



*The interplay between endogenous
technical change and the labour market in
climate policy assessment*

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Outline

1. Research problematic
2. Analytical exploration of an IMACLIM-S maquette
3. Sensitivity analysis on a numerical experiment
4. Scrutiny of a pathological parameterisation

Problematic

Florence, 12 juin 2007

Key features of IMACLIM-S

IMACLIM-S is a compact static CGEM devoted to the macroeconomic assessment of climate policies, with key features:

- **Endogenous technical change:** 'hybrid' factor substitution together with Hicks-neutral induced technical change
- **Static decreasing returns:** factor consumptions increase with real output at constant production capacity
- **Equilibrium unemployment:** real wages and unemployment correlated by a wage curve

Off the textbook roads

Hybrid inputs substitution, unemployment: a necessity with drawbacks

- Trade-off between **policy relevance** and possibility of **analytical control**
- Whereas: climate policy exploration necessitates **large departure from trends**: exacerbated need for model robustness

Indeed, numerical sensitivity analysis hints at the possibility of **no/multiple equilibrium**

Analytical exploration of a maquette of IMACLIM-S

Florence, 12 juin 2007

A 4-equation maquette

Development of a one-commodity one-region maquette of IMACLIM-S retaining only its central features

- **Endogenous technical progress**: factor consumptions (Hicks-neutral) decrease as real investment increases (the latter used as a static proxy of capital accumulation)
- **Static decreasing returns**: factor consumptions increase with real output at constant production capacity
- **Wage curve**

+ aggregate budget constraint = 4-equation system
setting aside...

4-equation system: 4 variables

$$p Y = \Phi \Theta (p \alpha Y + w l Y + p \beta Y) \quad (1)$$

$$\Phi = \varphi_1 \left(\frac{r \Phi \Theta (w l Y + p \beta Y)}{p} \right)^{-\varphi_2} \quad (2)$$

$$\Theta = \theta_1 Y^{\theta_2} \quad (3)$$

$$\frac{w}{p} \left(\frac{L - \Phi \Theta l Y}{L} \right)^{\varepsilon} = c \quad (4)$$

- Output and price of the only commodity (Y , p)
- Hicks-neutral technical progress Φ
- Decreasing returns Θ

4-equation system: 8 calibrated parameters

$$p Y = \Phi \Theta (p \alpha Y + w l Y + p \beta Y) \quad (1)$$

$$\Phi = \varphi_1 \left(\frac{r \Phi \Theta (w l Y + p \beta Y)}{p} \right)^{-\varphi_2} \quad (2)$$

$$\Theta = \theta_1 Y^{\theta_2} \quad (3)$$

$$\frac{w}{p} \left(\frac{L - \Phi \Theta l Y}{L} \right)^{\varepsilon} = c \quad (4)$$

Calibration straightforward on any national accounts & unemployment level

4-equation system: 3 positive elasticities

$$p Y = \Phi \Theta (p \alpha Y + w l Y + p \beta Y) \quad (1)$$

$$\Phi = \varphi_1 \left(\frac{r \Phi \Theta (w l Y + p \beta Y)}{p} \right)^{-\varphi_2} \quad (2)$$

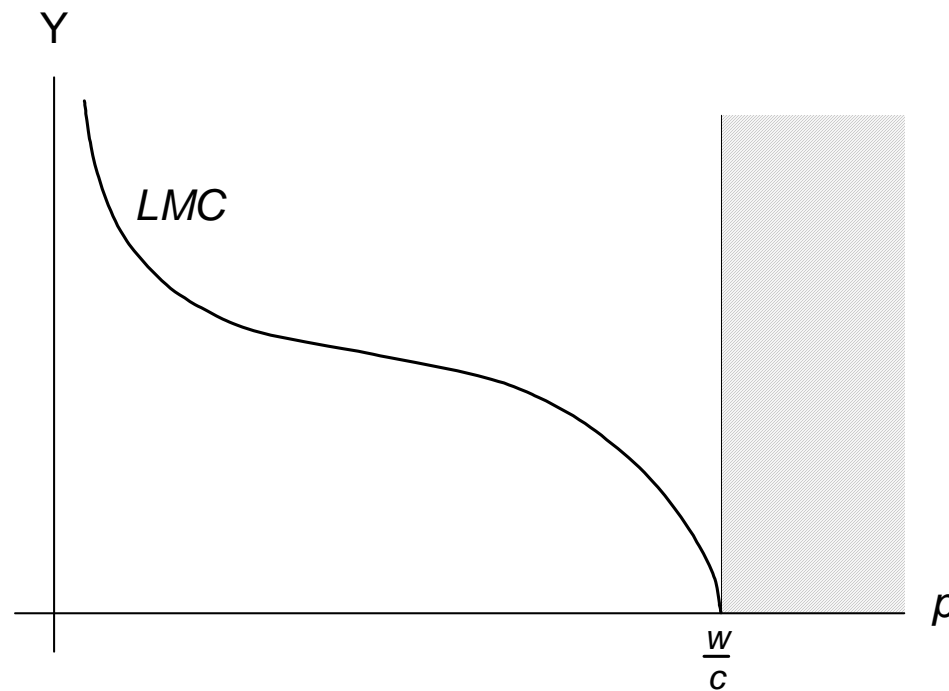
$$\Theta = \theta_1 Y^{\theta_2} \quad (3)$$

$$\frac{w}{p} \left(\frac{L - \Phi \Theta l Y}{L} \right)^{\varepsilon} = c \quad (4)$$

- Elasticity of real wage to unemployment ε
- Elasticity of inputs reduction to real investment φ_2
- Elasticity of cost to real output θ_2

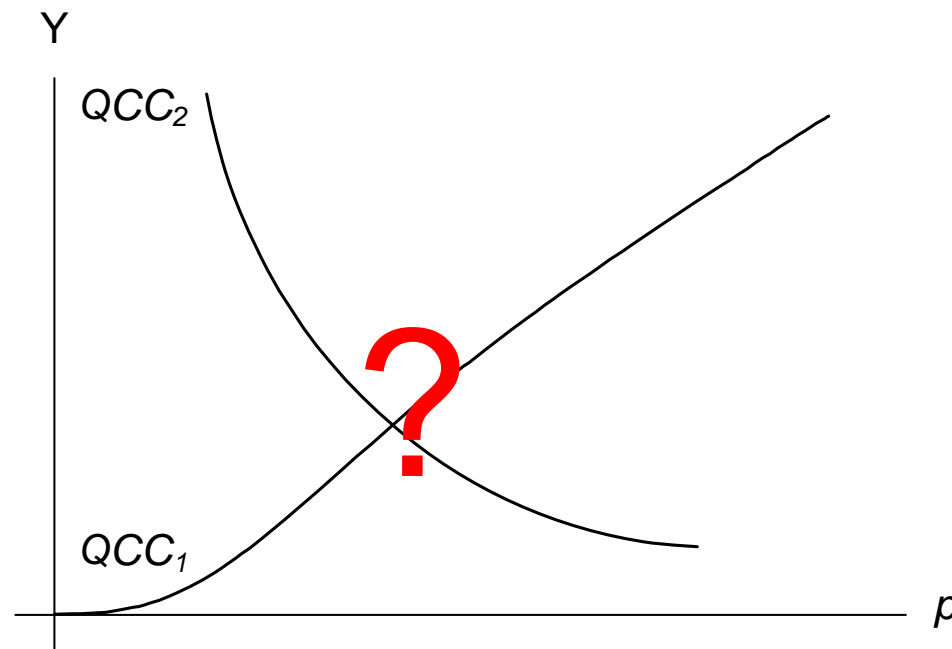
Reduction to 2 (p, Y) equations – equation 1

Injecting TP and DR in wage curve:
unambiguous ‘labour market constraint’



Reduction to 2 (p, Y) equations – equation 2

Injecting ETC and DR in aggregate budget constraint:
ambiguous 'quantity/cost constraint'



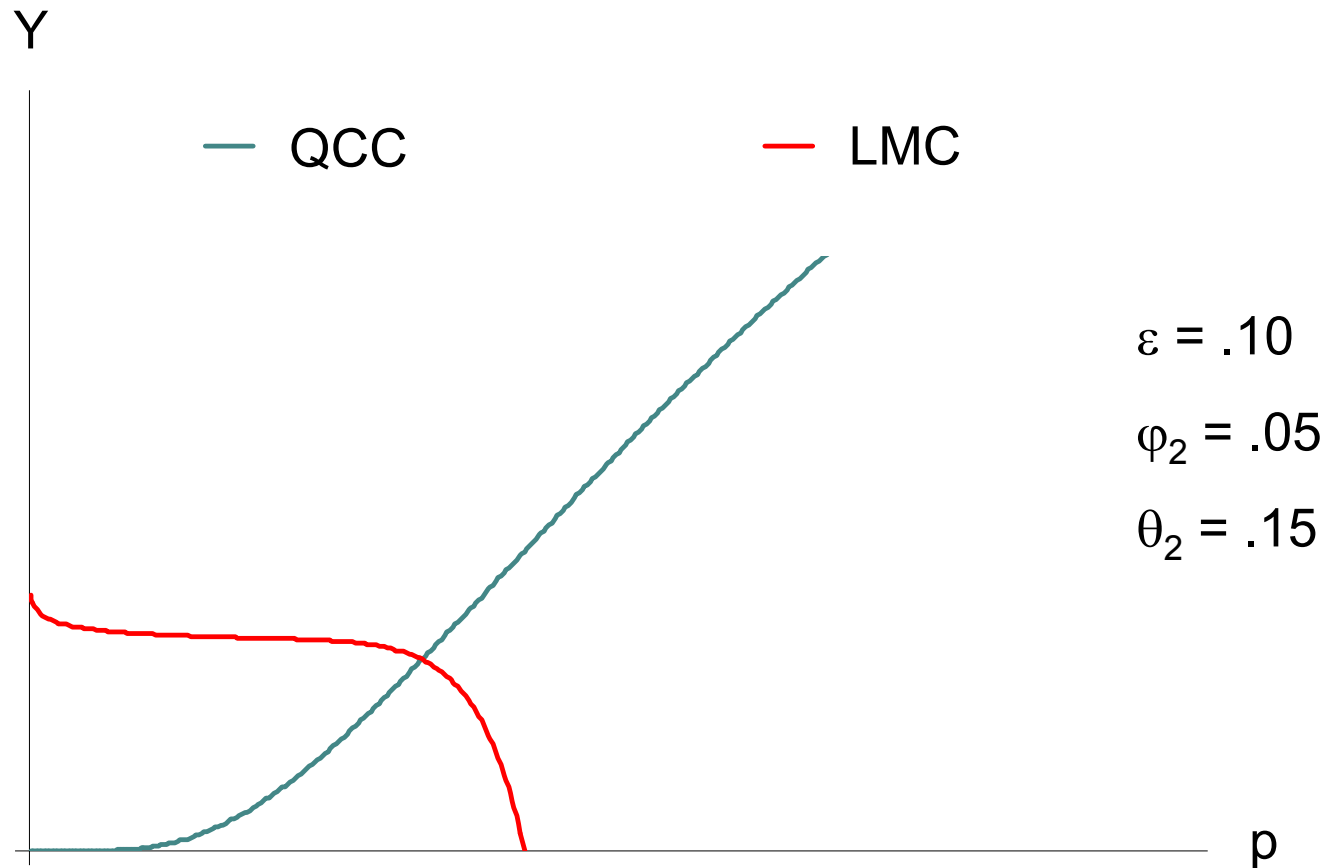
Elasticity of DR $\theta_2 >$ elasticity of TP φ_2

Decreasing returns overcome any efficiency gains from induced technical progress

- Factor intensities **increase** with output,
- In (p, Y) QCC is an **increasing** function

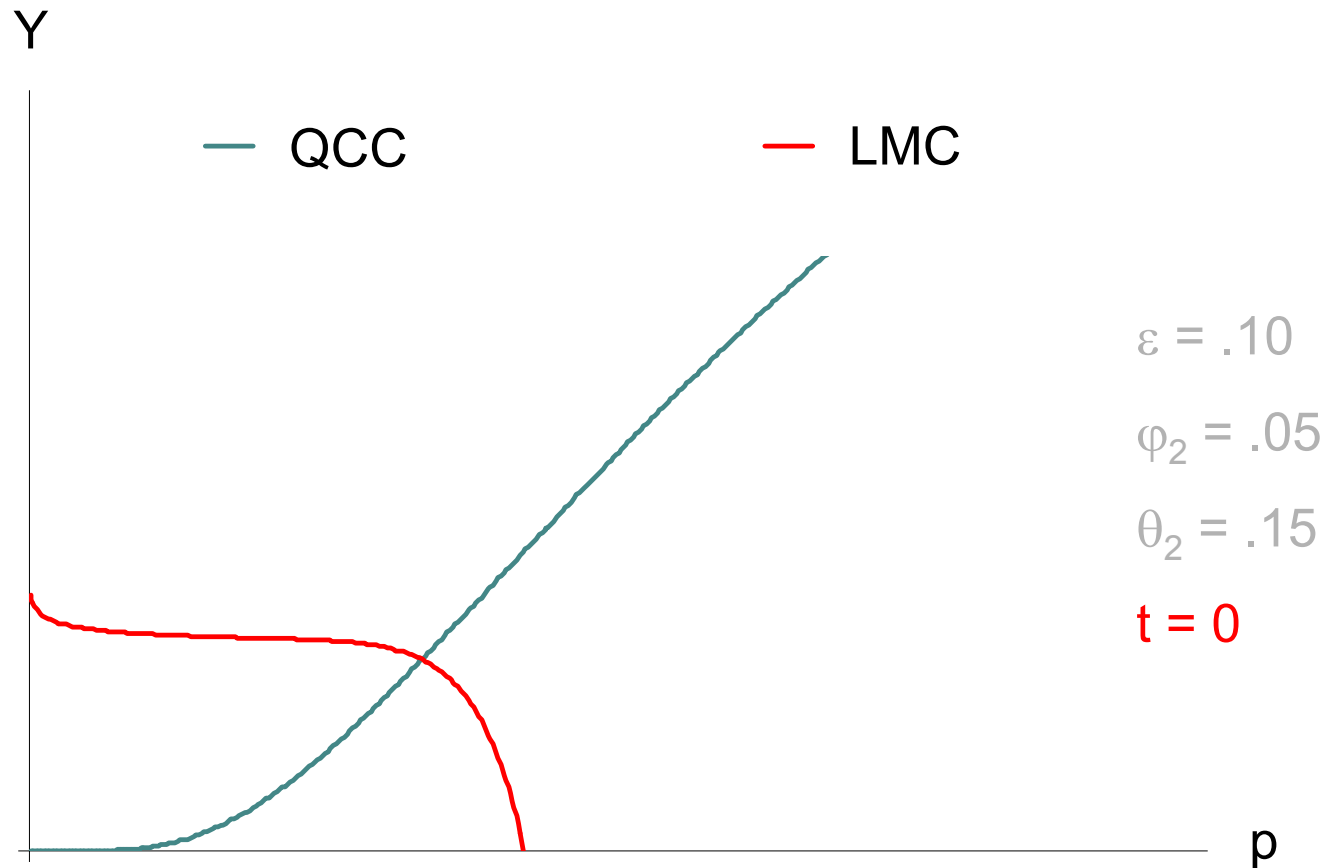
If $\theta_2 > \varphi_2$
the 4-equation maquette
has one, unique equilibrium

Numerical maquette: a 'well-behaved' world

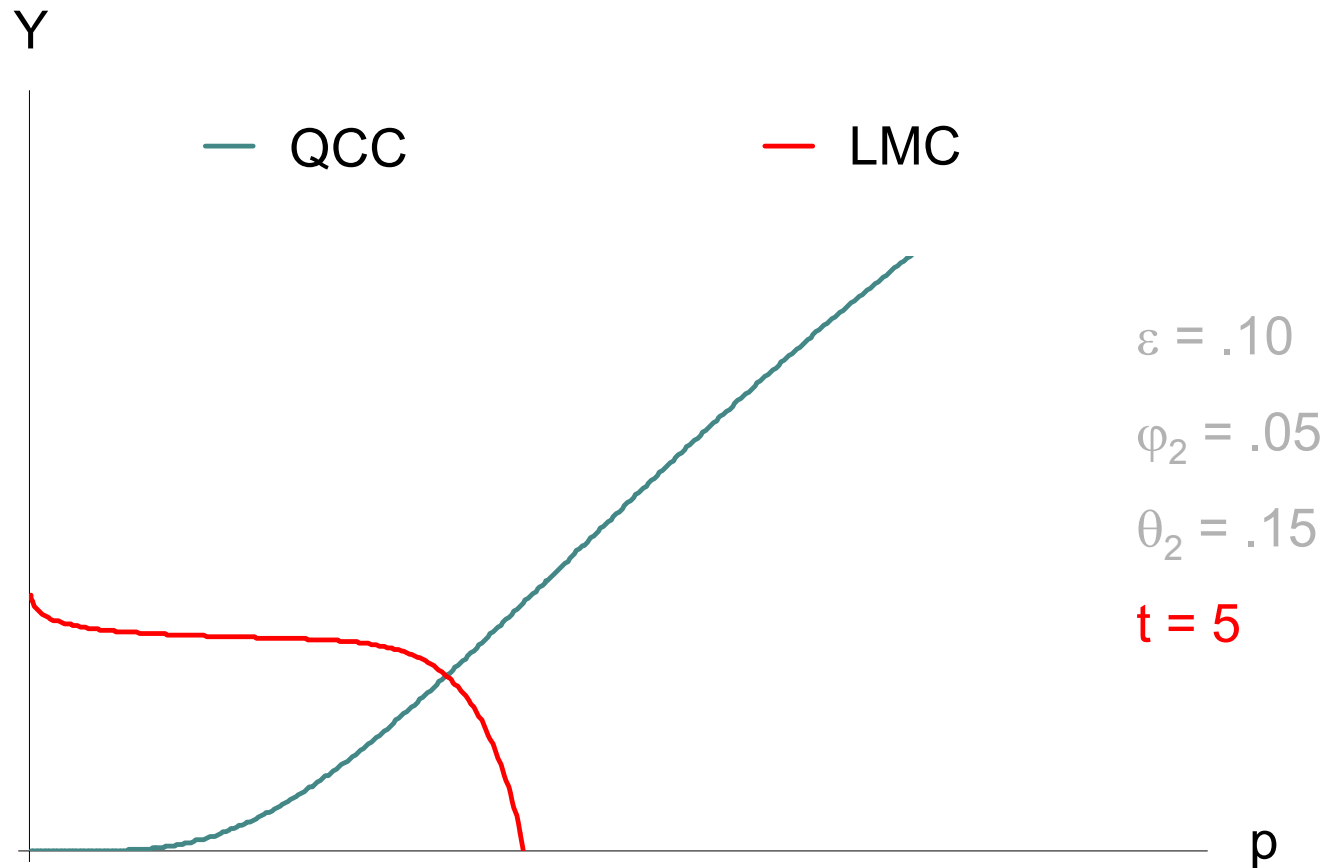


Based on a global 2010 projection developed for the TranSust project.

