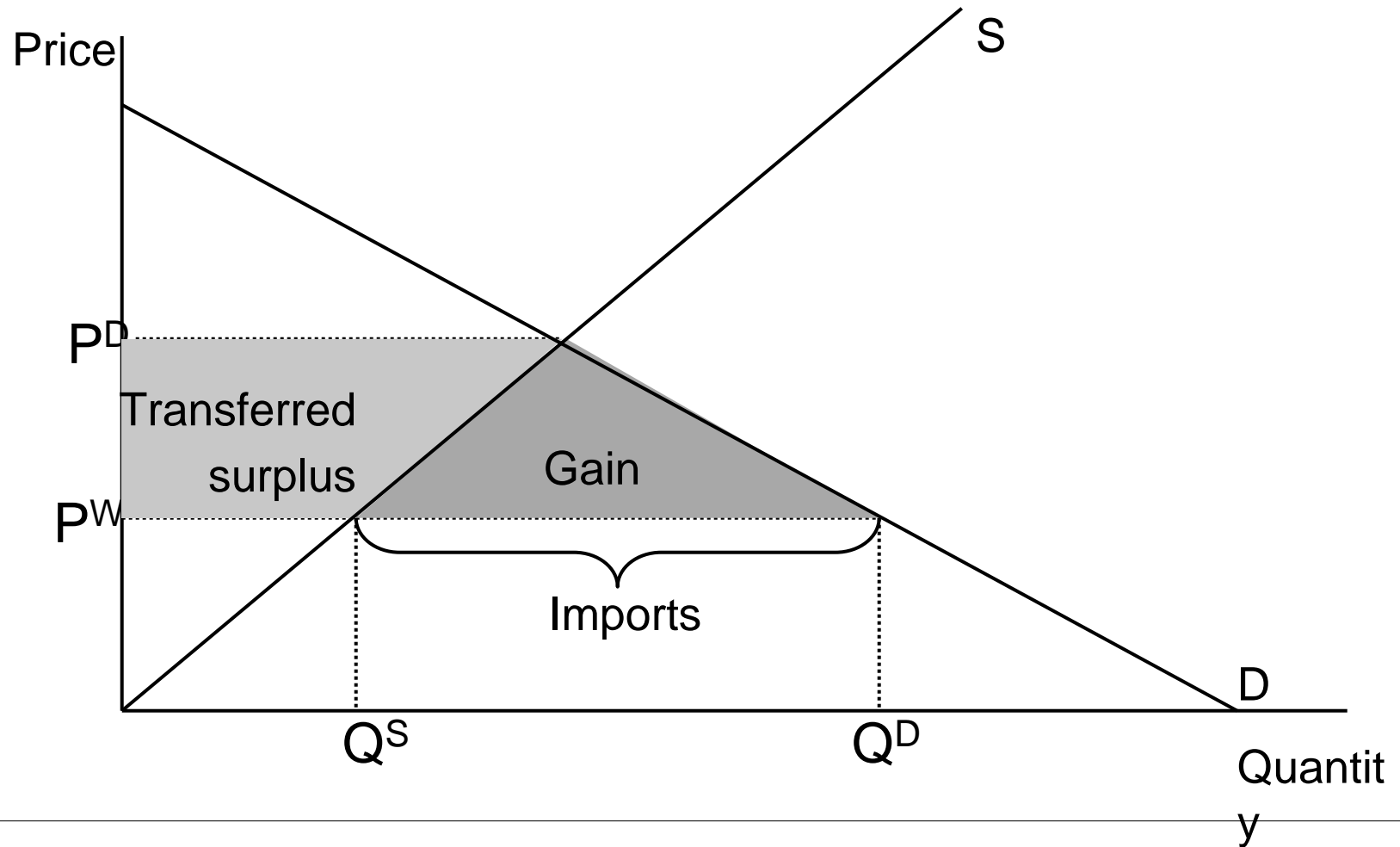
Free trade: producers loose



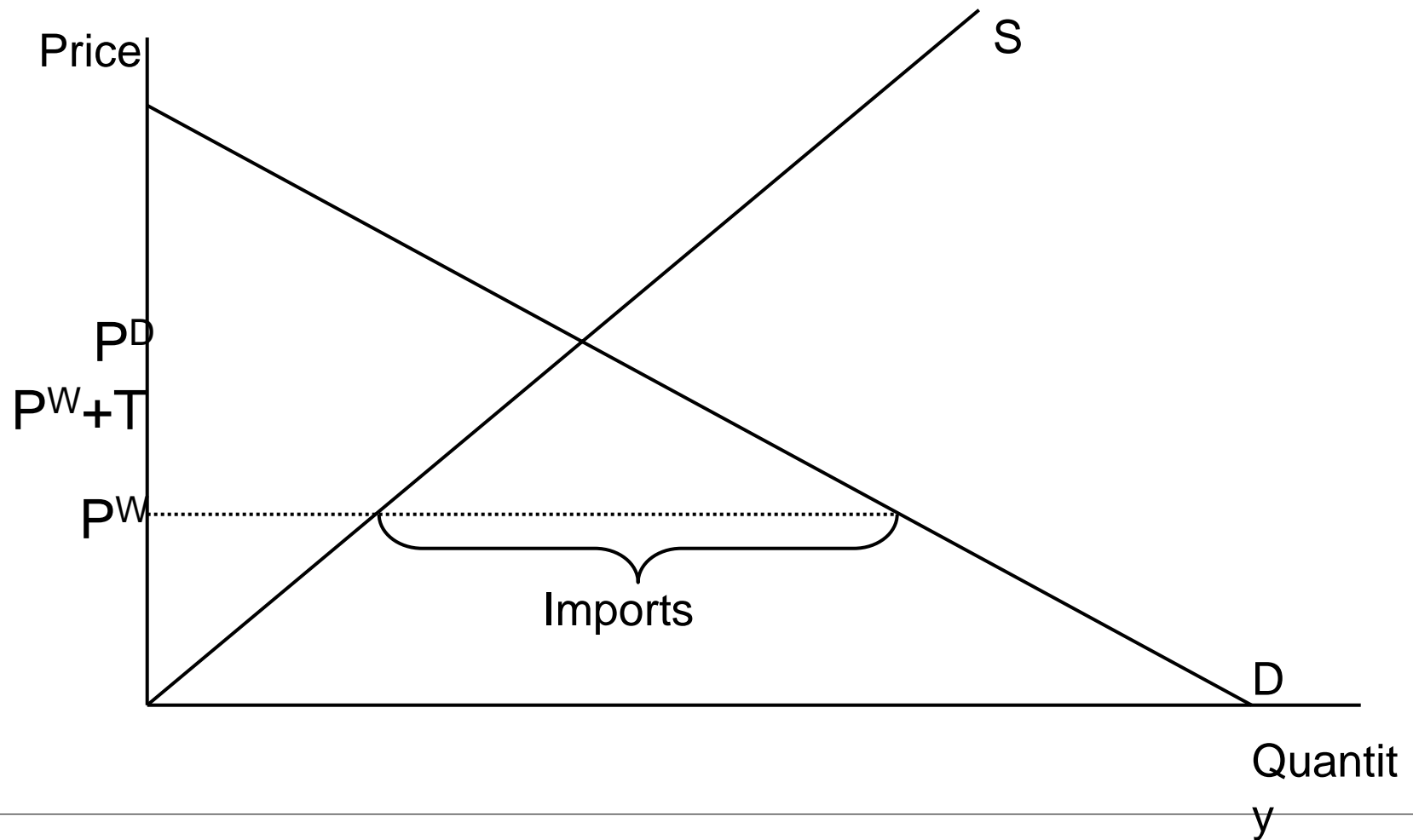
Free trade: economy as a whole gains



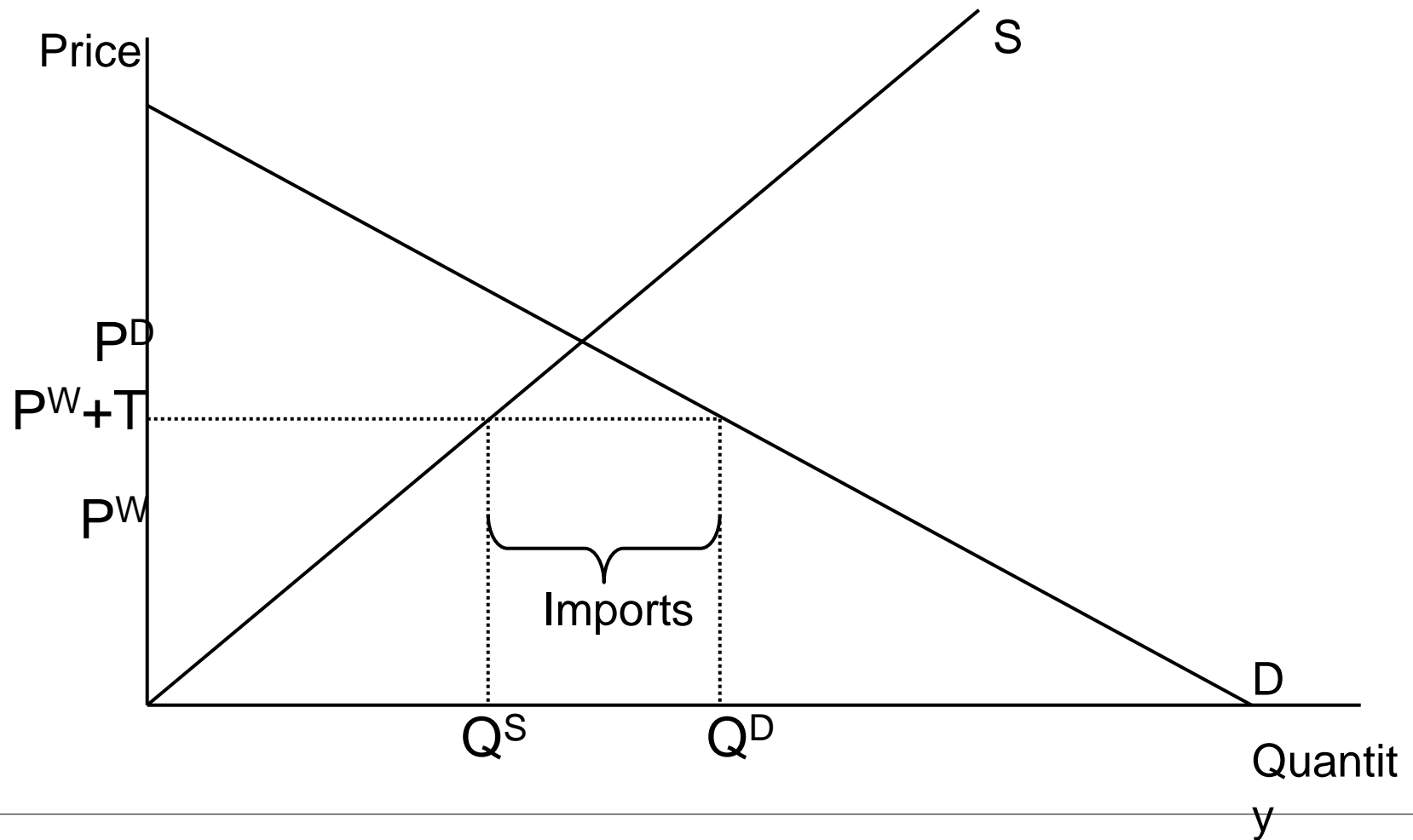
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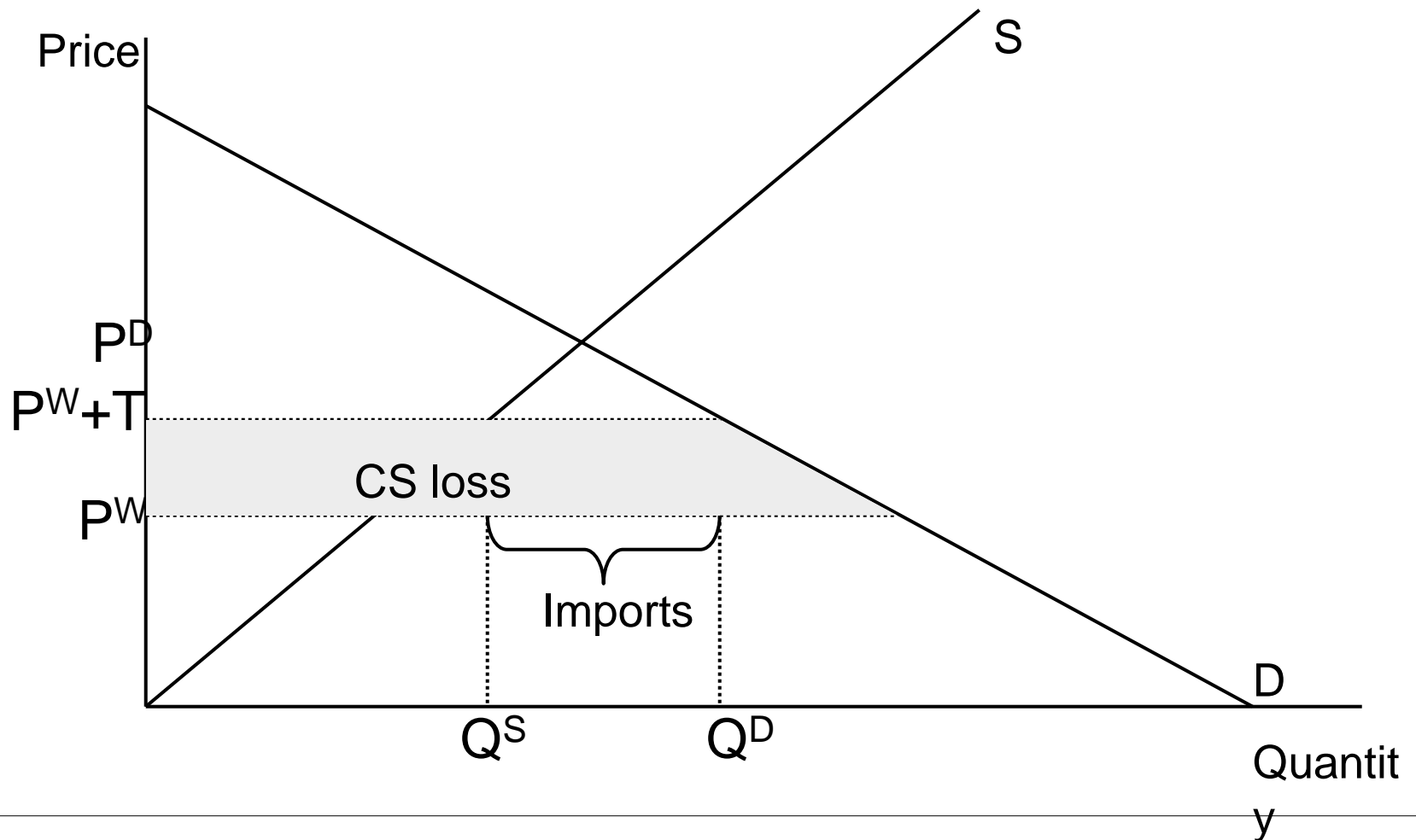
Import tariff: imports reduce