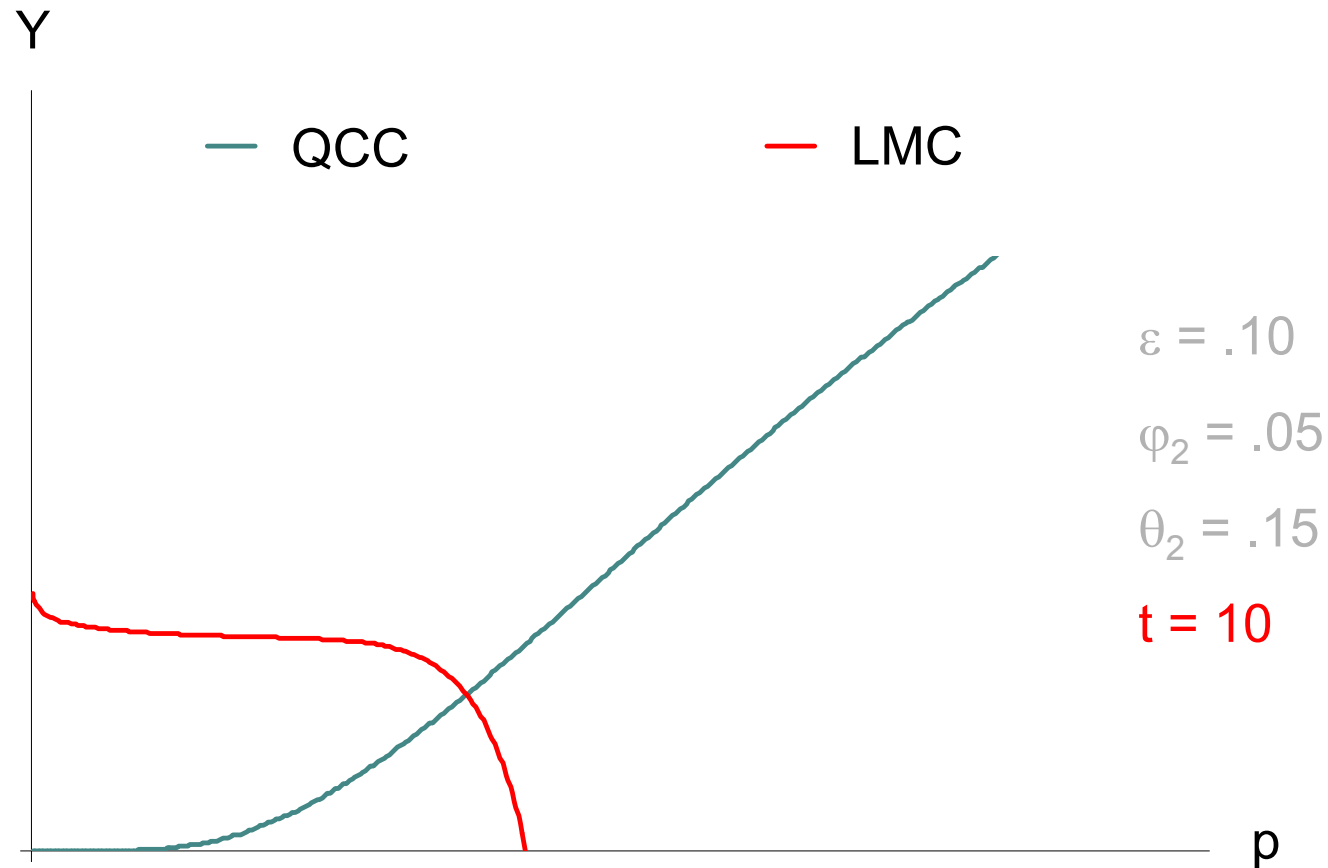
Implementation of an excise tax t



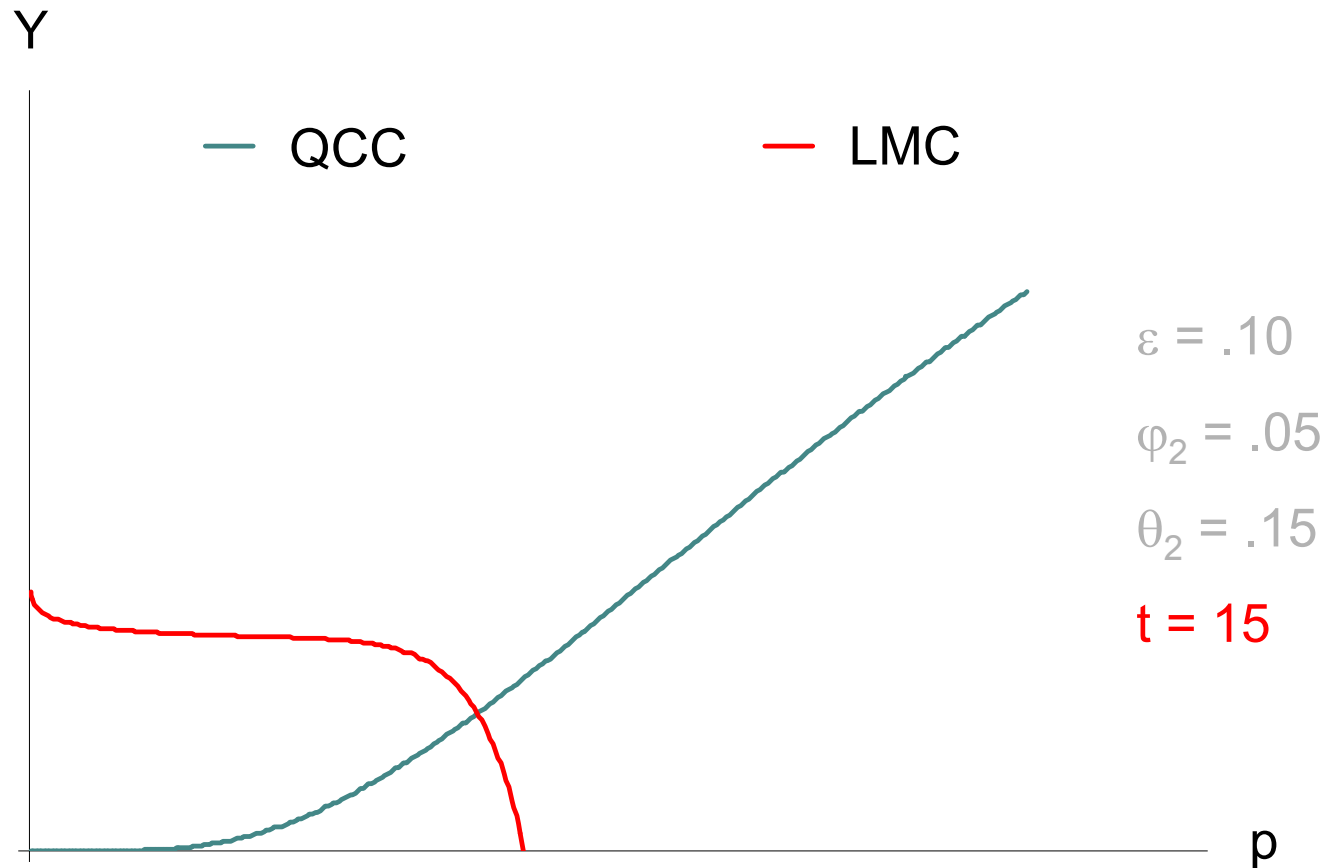
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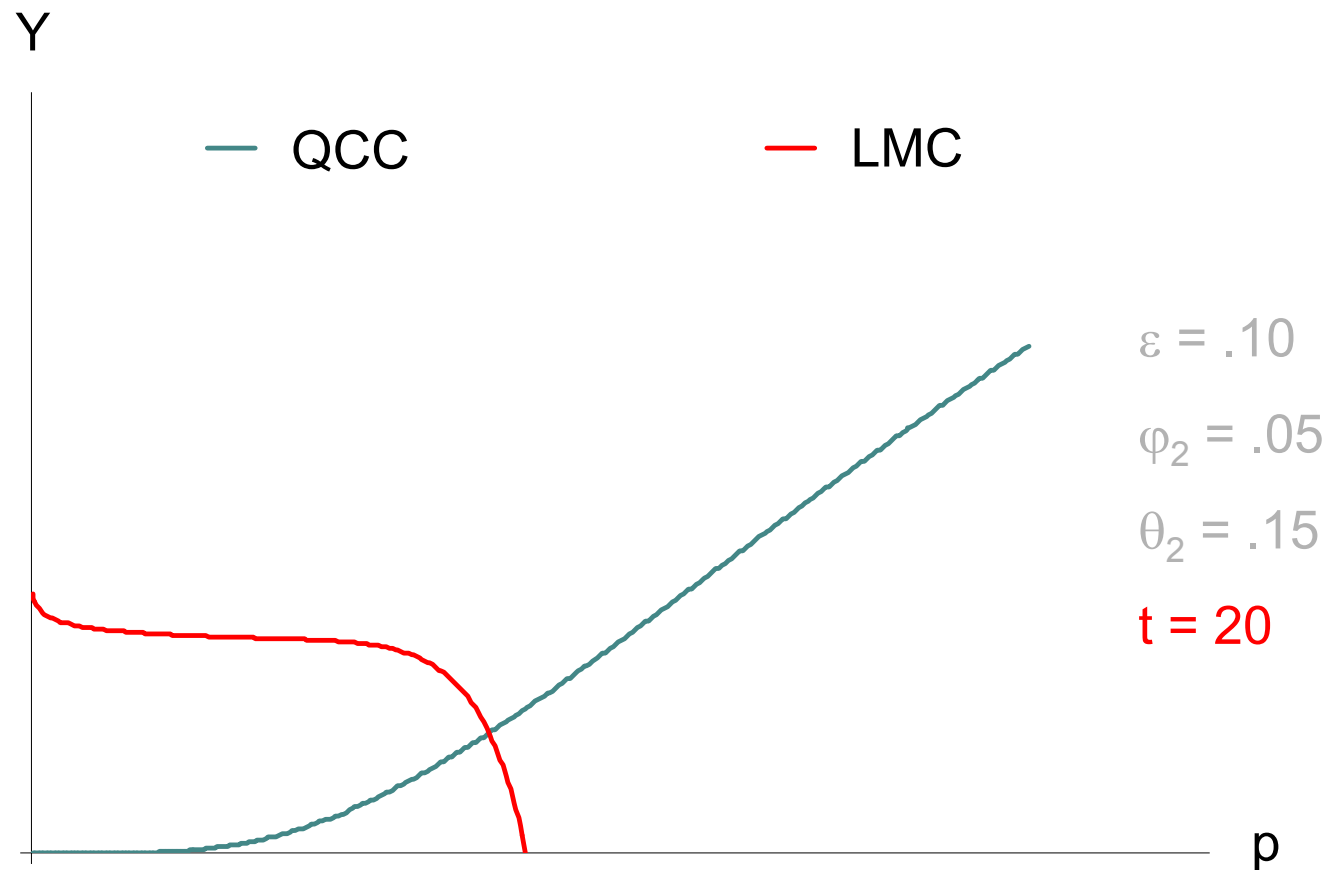
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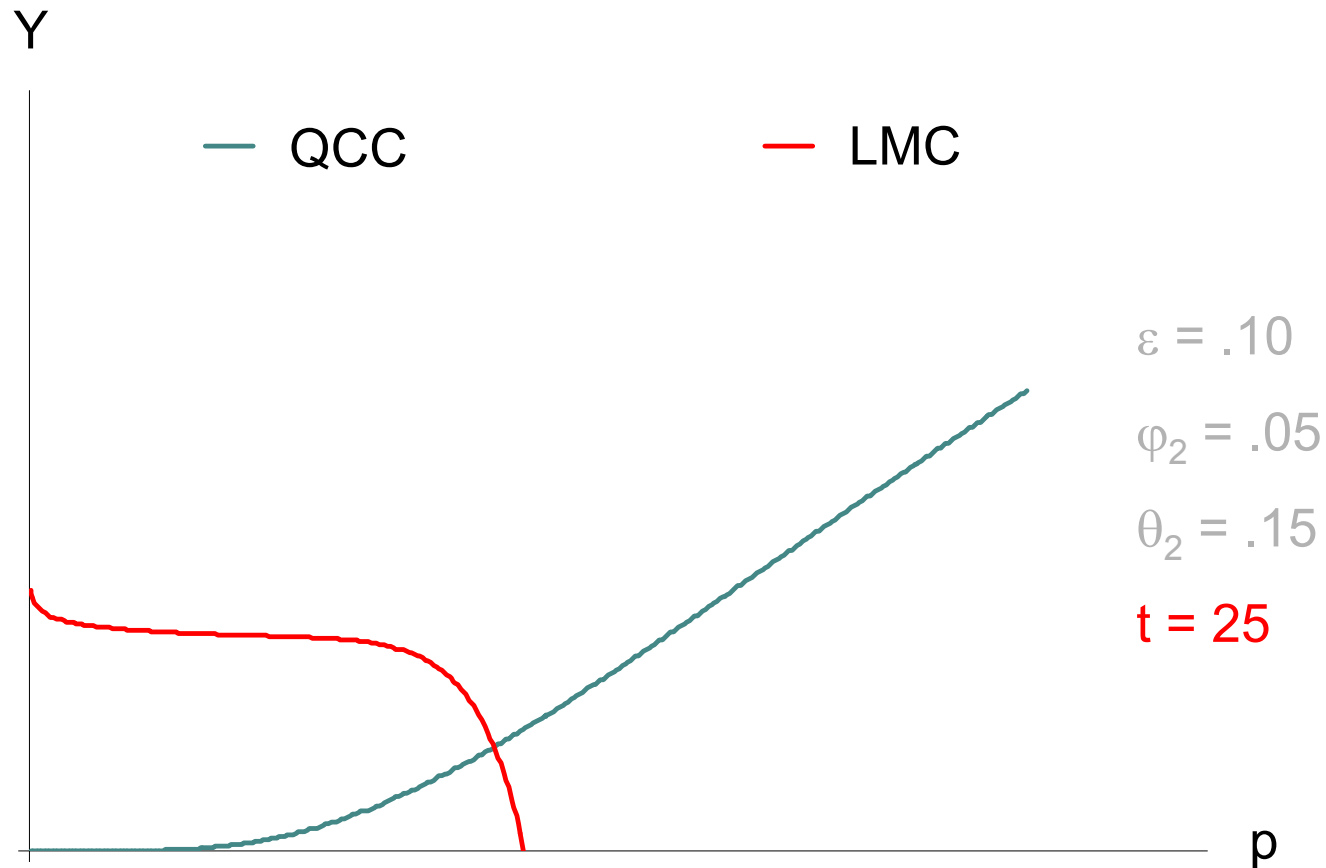
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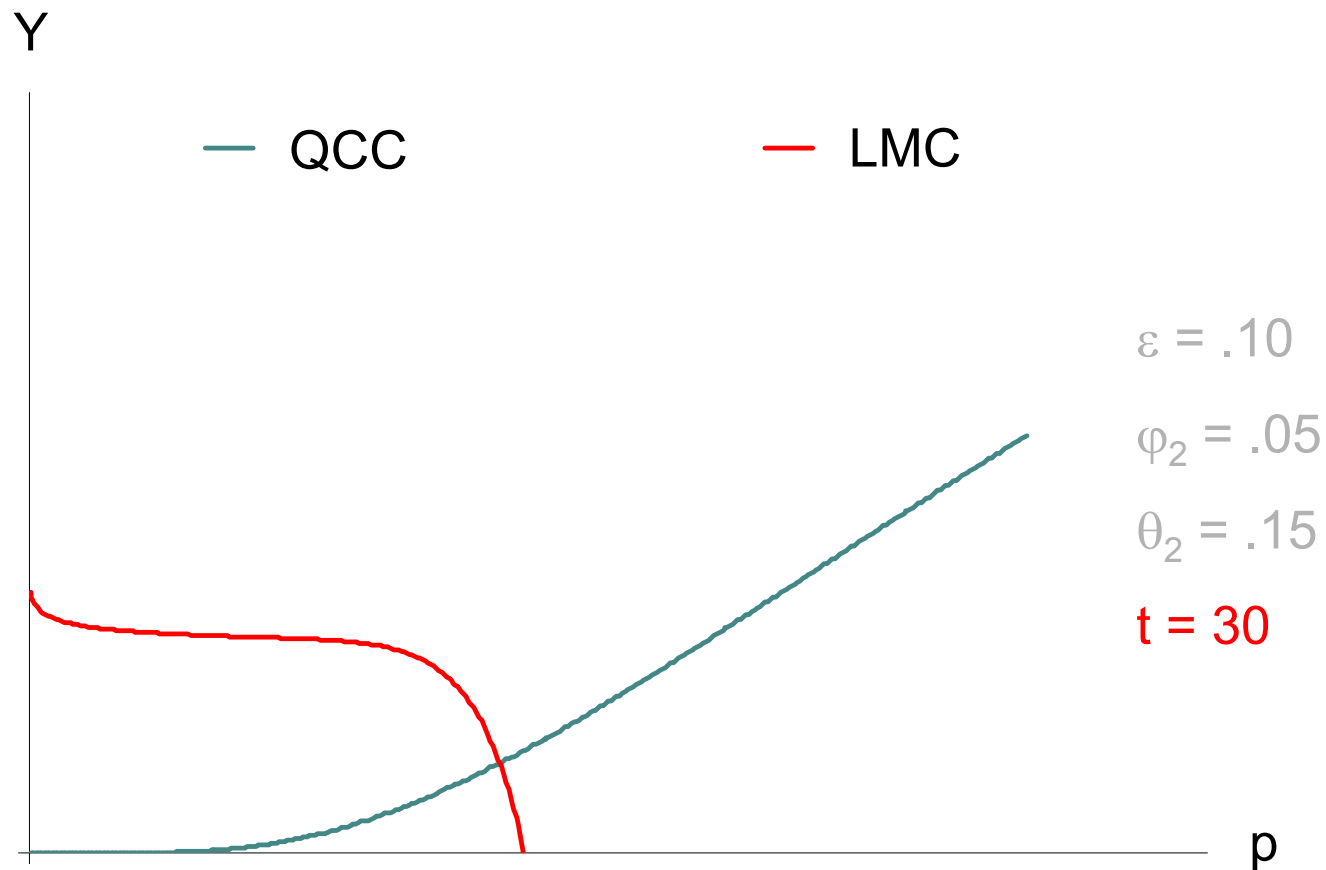
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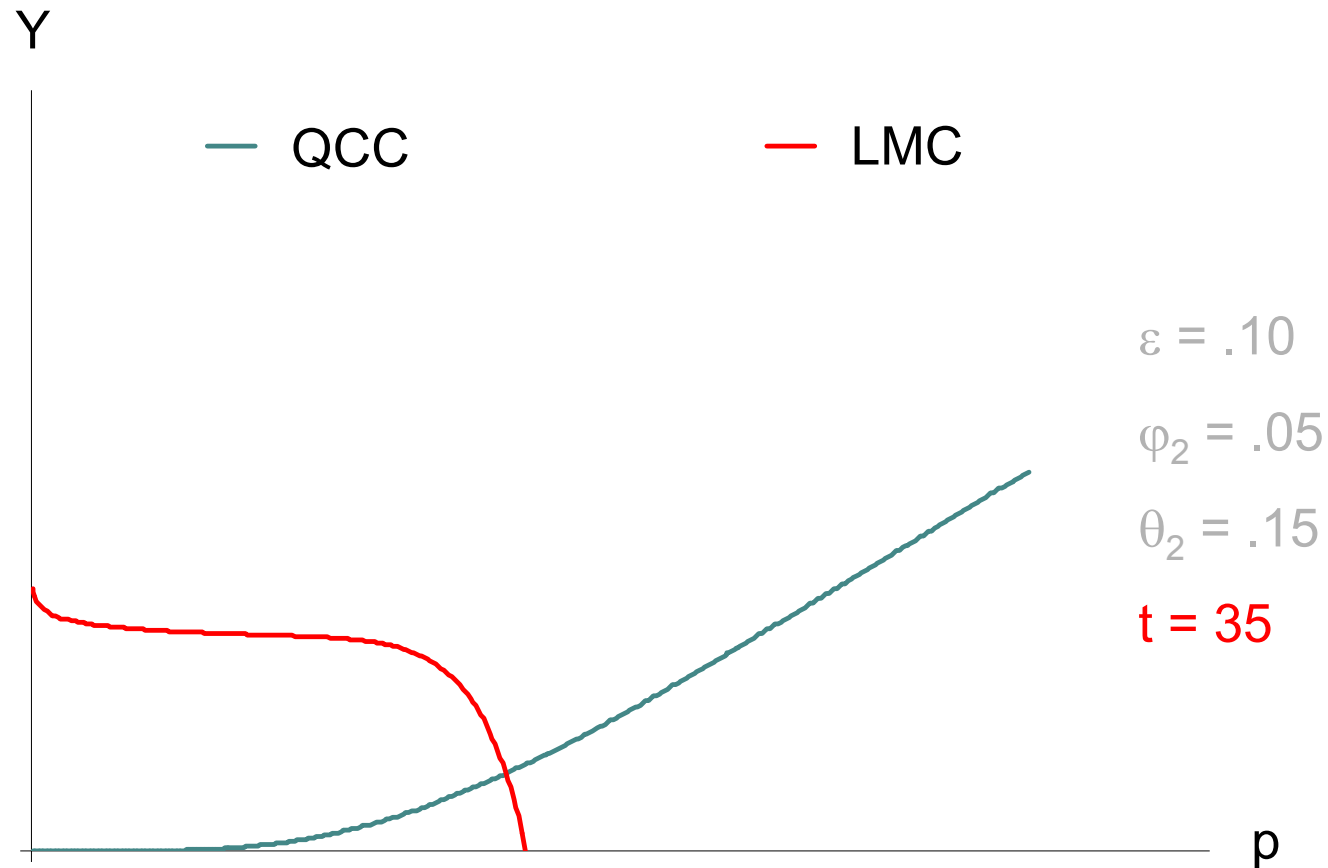
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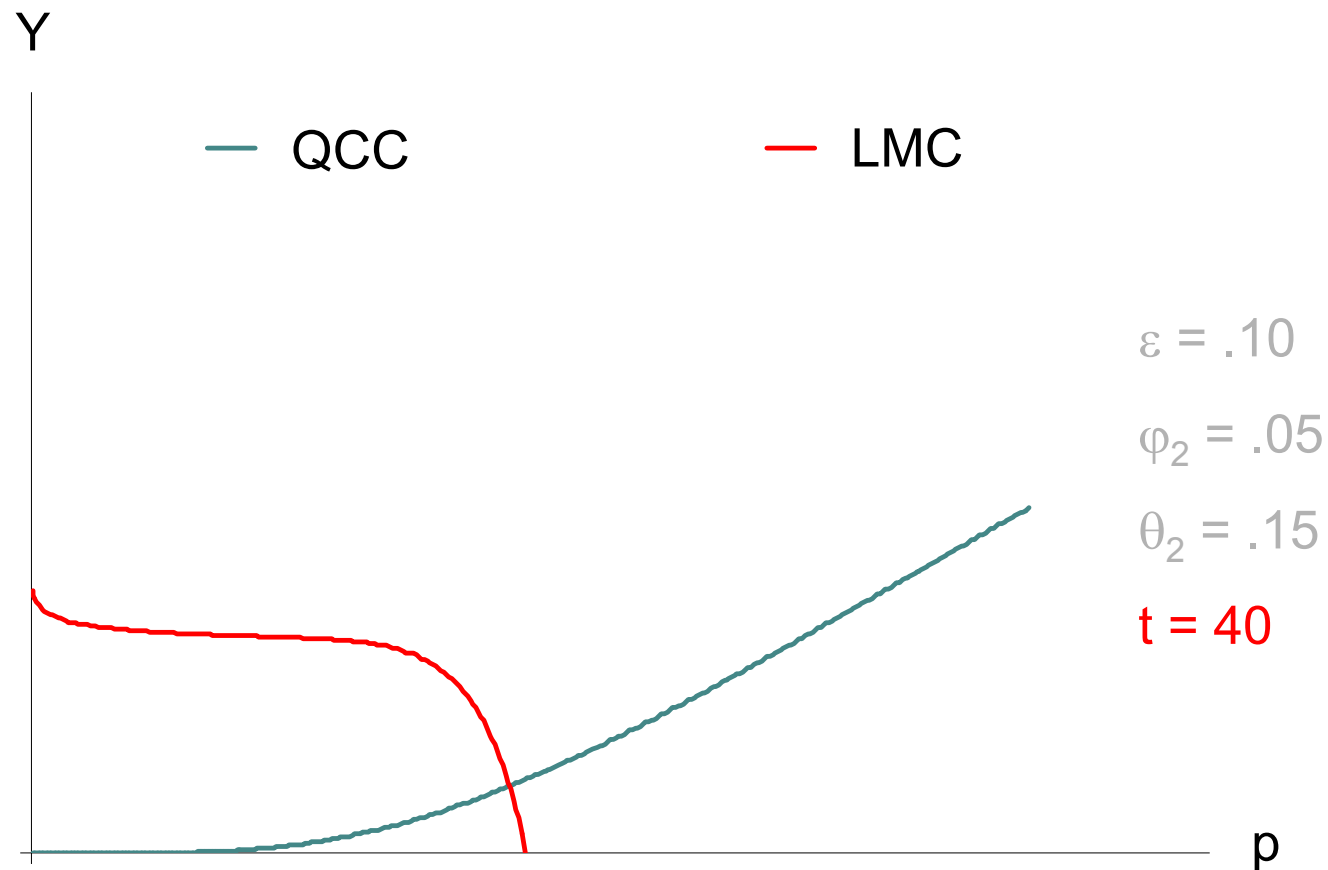
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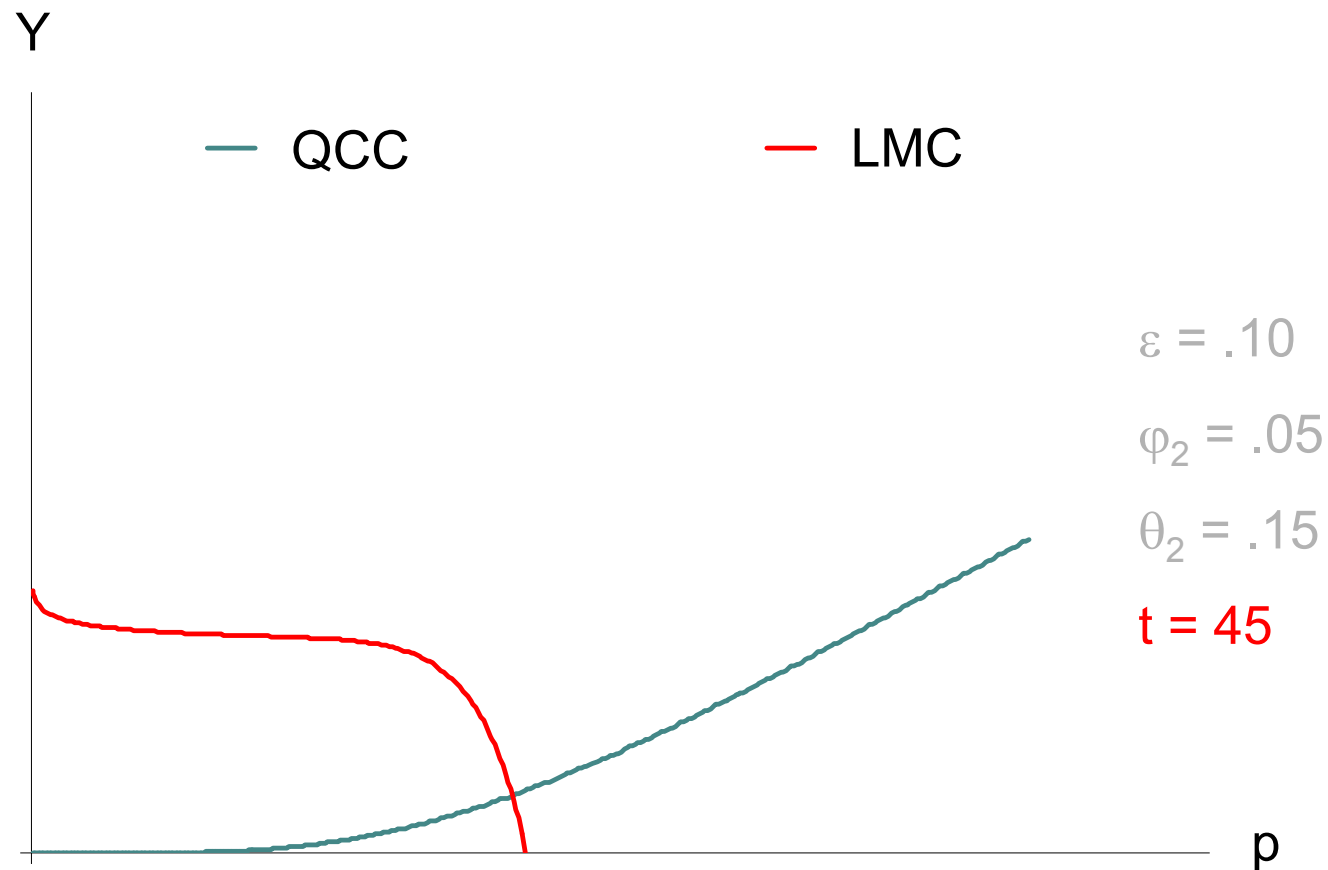
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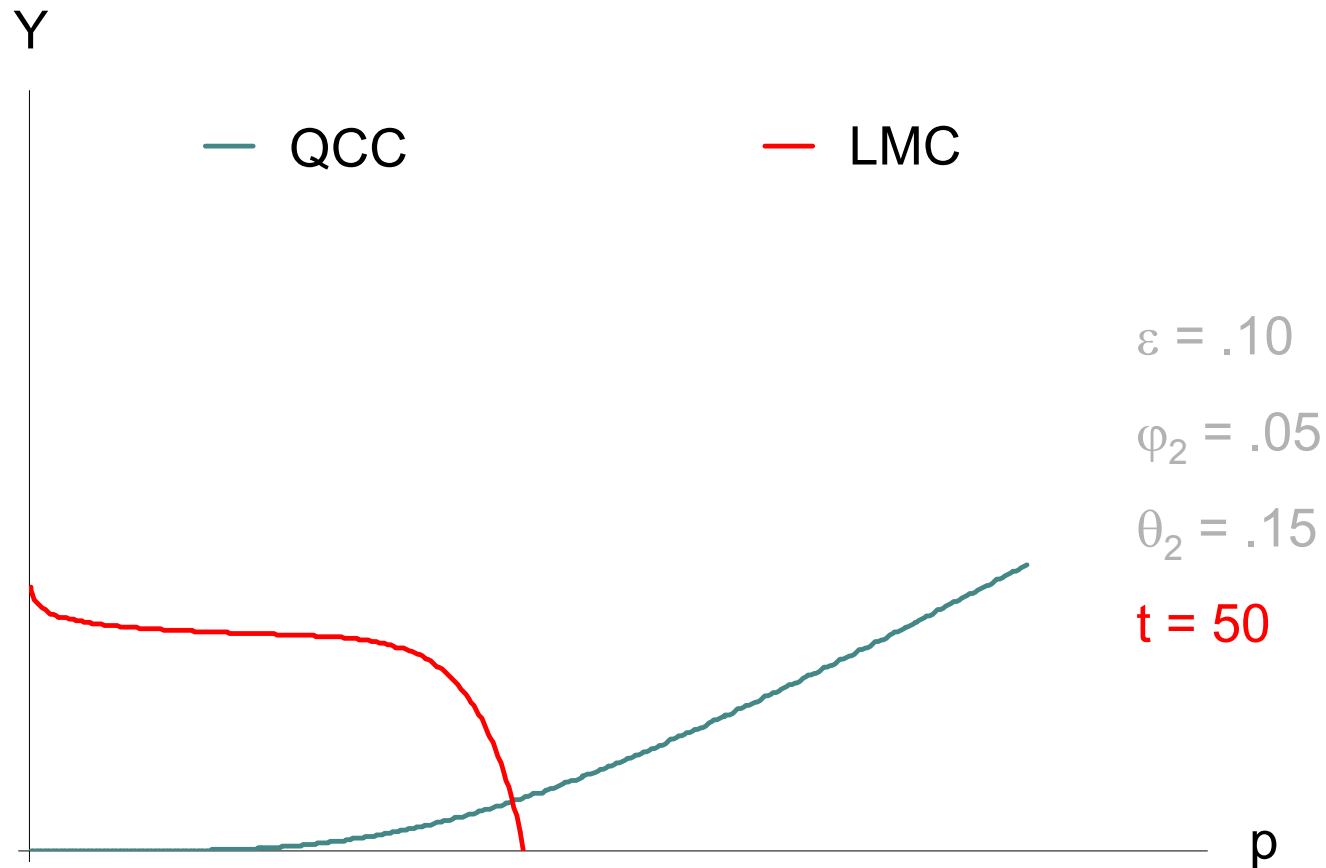
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Implementation of an excise tax t