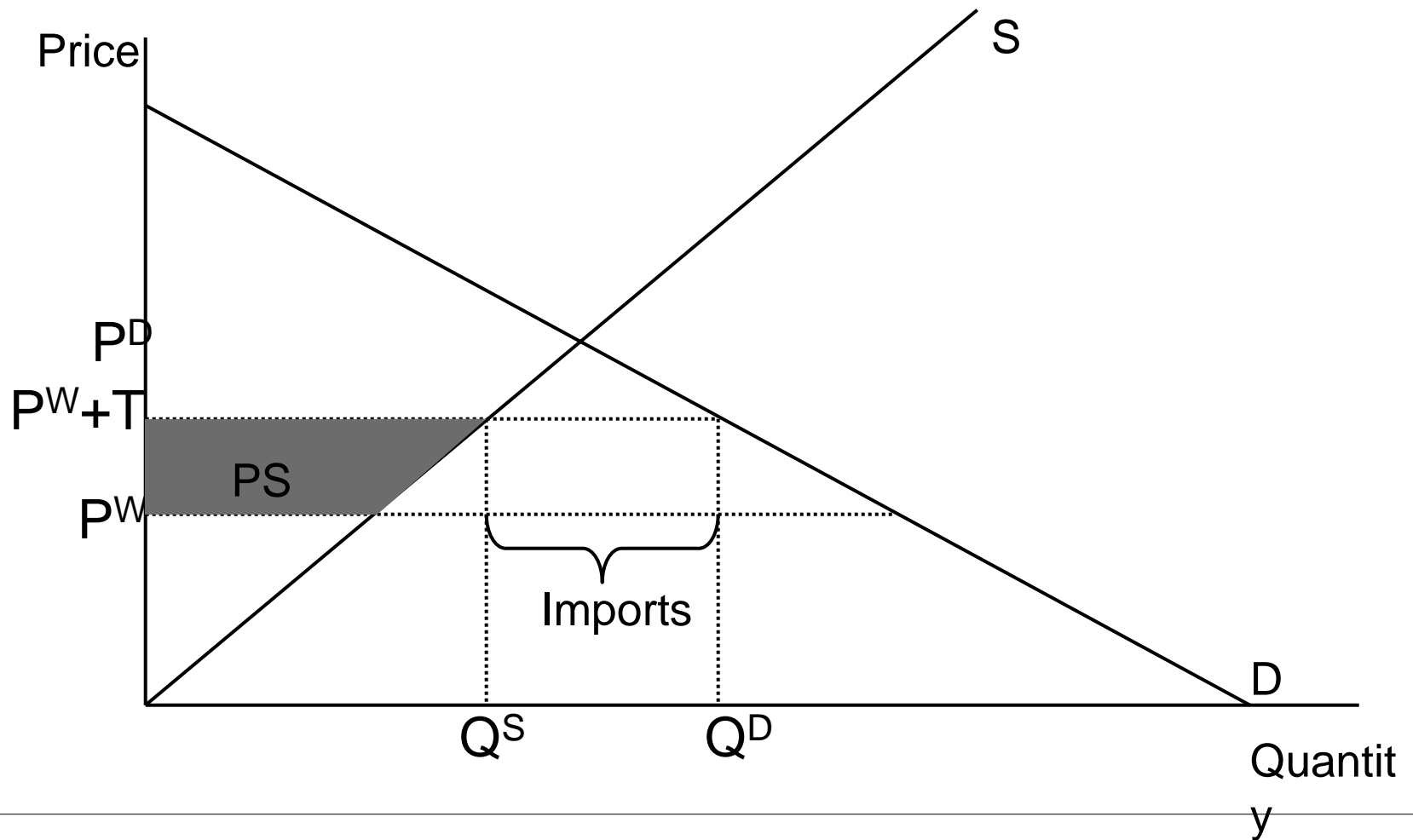
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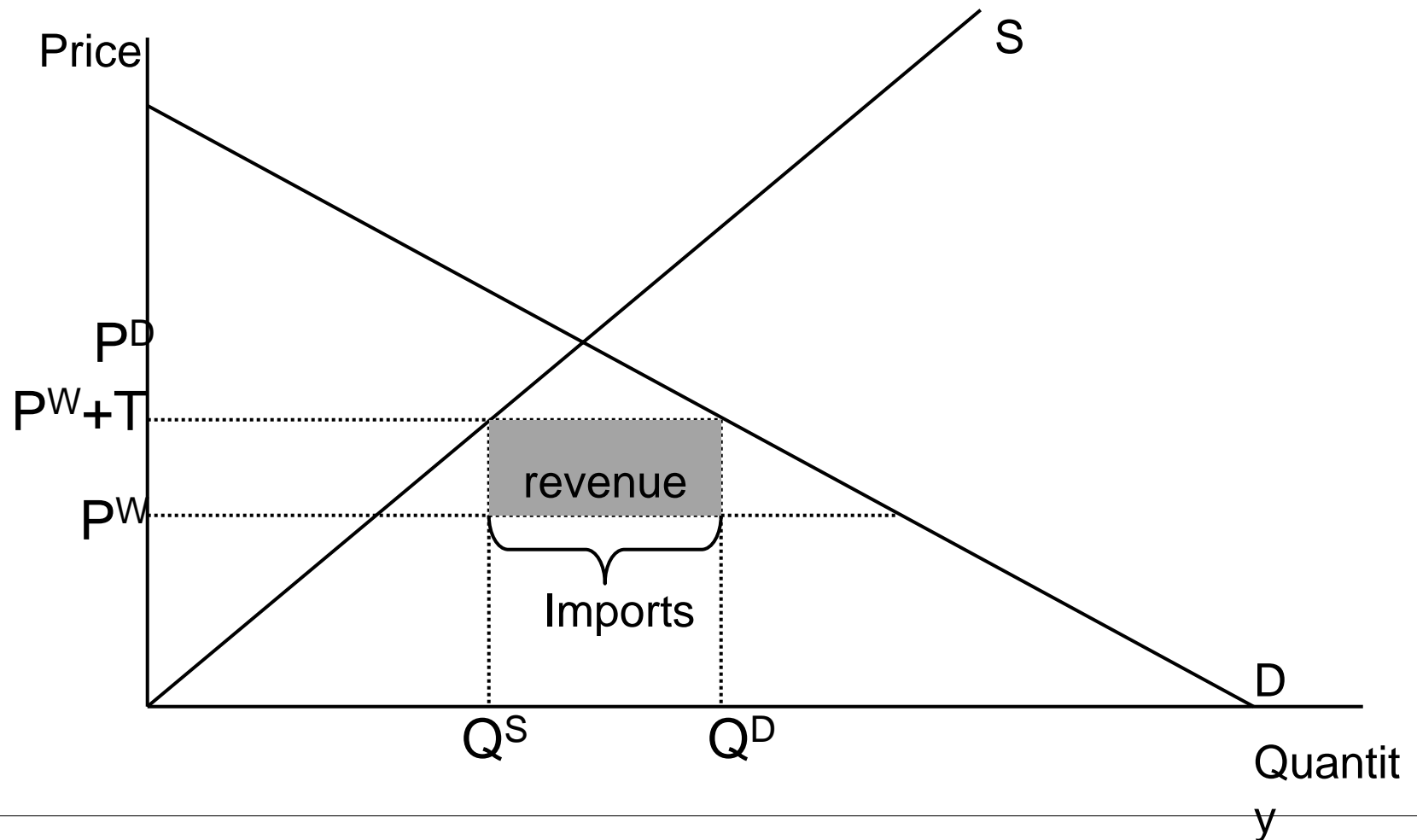