Impact on the Labour Market Constraint

At a constant output level
(no DR impacts):

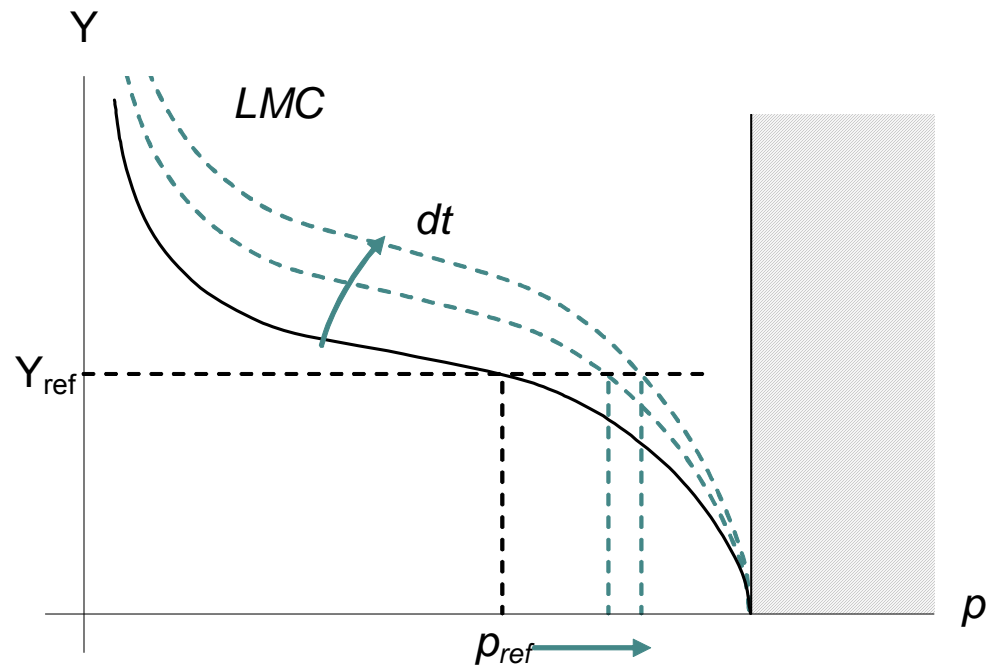
Tax revenues = transfer
from producer to consumer

↓
Higher income i.e. savings

↓
Technical Progress i.e.
decreased labour intensity

↓
Higher unemployment

↓
Weakened bargaining
power, lower real wages =
higher commodity price p



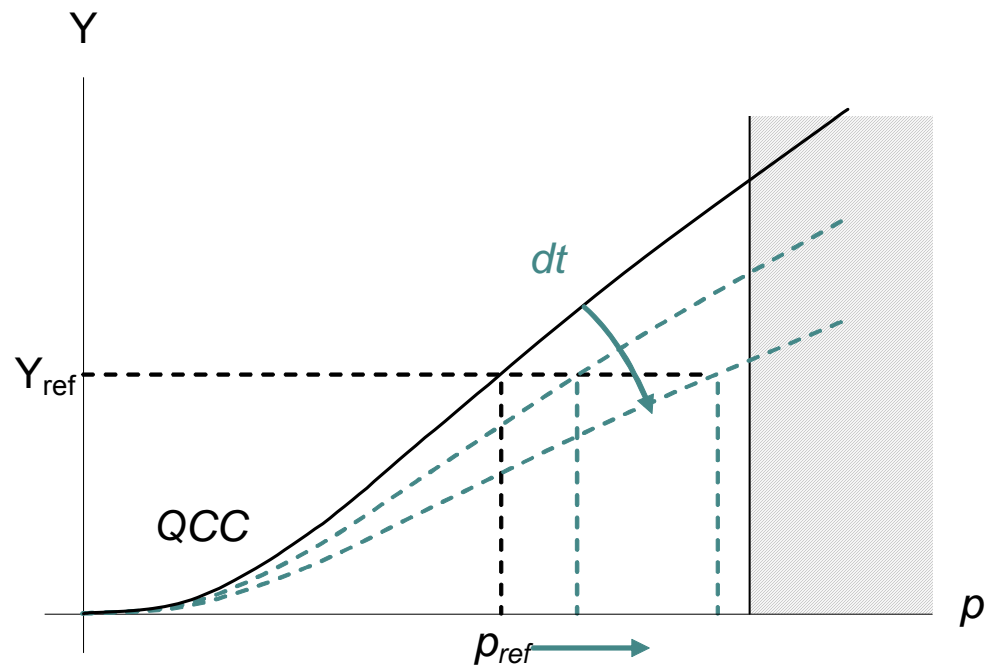
Impact on the Quantity/Cost Constraint

At a constant output level
(no DR impacts):

Same as above: lump-sum
recycling implies higher
savings \rightarrow TP \rightarrow
decreased factor
consumptions,

But: the direct impact of
the tax on the production
cost is stronger,

Commodity price p rises



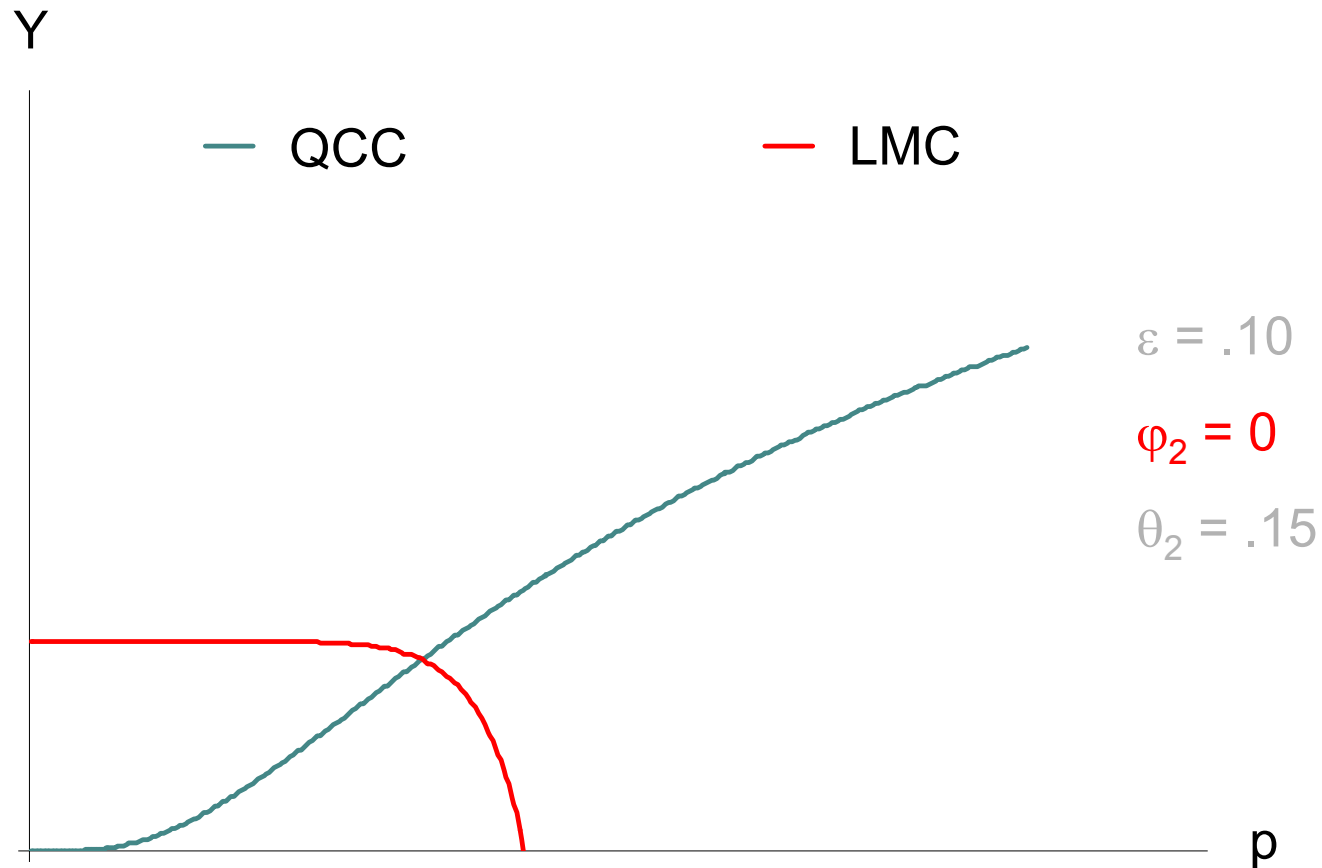
Elasticity of DR $\theta_2 <$ elasticity of TP φ_2

Technical progress is strong enough to overcome the negative effect of decreasing returns:

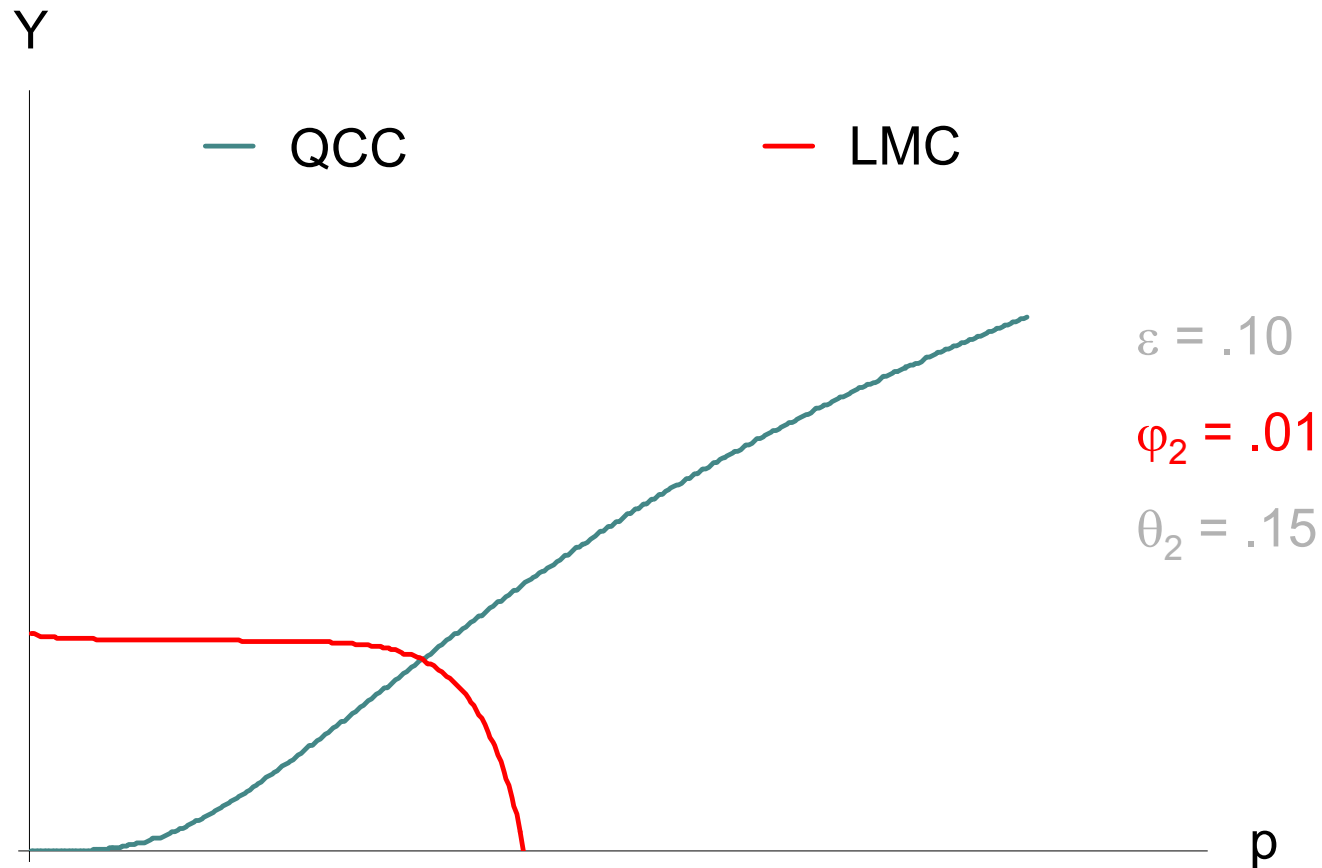
- Factor intensities **decrease** as output increases,
- QCC is a **decreasing** function in (p, Y)

If $\theta_2 < \varphi_2$
neither the existence
nor the uniqueness
of an equilibrium is guaranteed

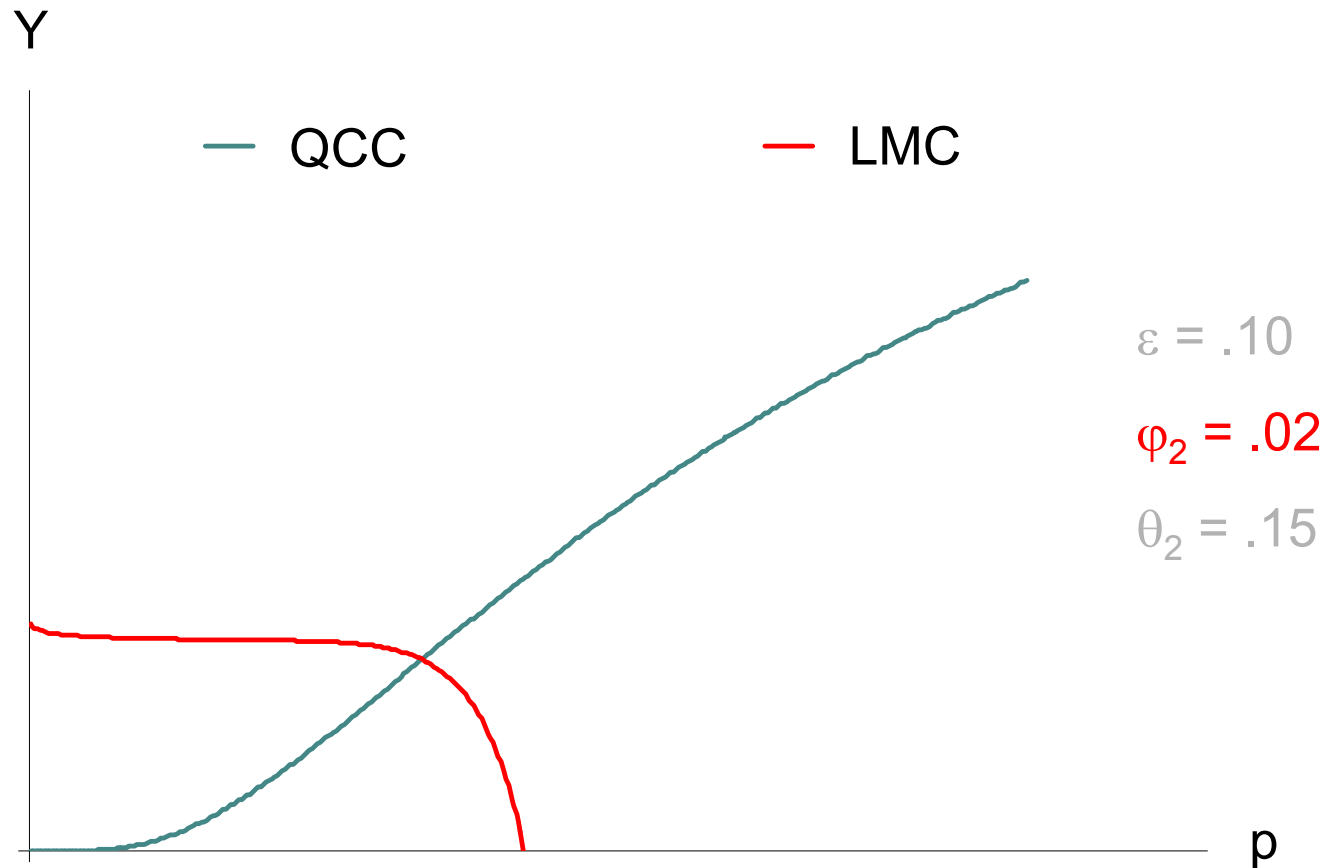
Sensitivity to TP elasticity φ_2



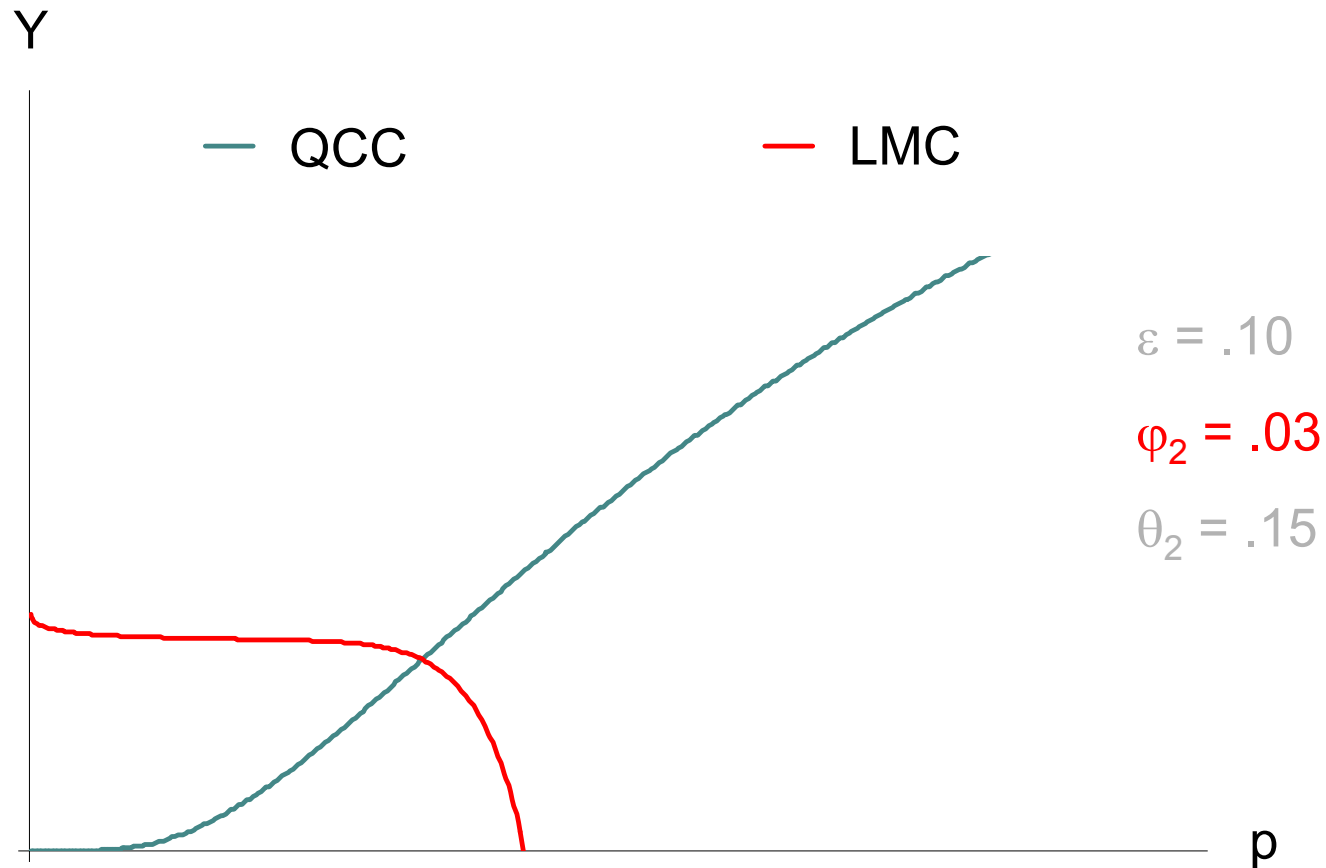
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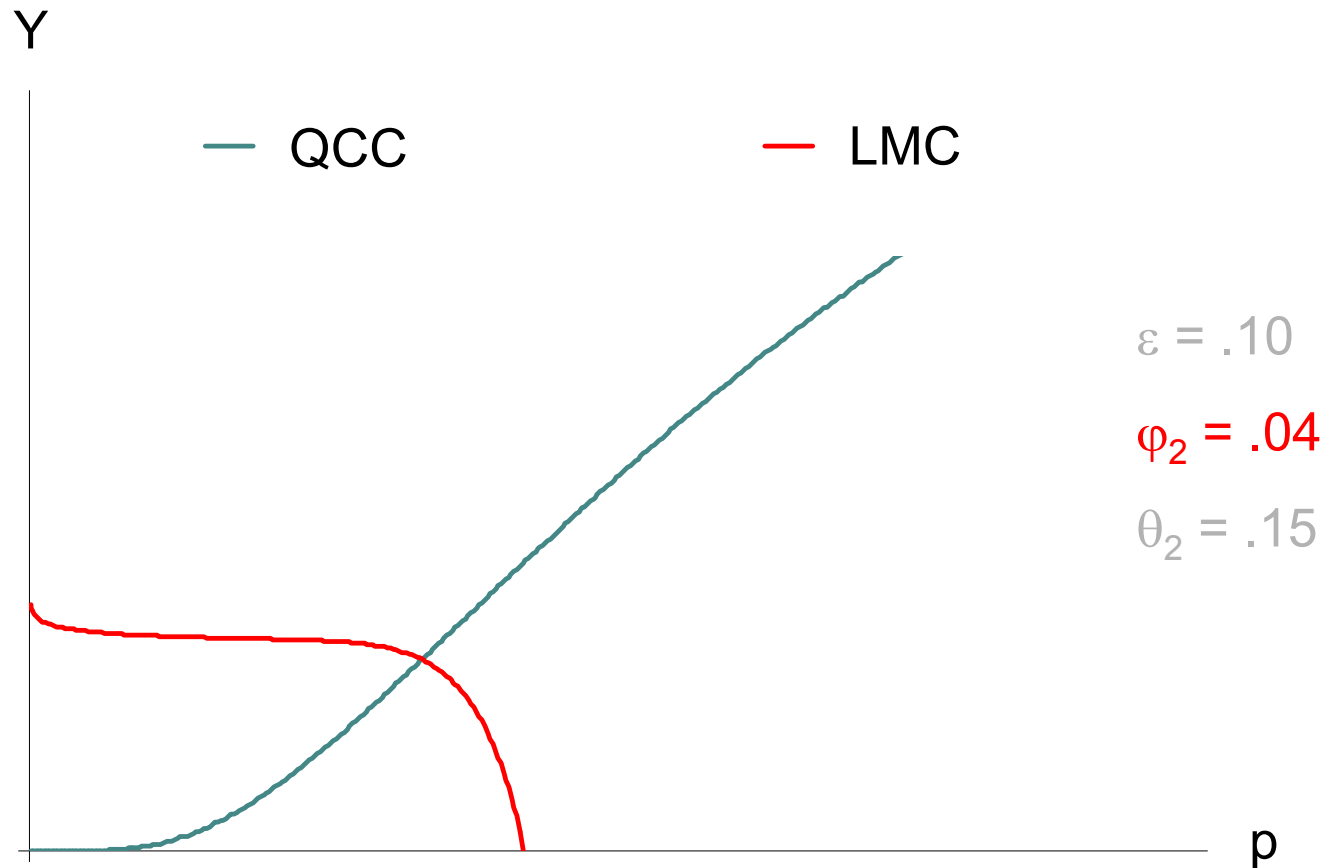
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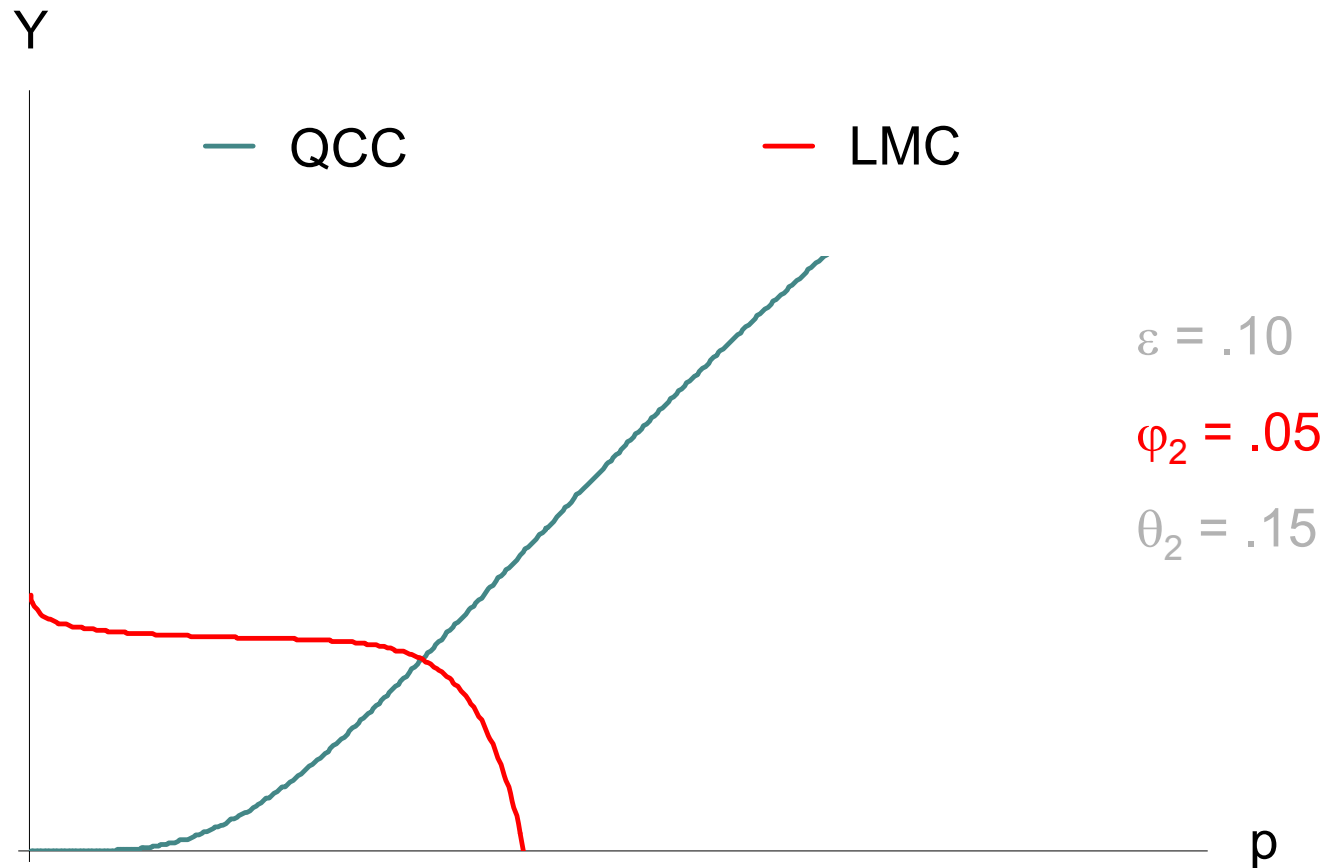
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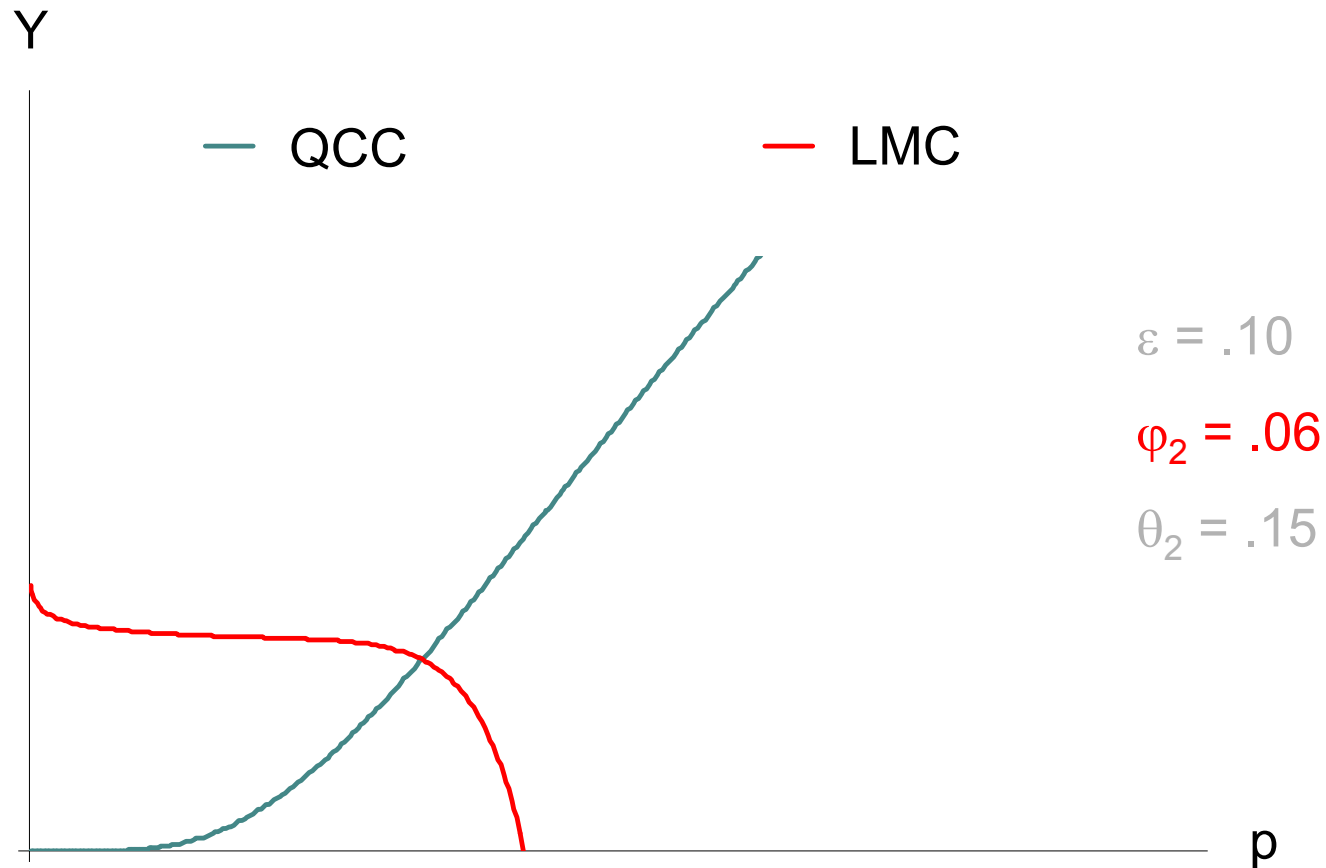
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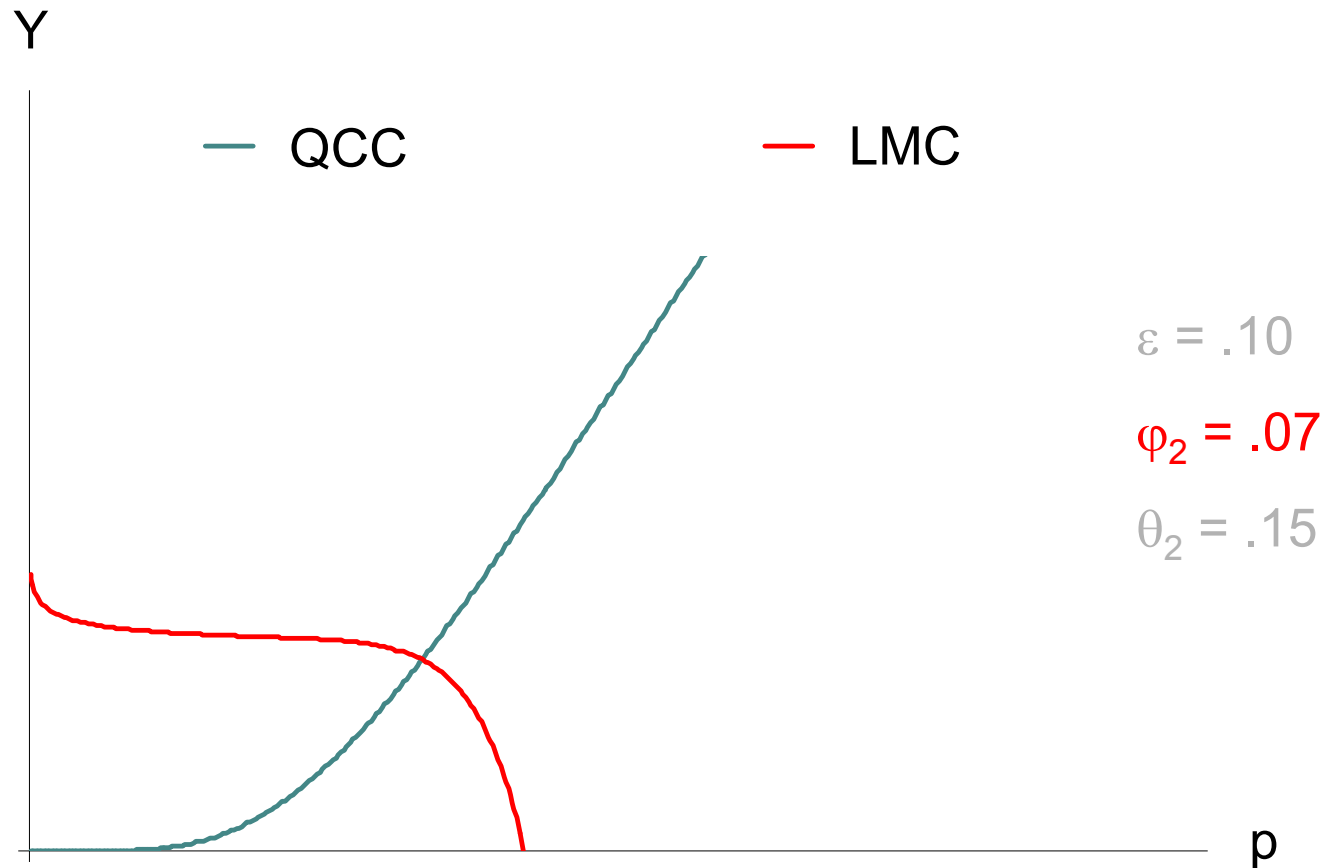
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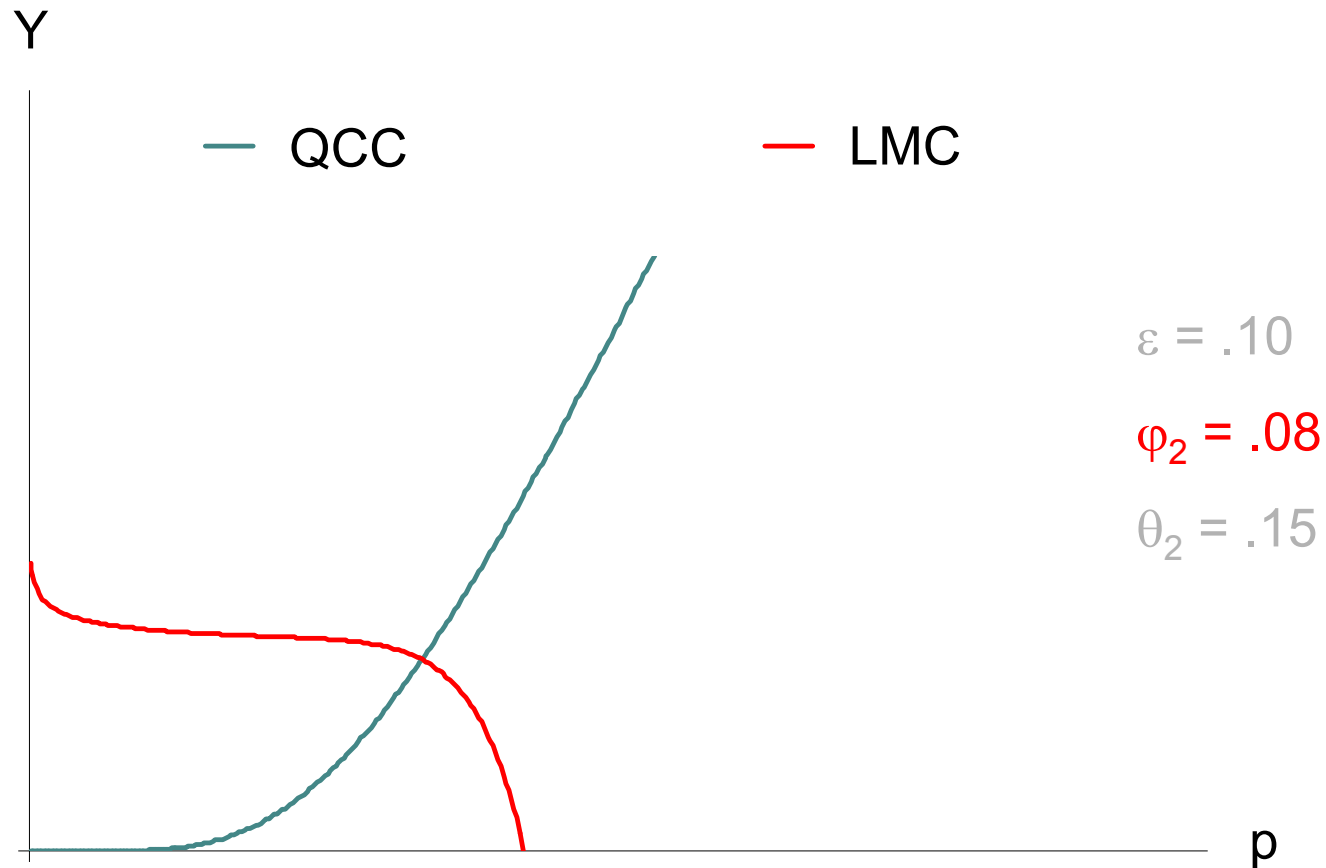
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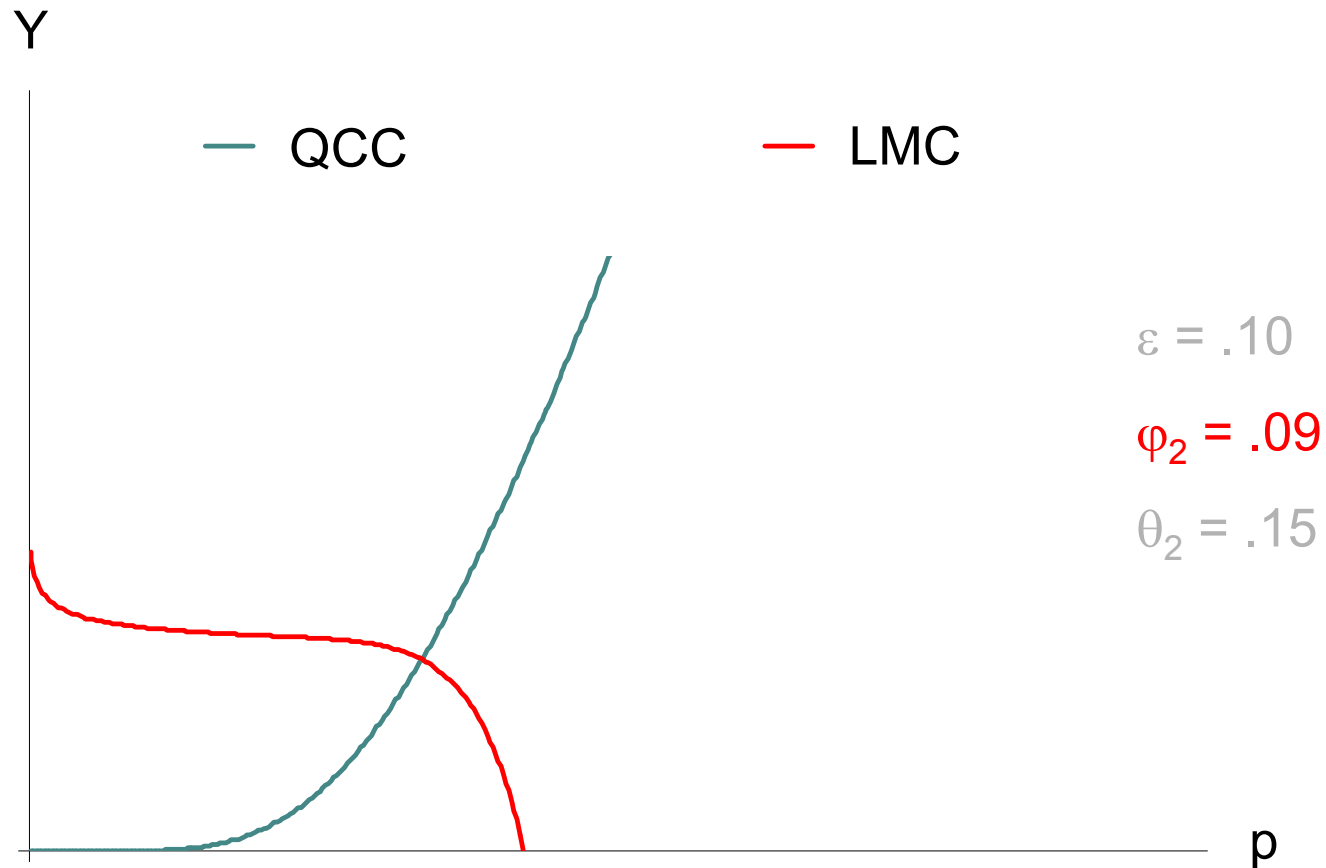
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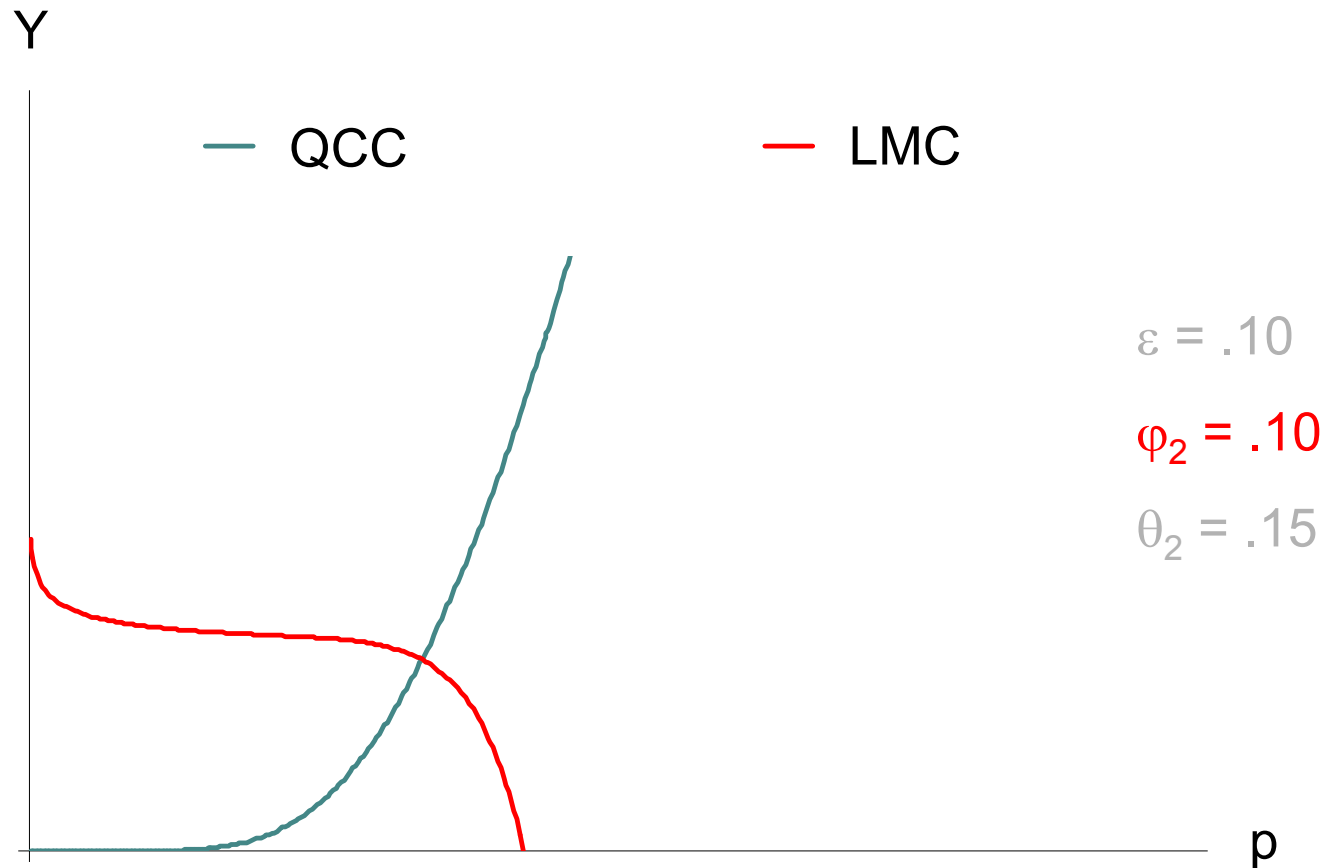
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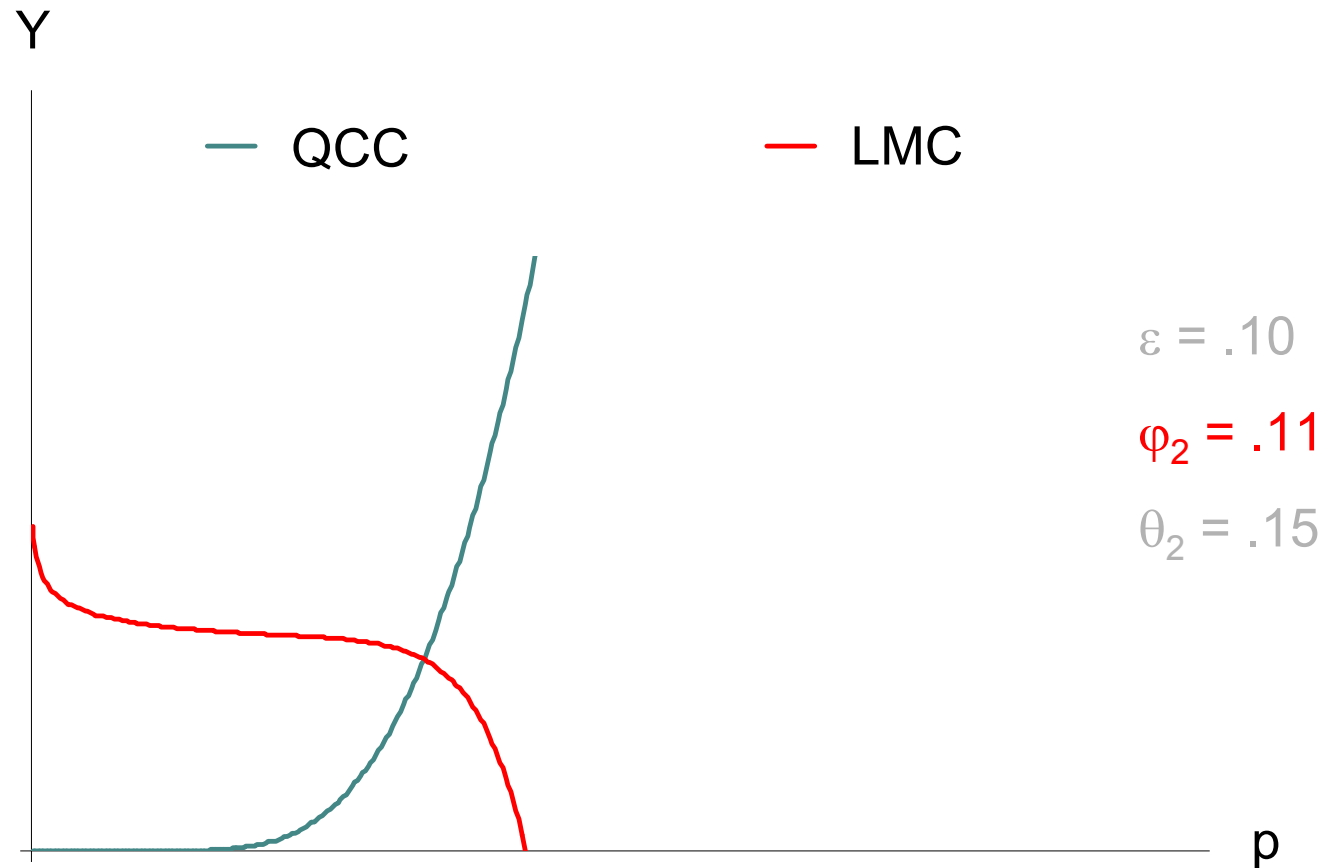
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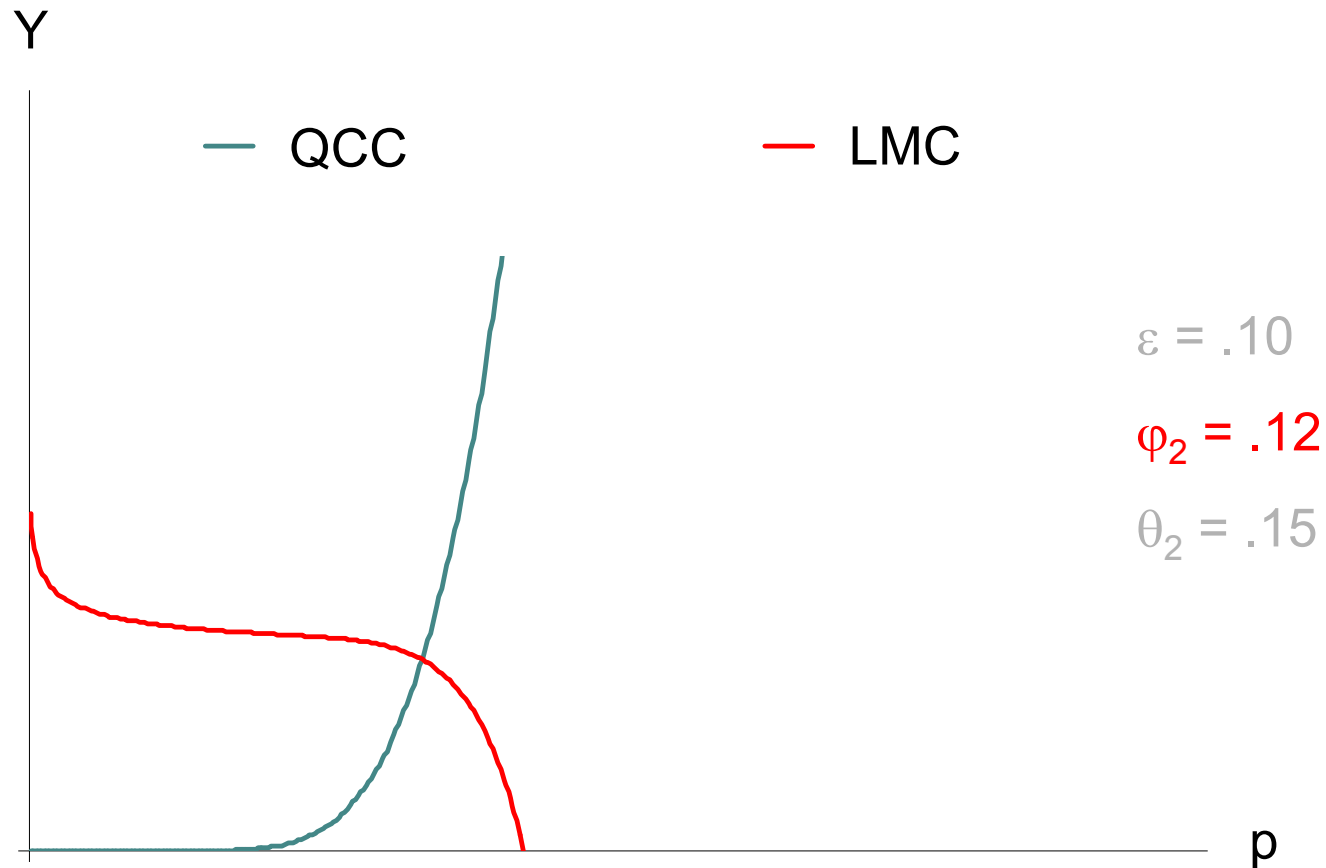
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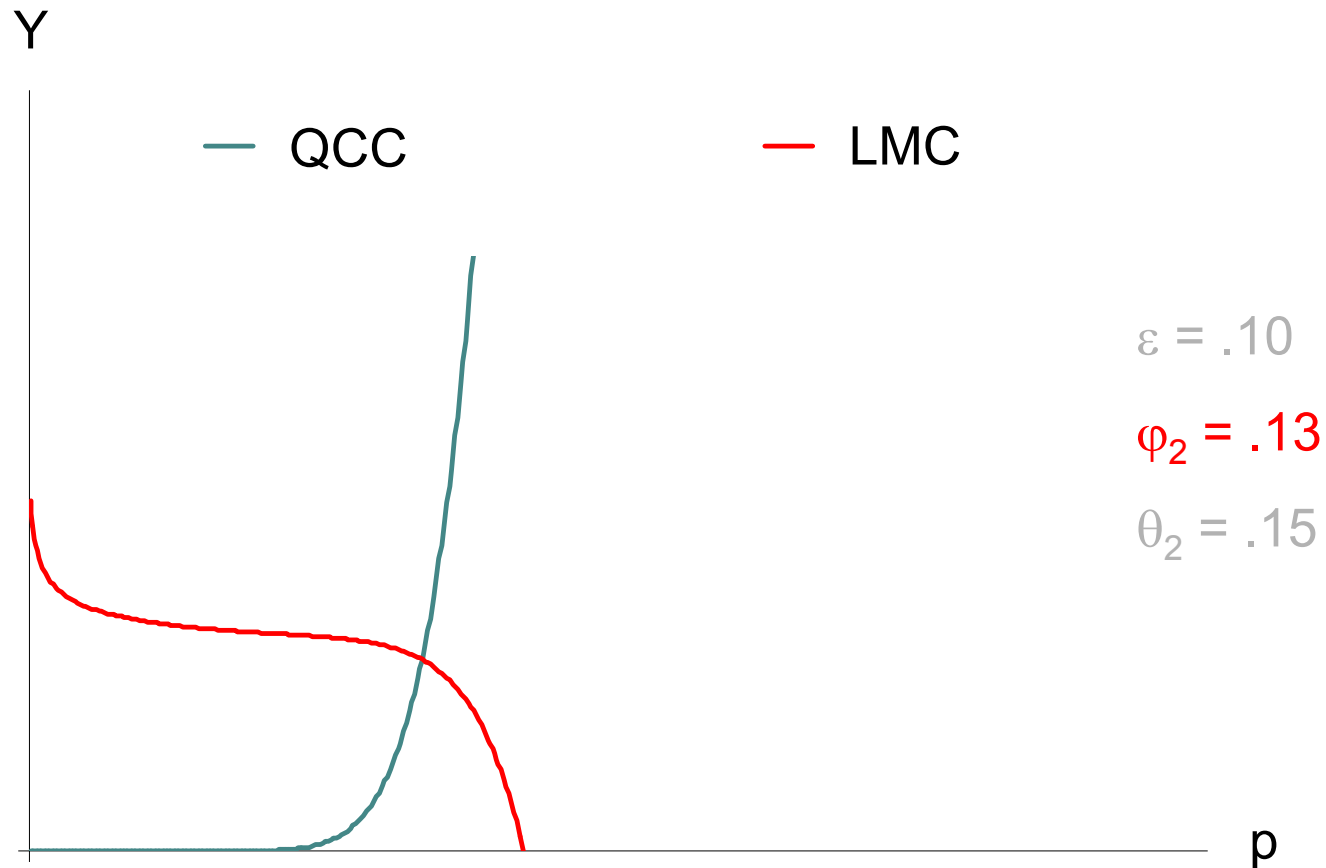
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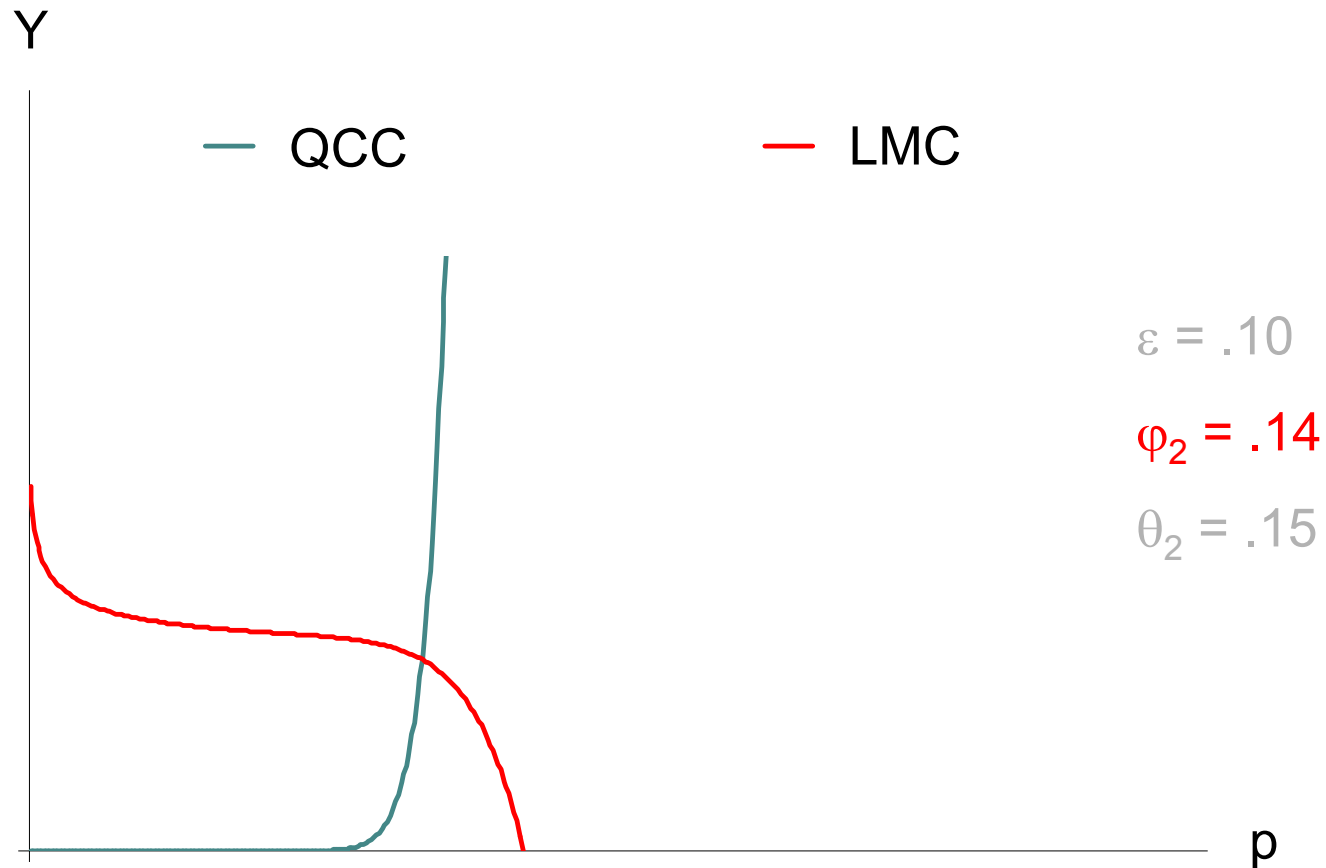