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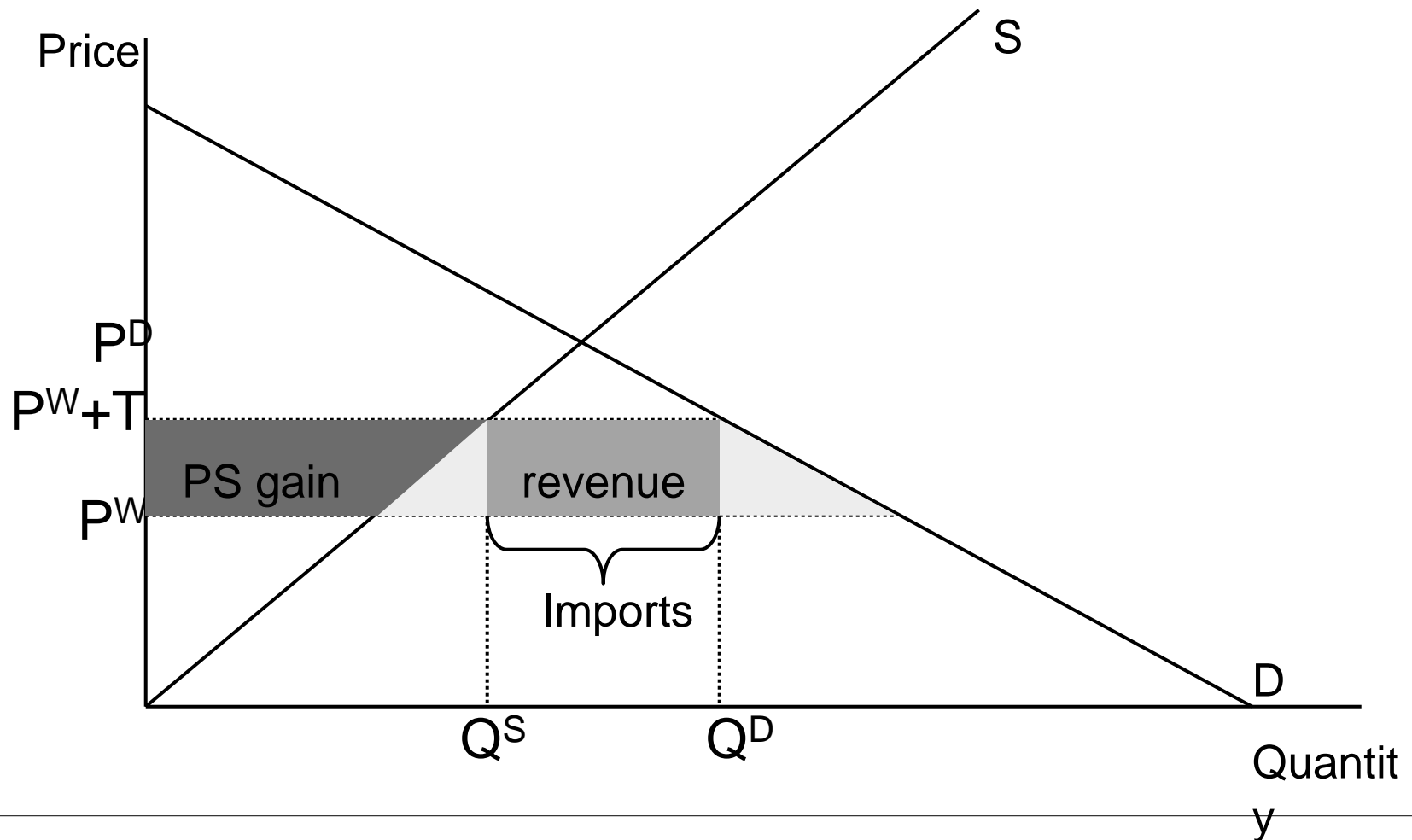
Import tariff: producers gain



Import tariff: government gets revenue

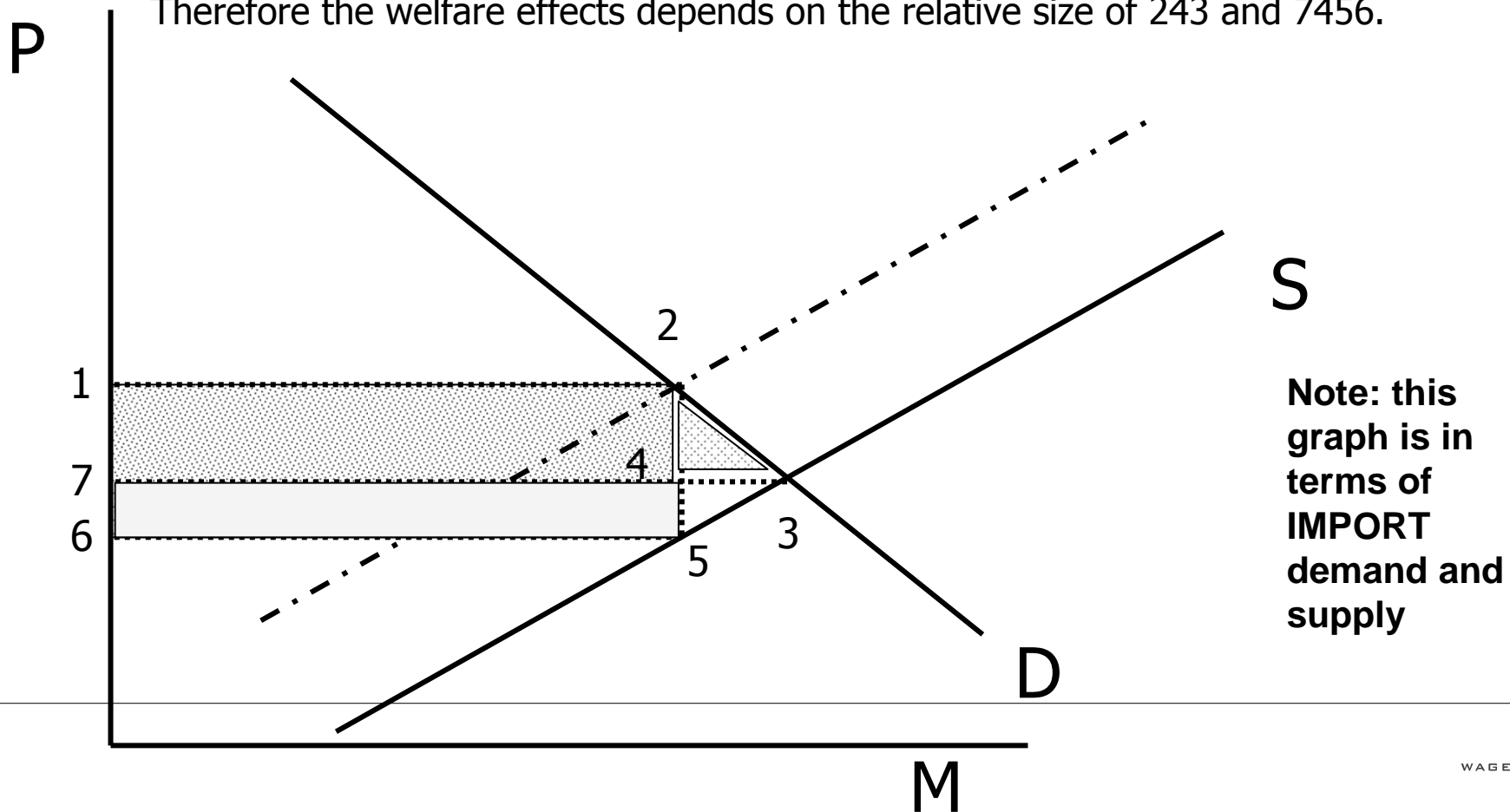


Import tariff: economy has a deadweight loss



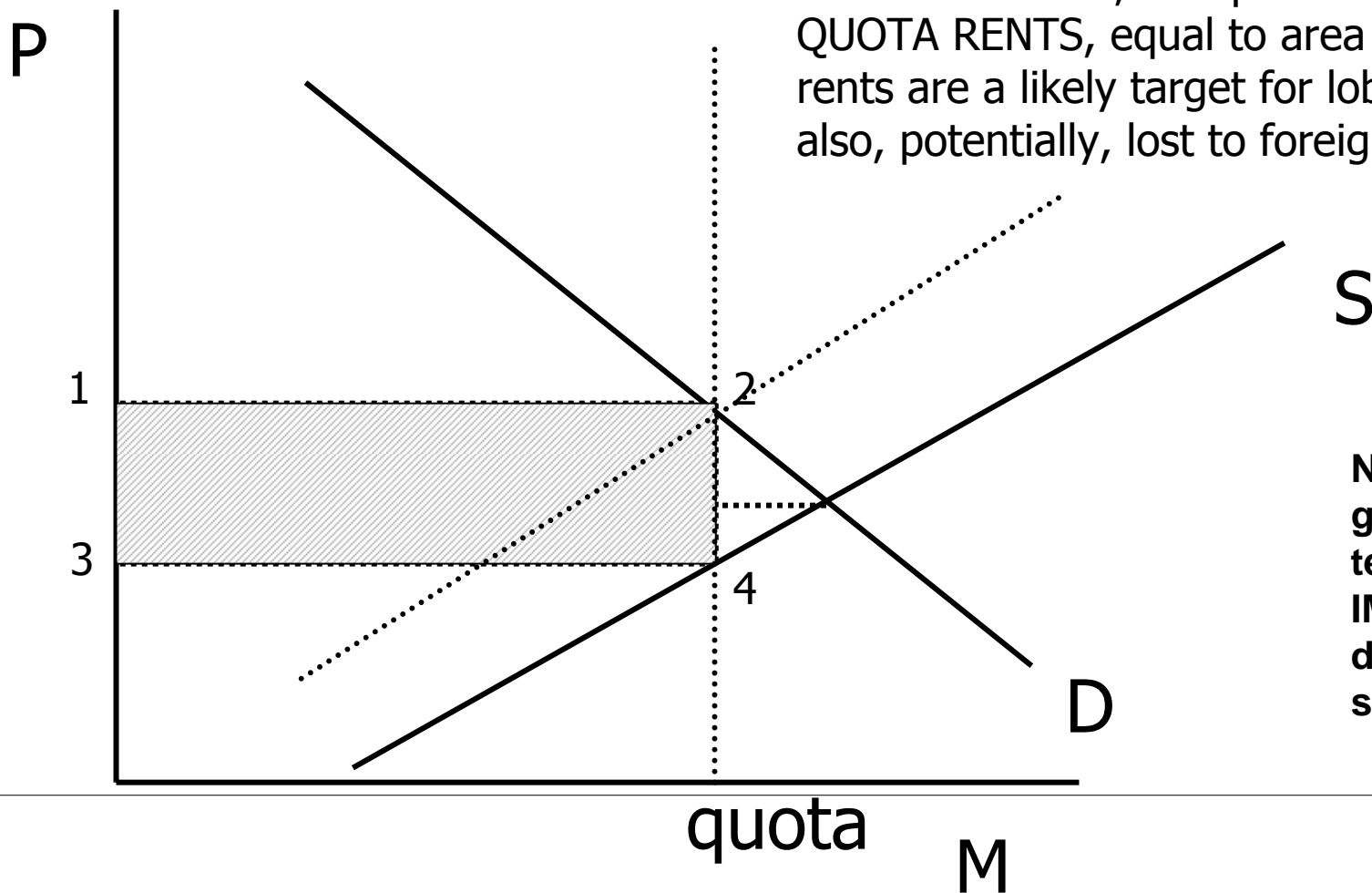
GEOMETRY -- a large country import tariff

Here we have again illustrated an import tax. Import taxes collected are area 1256. Consumer cost is area 12347. Taxes collected amount to area 1265. The welfare gain equals the difference between consumer losses and taxes. Some taxes (area 