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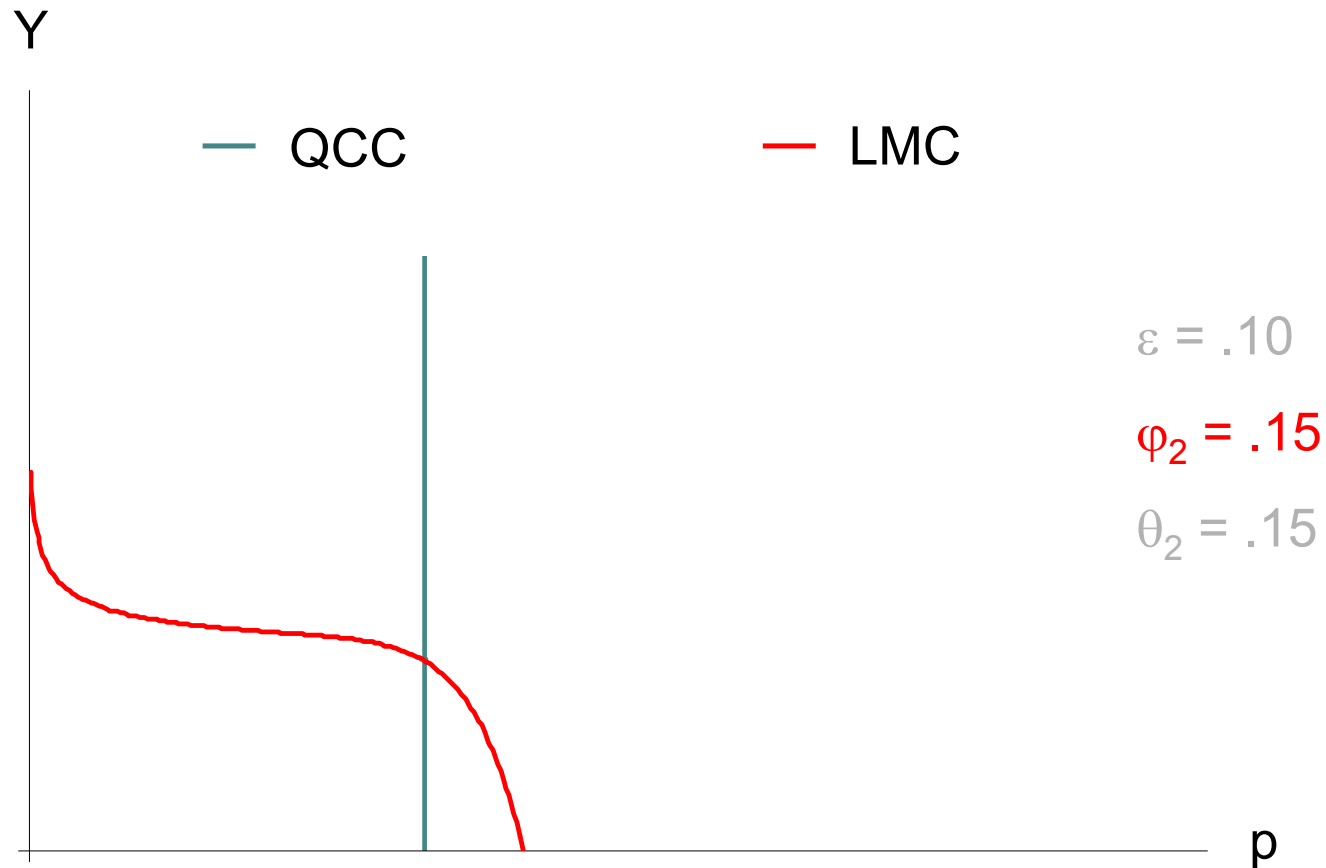
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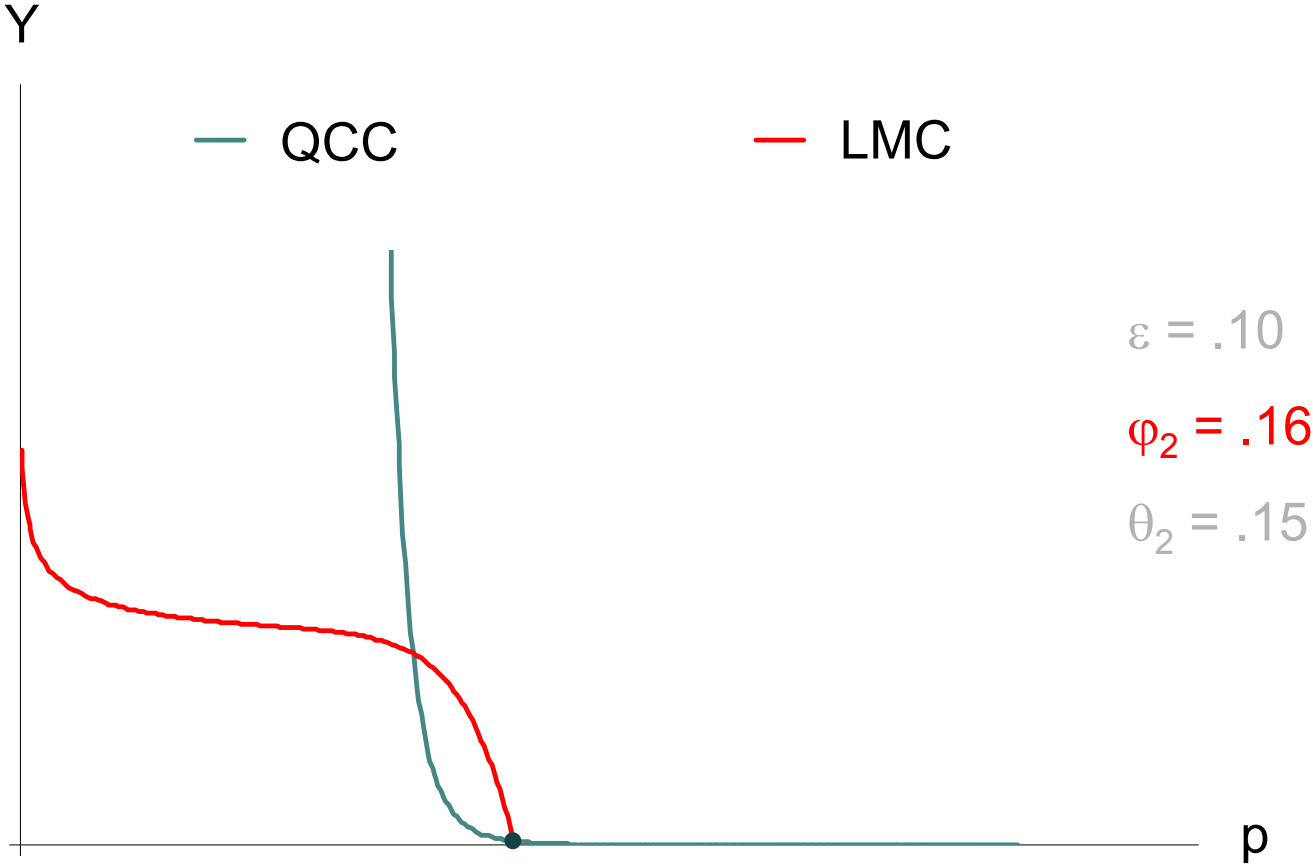
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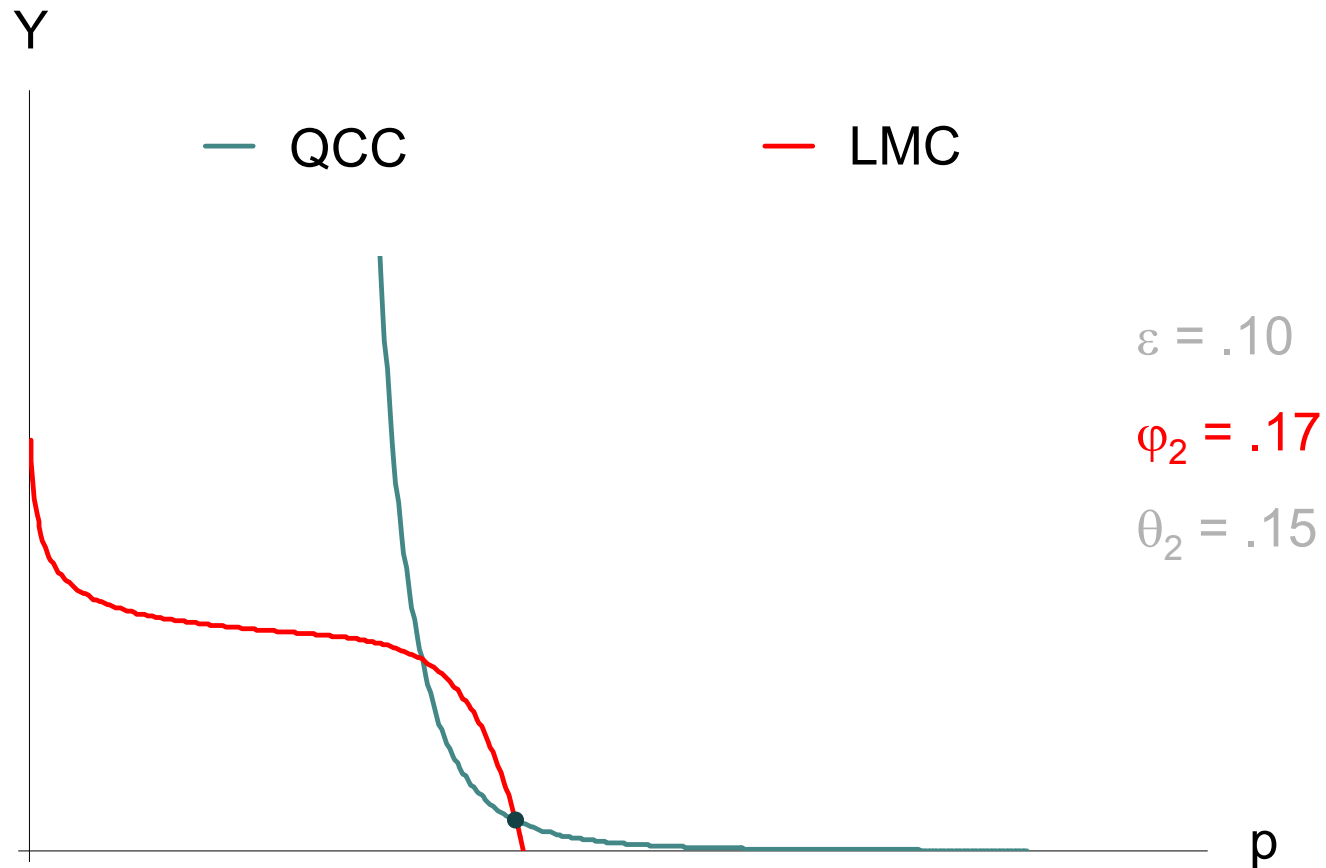
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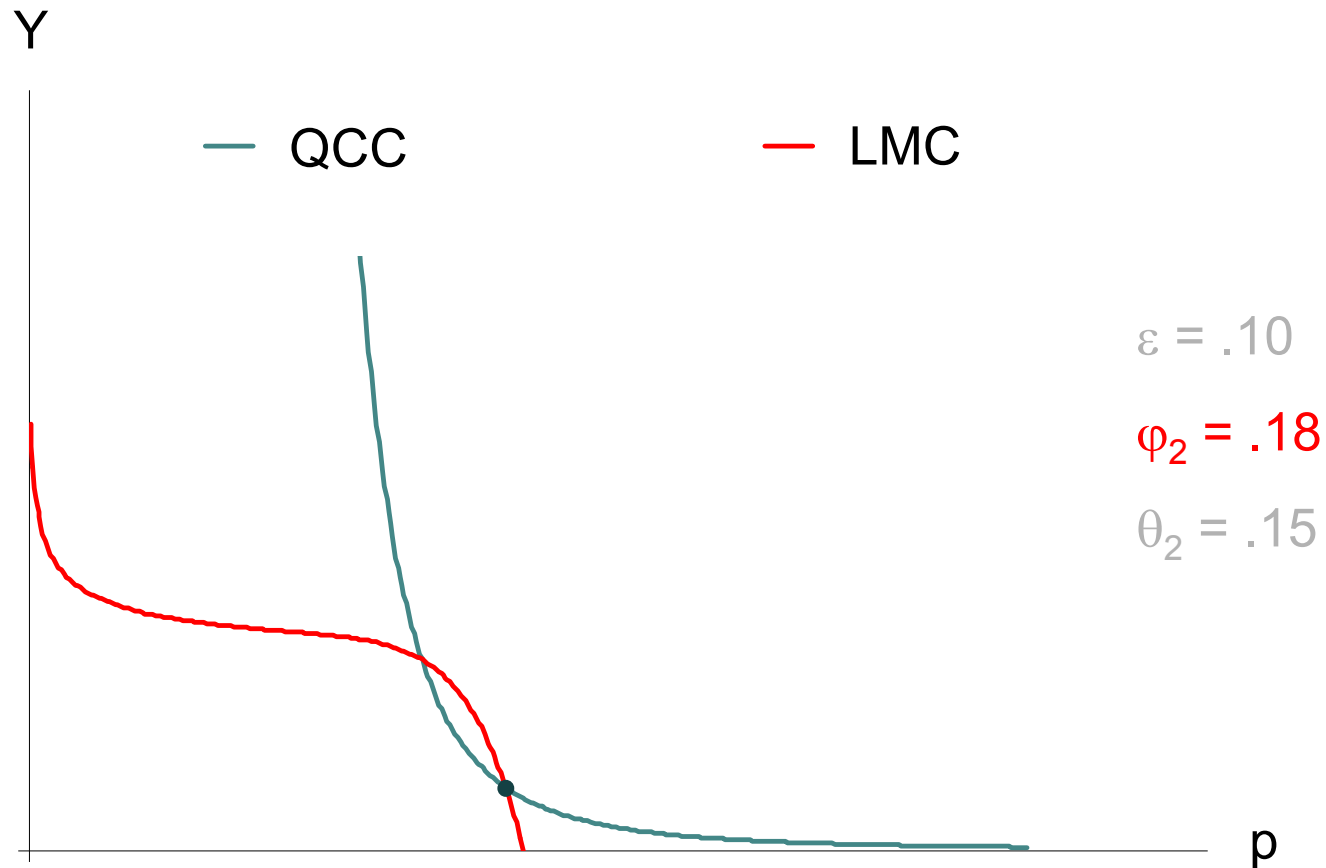
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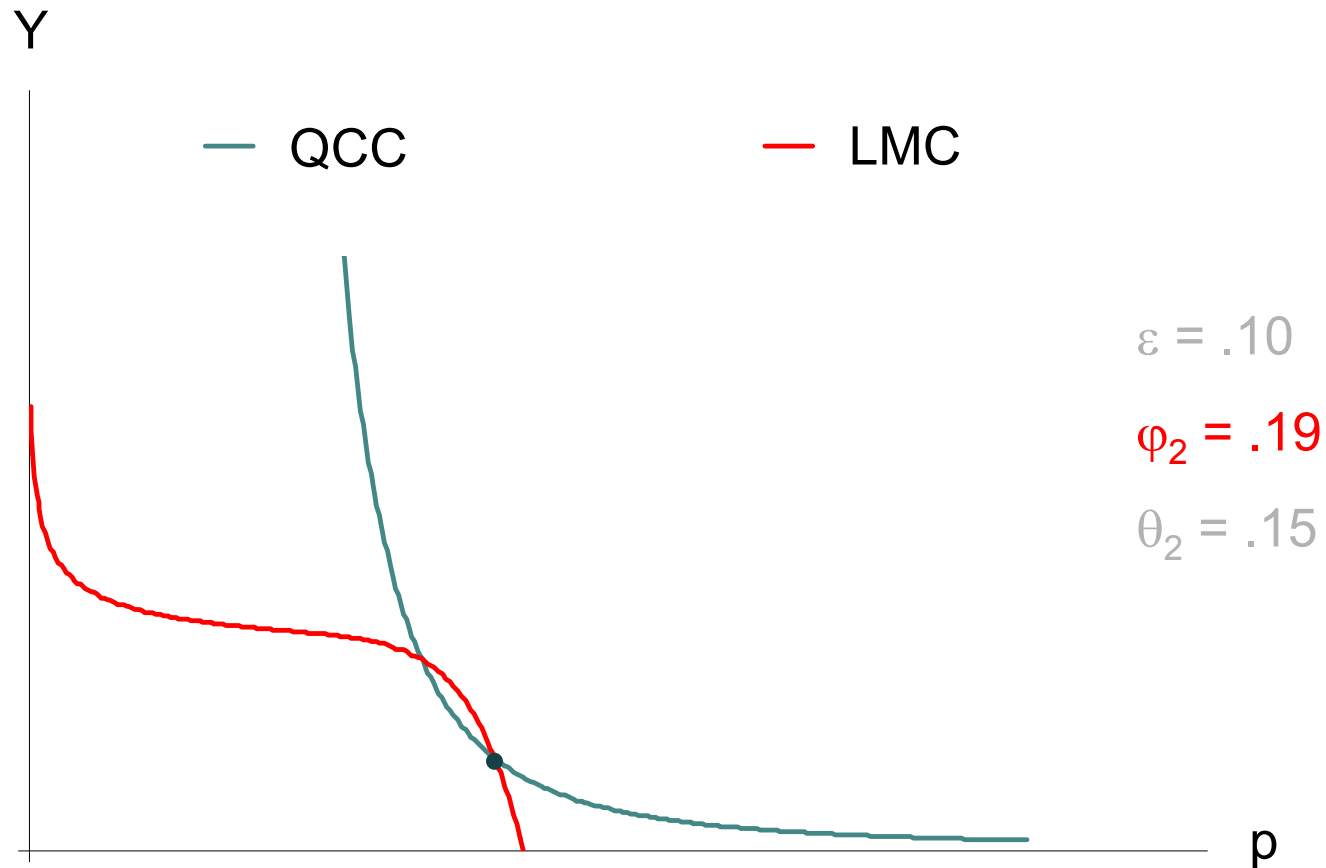
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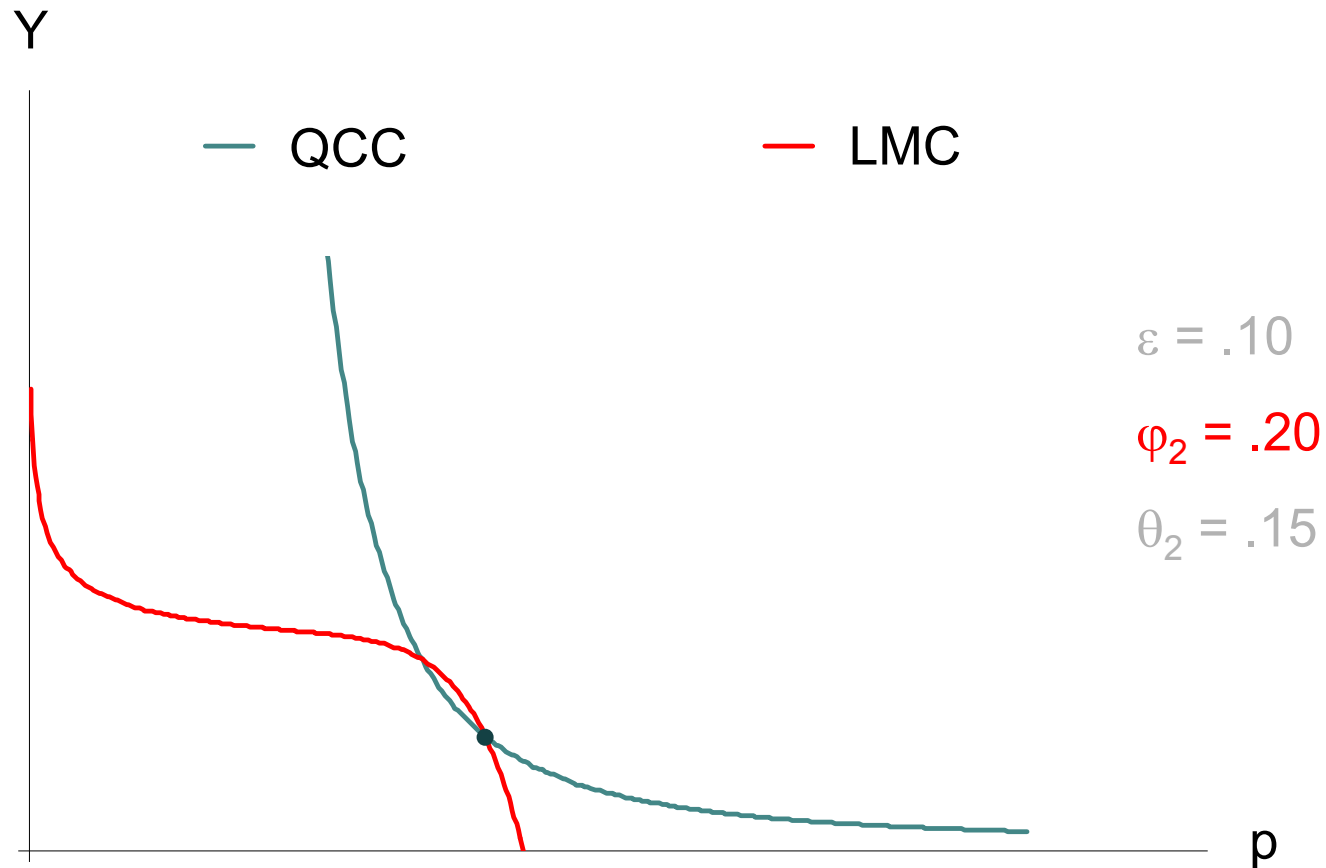
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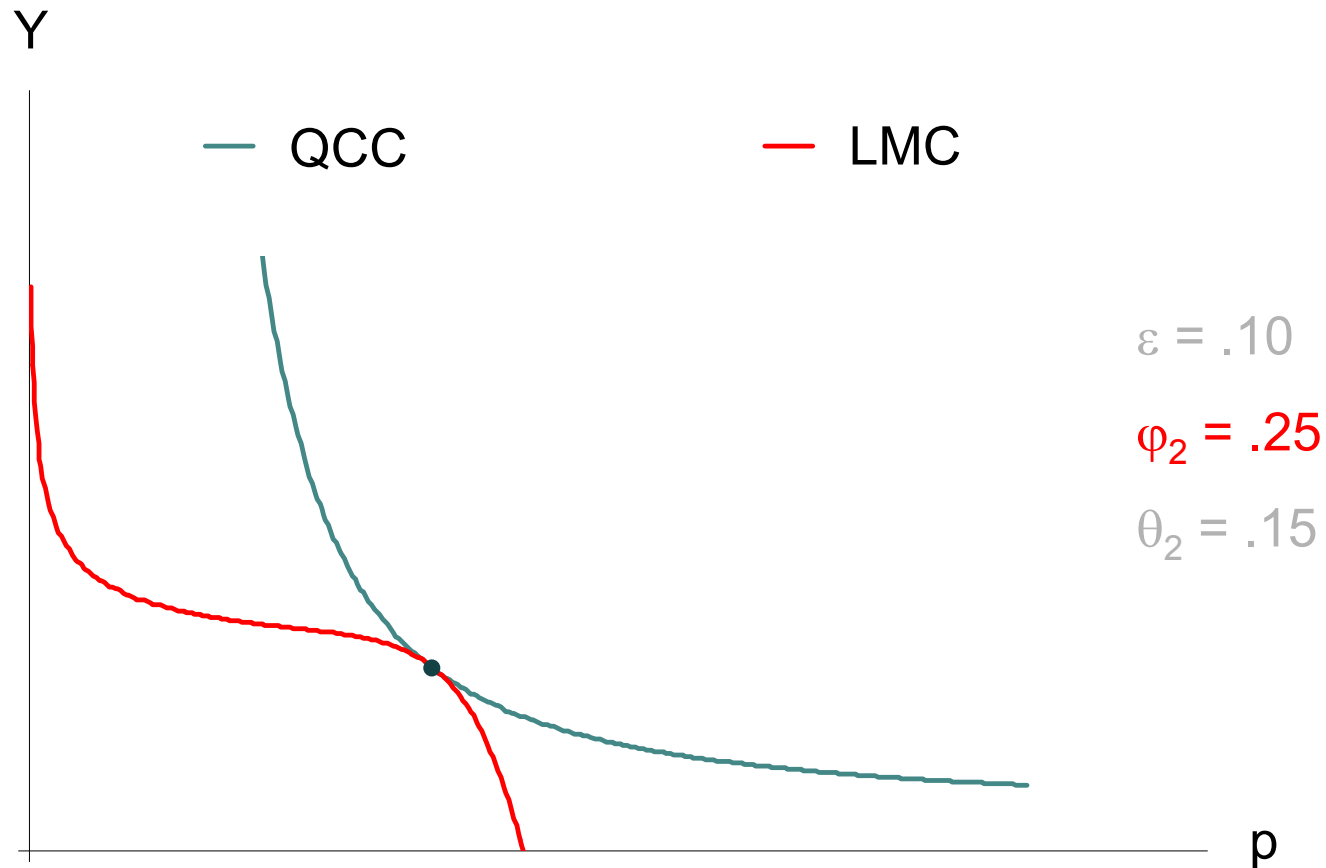
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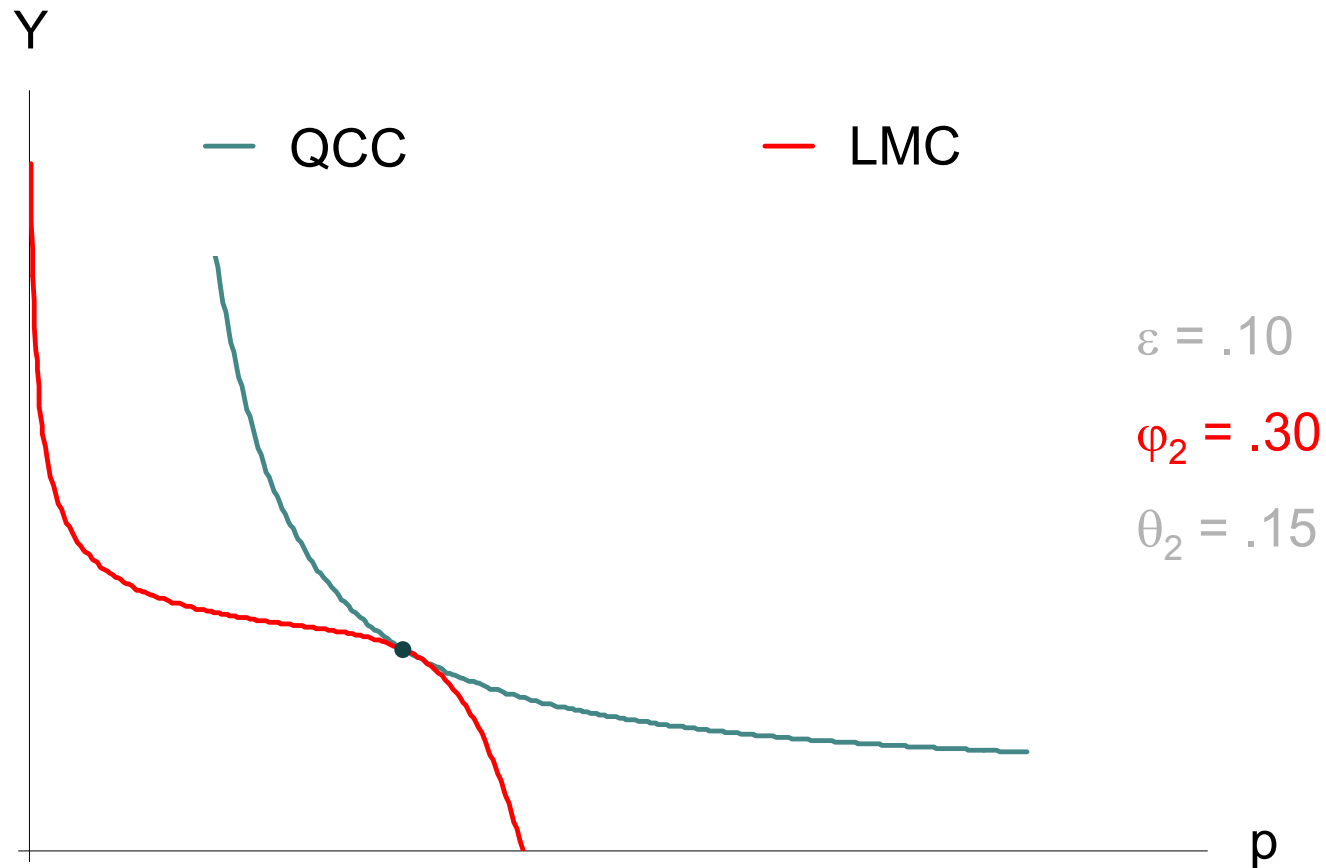
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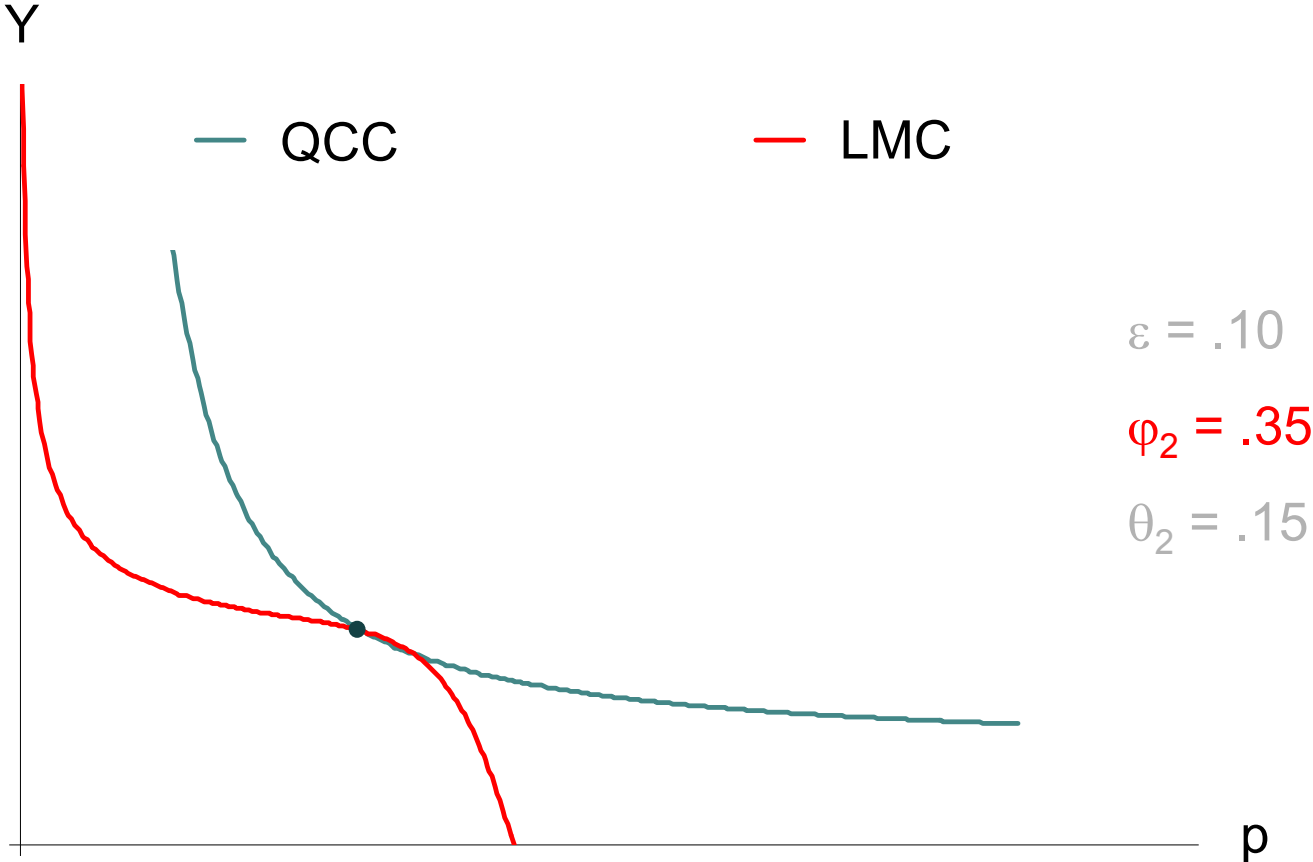
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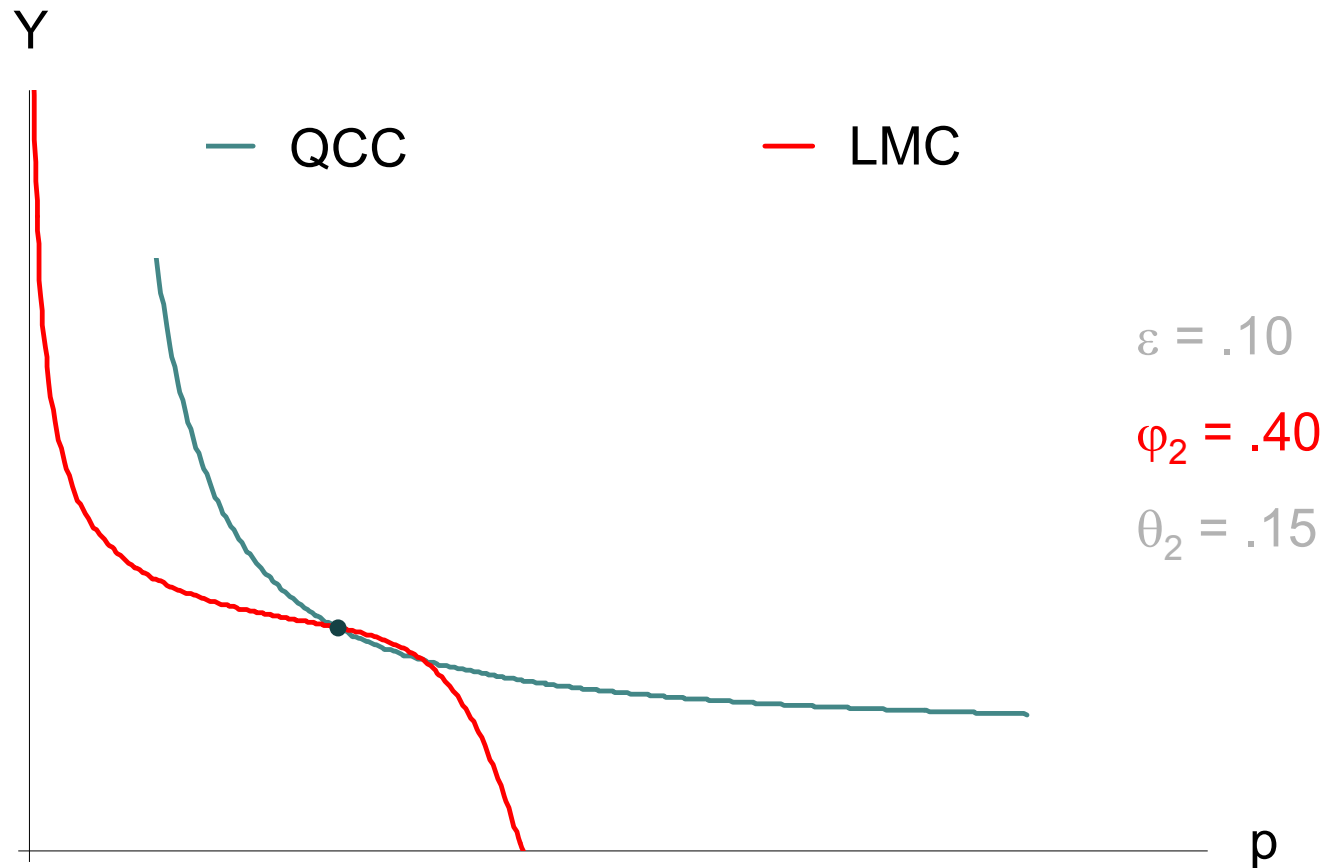
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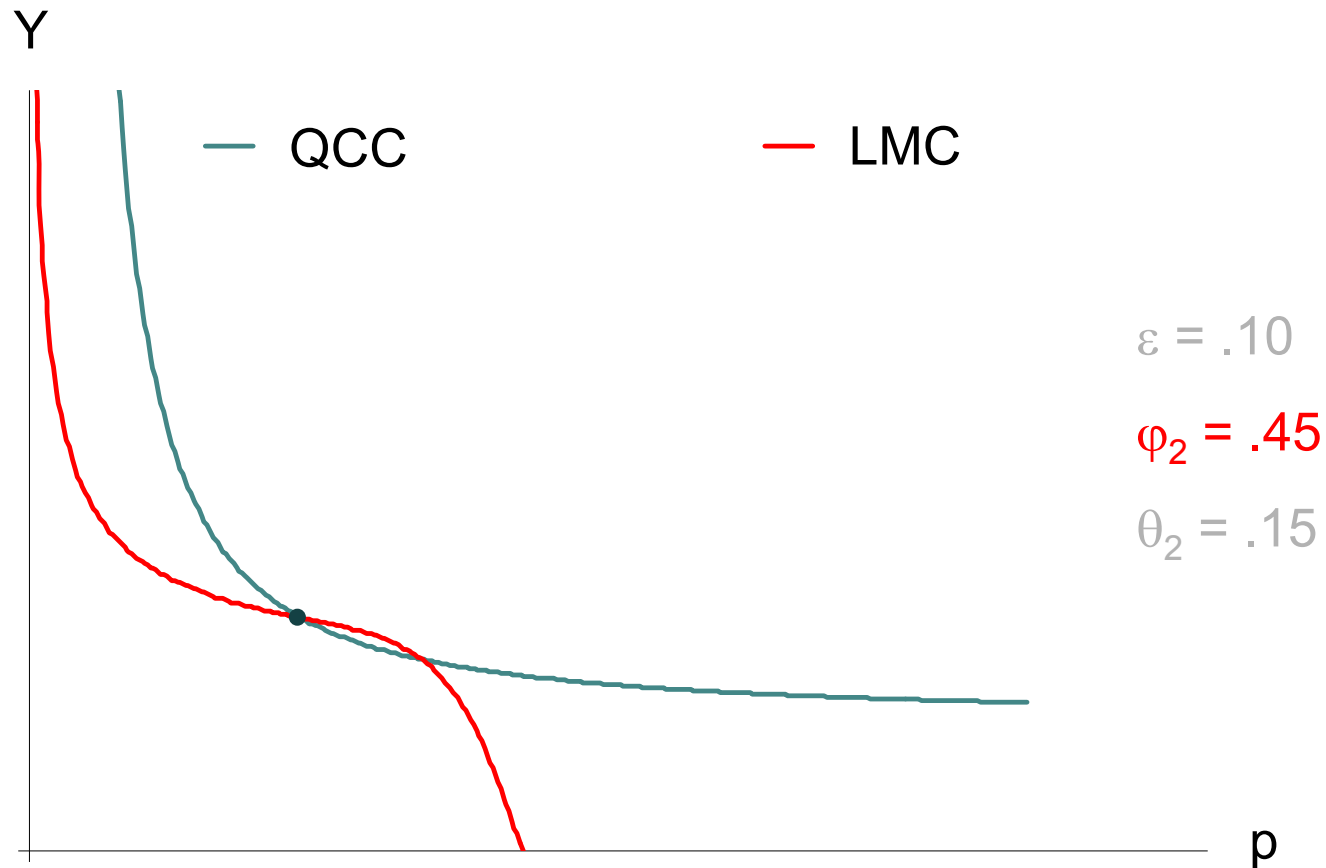
Sensitivity to TP elasticity φ_2