7456) come from terms of trade gains, as the import price declines relative to domestic price. Therefore the welfare effects depends on the relative size of 243 and 7456.



GEOMETRY -- an import quota

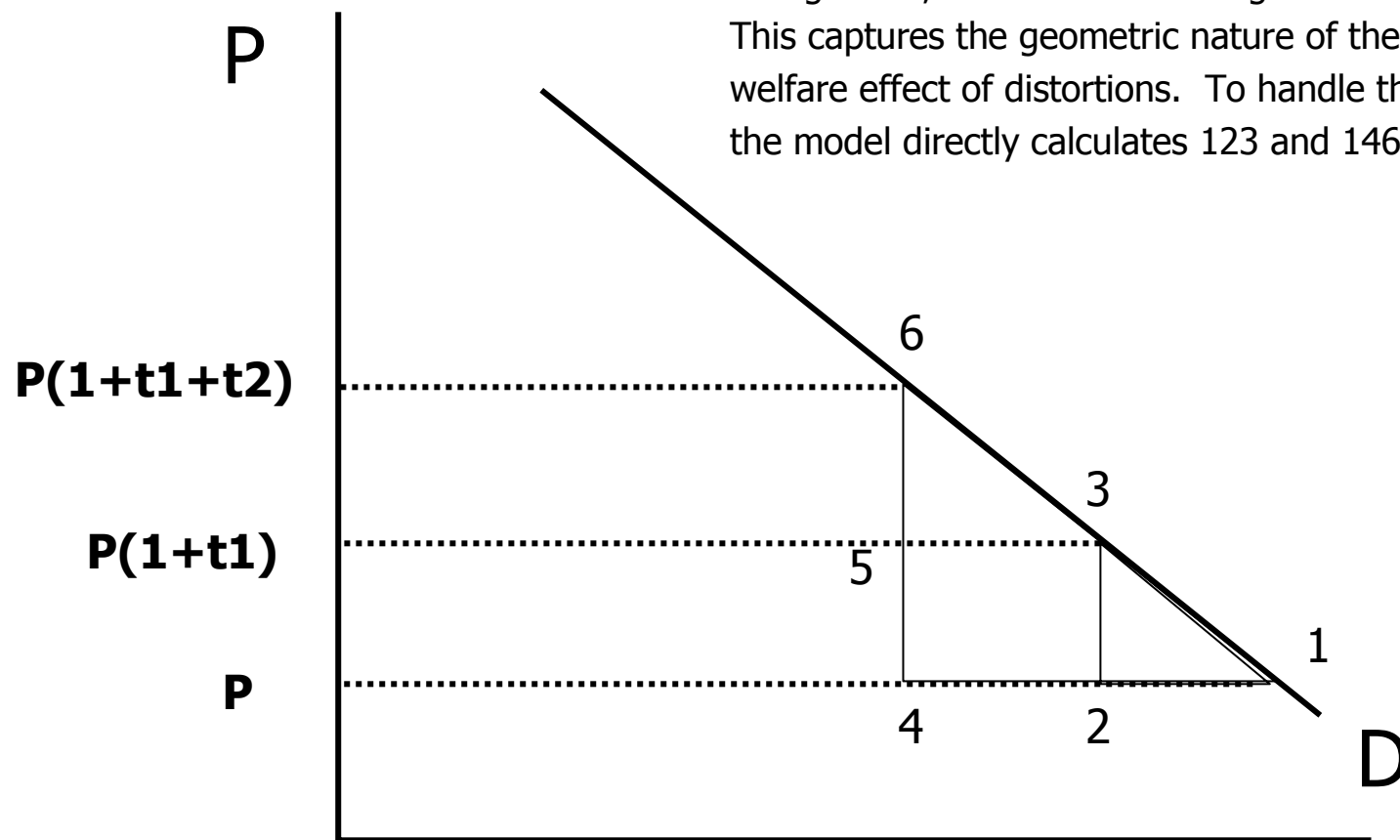
Here we have illustrated an import quota. In contrast to a tax, the quota creates import QUOTA RENTS, equal to area 1234. These rents are a likely target for lobbying. They are also, potentially, lost to foreigners.