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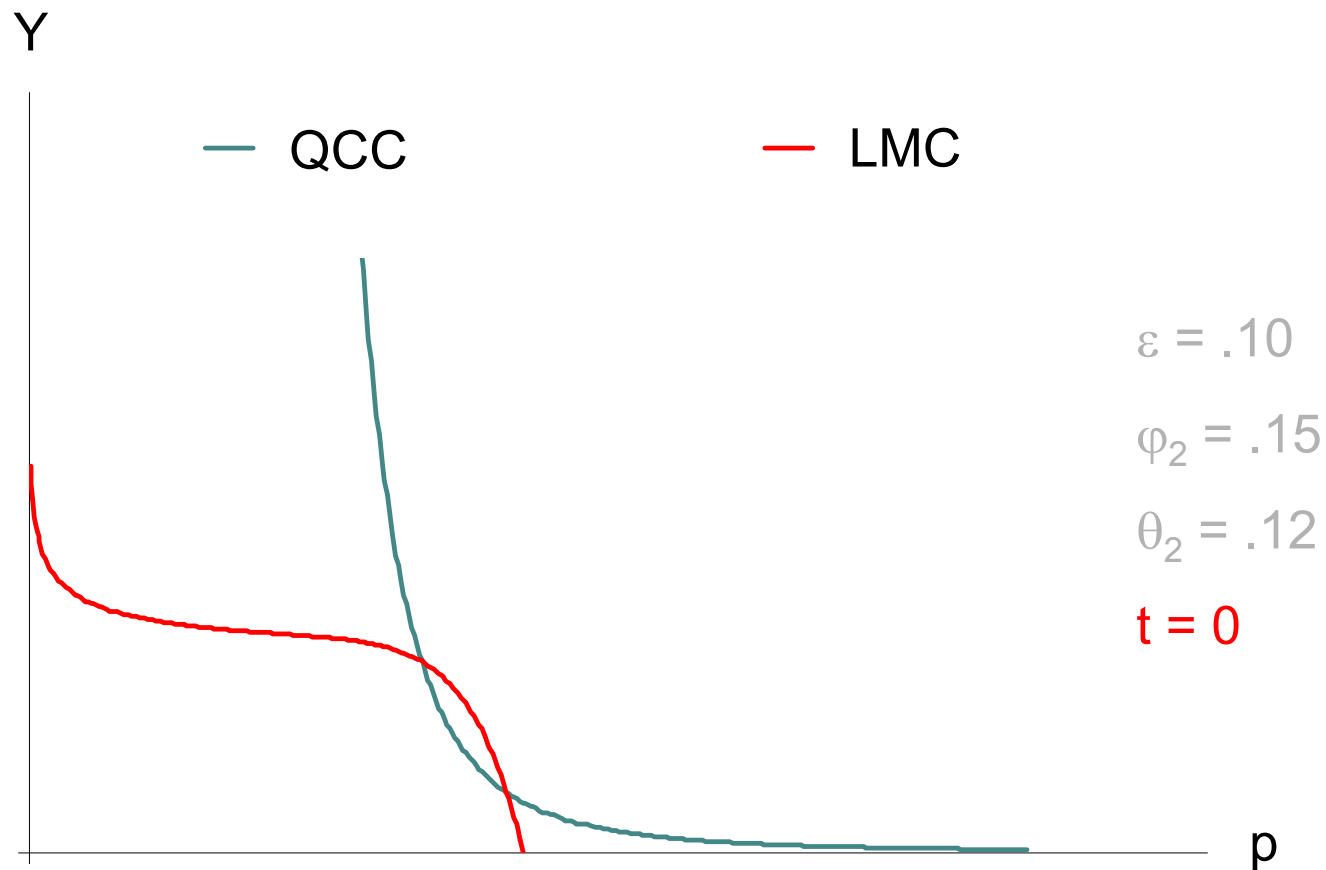
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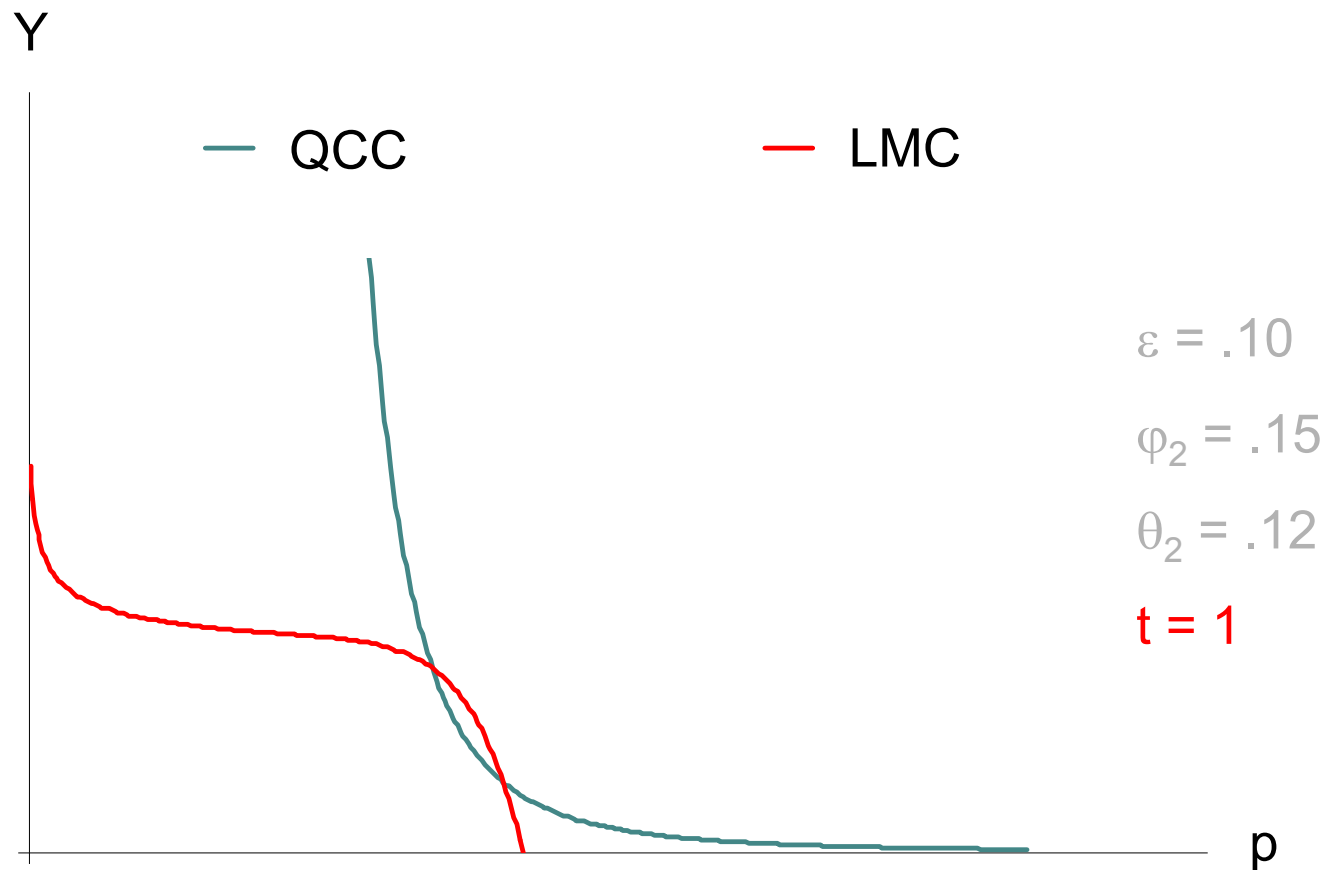
How bad is it?