Note: this graph is in terms of IMPORT demand and supply

GEOMETRY -- secondary effects of tariffs

Note that, given a tariff t_1 , the welfare effect of an additional import duty is not only the triangle 635, but also the rectangle 3542. This captures the geometric nature of the welfare effect of distortions. To handle this, the model directly calculates 123 and 146.



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 - Assignment 2: graphical policy analysis
- General equilibrium model: mathematical
 - Assignment 3: quantitative policy analysis

A simple PE model without trade: supply, demand and market clearing

ALGEBRA -- effects of tariffs/quotas

A simple PE model with trade

6 equations and 6 unknowns: Q_d , Q_s , M_d , M_s , P , P^*

Some manipulations to solve the model:

- We can derive an import demand equation from eq. (3):
- $Md(P) = Qd(P) - Qs(P) = k_{md} P^{\epsilon_{md}}$
- The constant k_{md} can be calibrated from initial data
- The import demand elasticity can then be retrieved as:

Some manipulations to solve the model -II

- To solve the model ‘by hand’ we linearize the equations
- Example:

Some manipulations to solve the model -III

- After some manipulations we can solve the linearized model for the domestic equilibrium price P :

(Of course we need to calculate $\exp(\ln(P))$ to get the level of P)

Linear or non-linear?

- The log-linear version holds as a local approximation for more general functional forms.
- We can also solve the non-linear version directly through linear approximation methods (EULER, GRAGG)
- We can also solve the non-linear version in a spreadsheet....

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Nonlinear Spreadsheet Models

- The model is specified as a system of implicit equations
$$g(\mathbf{x}) - f(\mathbf{x}) = 0$$
$$h(\mathbf{x}) - k(\mathbf{x}) = 0$$
etc...
- The model is solved by solving for one of these equations, treating the others as constraints.

A view of the model

Perfect substitutes model

Wheat Iran 2001

note: use "solver", under the "Tools" menu. Solver settings have been set.

all data in US\$ x 1E6

Variable

Name	Inputs	
Qs0	4722	Benchmark sales of the domestic industry
Qd0	7936	Benchmark total sales (domestic origin and imported)
Es	0.5	Es: Elasticity of domestic supply
Ed	-2	Ed: Elasticity of demand
Ems	10	Ems: Elasticity of import supply
t0	18.00%	Initial tariff
t1	10.00%	New tariff
w0	0.00%	Initial foreign-held quota price wedge
w1	0.00%	Final foreign-held quota price wedge

Calibrated values

note: initial domestic price index equals 1.0

Ks	4.7E+03	Ks : domestic supply constant term
Kd	7.9E+03	Kd: total demand constant term
Kms	1.7E+04	Kms: import supply constant term
Kmd	3.2E+03	Kmd: import demand constant term
Md	3.2E+03	Md: Import demand
Emd	-4.2E+00	Emd: elasticity of import demand

Counterfactual equilibrium price

P_In	0.952	Linear domestic price solution:
P_nln	0.955	Non-linear domestic price solution
	-6.9E-07	non-linear optimization constraint (excess supply), Qd-Qs-M=0
Pfree_In	0.890	Free trade price (linear)
Pfree_nln	0.894	Free-trade price (nonlinear)
	0.0E+00	non-linear free trade constraint

We have specified one cell as a problem to be solved given constraints.

Solver Parameters [?] [X]

Set Target Cell:

Equal To: Max Min Value of:

By Changing Cells:

Subject to the Constraints:

<input type="text" value="\$C\$35 = 0"/>	<input type="button" value="Add"/>
	<input type="button" value="Change"/>
	<input type="button" value="Delete"/>

Solver options in Excel

Solver Options [?] [X]

Max Time: seconds

Iterations:

Precision:

Tolerance: %

Convergence:

Assume Linear Model Use Automatic Scaling

Assume Non-Negative Show Iteration Results

Estimates Derivatives Search

Tangent Forward Newton

Quadratic Central Conjugate

OK

Cancel

Load Model...

Save Model...

Help

Over to the computer

- Familiarize yourself with the spreadsheet
- Data for wheat Iran provided in
..\DATA\WheatDataIran.XLS

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Assignments

- Group 1: analyze effect of lower tariff in terms of domestic and import prices, production, trade and welfare
- Group 2: analyze effect of import quota. Provide way to estimate the size of the 'quota wedge'.
- Group 3: investigate sensitivity of results w.r.t. assumptions on elasticities of demand and supply. How does welfare assessment change if domestic demand is more or less elastic?

Nature of experiment

- Comparative static
- Initial situation \rightarrow new situation

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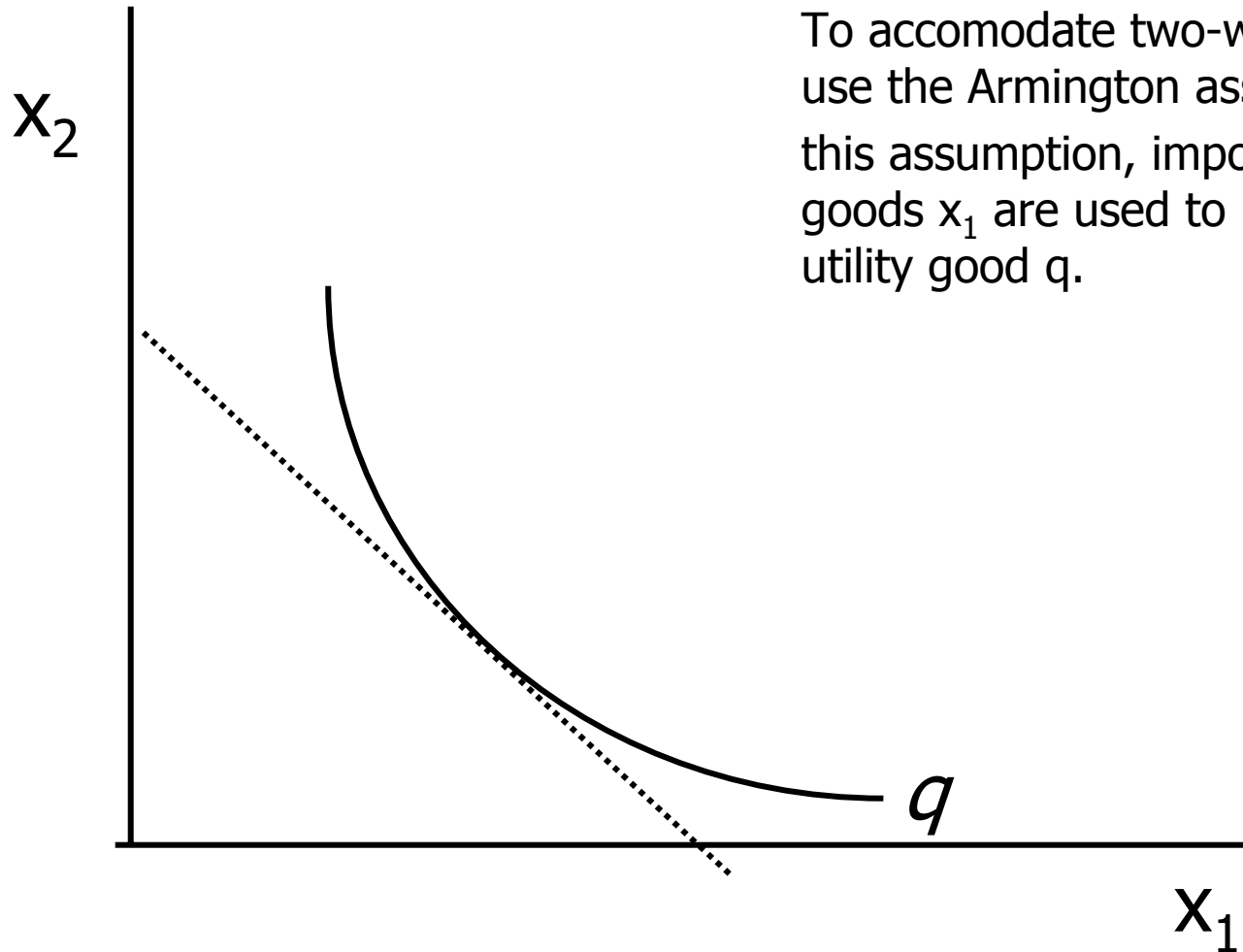
shock

Large country model: ToT effects non-zero

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Armington preferences



To accommodate two-way trade, we can use the Armington assumption. Under this assumption, imports x_2 and domestic goods x_1 are used to produce a composite utility good q .

Algebra: from first order conditions For CES demands

P is a composite price

P_j is the price of good j

E is total expenditure

k_{si} is a supply function constant term

k_a is a composite demand constant term

σ is the elasticity of substitution

$\rho = (\sigma - 1) / \sigma$



A view of the model

Inputs Non-linear Armington model

note: use "solver", under the "Tools" menu. Solver settings have been set.

200	Benchmark sales of X1 (i.e. domestic) industry	NOTE: sales at internal prices!
1000	Benchmark sales of country 2 imports (<i>targeted by policy change</i>)	
200	Benchmark sales of country 3 imports	
1400	Benchmark total sales (domestic origin and imported)	
1.5	NA: Composite elasticity of demand	
3	Es1: Elasticity of domestic supply	
5	Es2: Elasticity of country 2 import supply	
5	Es3: Elasticity of country 3 import supply	
5	σ : Elasticity of substitution	
25.00%	t2,0: Initial tariff on country 2 imports	
25.00%	t3,0: Initial tariff on country 3 imports	
25.00%	t2,1: Final tariff on country 2 imports	
25.00%	t3,1: Final tariff on country 3 imports	
0.00%	w2,0: Initial export tax/quota price wedge on country 2 imports	
0.00%	w3,0: Initial export tax/quota price wedge on country 3 imports	
25.00%	w2,1: Final export tax/quota price wedge on country 2 imports	
0.00%	w3,1: Final export tax/quota price wedge on country 3 imports	

Calibrated values

2.00E+02	Ks1 : domestic supply constant term	1.00	P1: calibrated domestic product market
3.05E+03	Ks2 : country 2 import supply constant term	1.00	P2: calibrated internal price for good 2
6.10E+02	Ks3 : country 3 import supply constant term	1.00	P3: calibrated internal price for good 3
1.40E+03	KD : composite demand constant term	0.80	P2*: calibrated country 2 border price
0.68	ω_1 : CES weight for domestic good	0.80	P3*: calibrated country 3 border price
0.93	ω_2 : CES weight for country 2 import	1.00	PA: calibrated composite good price
0.68	ω_3 : CES weight for country 3 import		

Counterfactual solution values

counterfactual Excess demands	free-trade in X2		internal prices and Y	
	excess demands		free trade in X2	counterfactual
-9.2E-08	0.0E+00	P1: domestic product market	0.94	1.04
-8.4E-07	2.3E-13	P2: good 2 market	0.85	1.13
-1.6E-07	-5.7E-14	P3: good 3 market	0.95	1.03
-2.6E-11	0.0E+00	PA: composite good price	0.88	1.10
8.6E-08	0.0E+00	Y: total expenditure	1495.33	1333.68

end

Supplementary material

- Theoretical exercises with PE model

Assignment 1

- Form 3 groups that each analyze a scenario:
 - Import tariff
 - Import quota
 - Increased foreign capital inflow
- Give a justification of your policy:
 - What are the benefits for the country?
 - What are the costs for the country?

Impact of an import tariff/tax – Group 1

- Assume world price is lower than domestic price
- Objective is to compensate producers for losses

- Benefits:
 - Producers gain in surplus
 - Government gains tariff revenue

- Costs
 - Consumer surplus decreases
 - Efficiency loss (deadweight losses – triangles)

Impact of an import quota – Group 2

- Assume world price is lower than domestic price
- Objective is to compensate producers for losses

- Benefits:
 - Producers gain in surplus

- Costs
 - Consumer surplus decreases
 - Efficiency loss (deadweight losses – triangles)
 - Administration cost

Effects of increased foreign capital inflow –

Assumed: investment in manufacturing sector

Gr.3

- Direct benefits: Producer Surplus UP; Cons Surplus UP: Total Econ Gain UP
- Indirect benefits:
 - Employment opportunity UP
 - Foreign Excha. Stock UP
 - Backward linkage: domestic input demand UP
 - Forward linkage: other downstream industry Benefits
 - In sum, GNP rise
- Costs:
 - maintaining political-economic stability through:
 - fiscal policy; promotion; law enforcement; etc.