- 2 consistent equilibria (except tangency...)
 - High price & low volume vs high volume & low price... with identical labour force implies high vs low unemployment
 - Calibrated baseline is certain, but the **smallest** parameter change triggers uncertainty (underlying dynamics?)
- For 'reasonable' parameters
 - Elasticity of TP < elasticity of DR sufficient condition
 - A reasonable assumption for fast growing economies? Cf. China and India? **Requires further estimating**
- Implications on policy assessment?

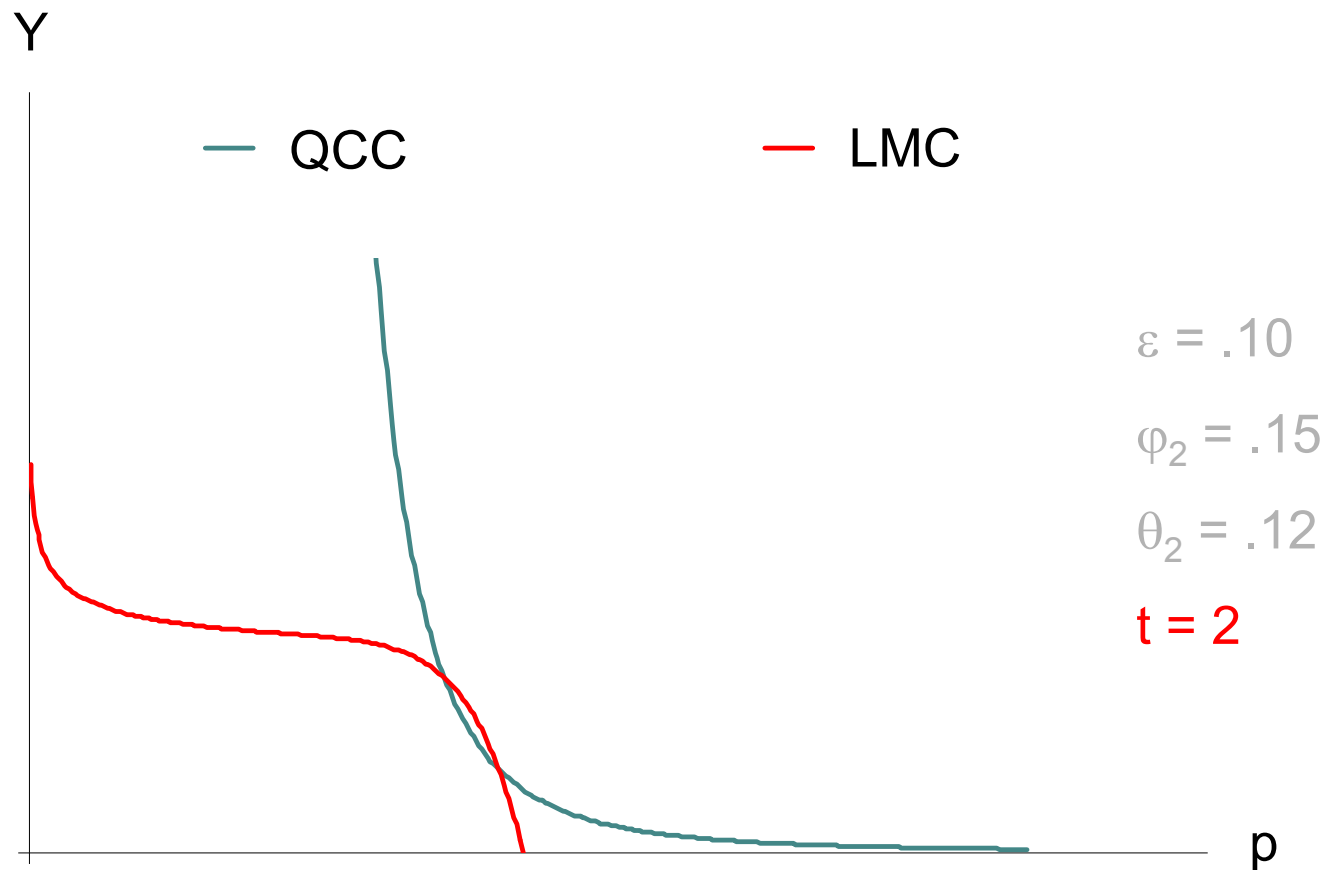
Excise tax t , $\varphi_2 > \theta_2$



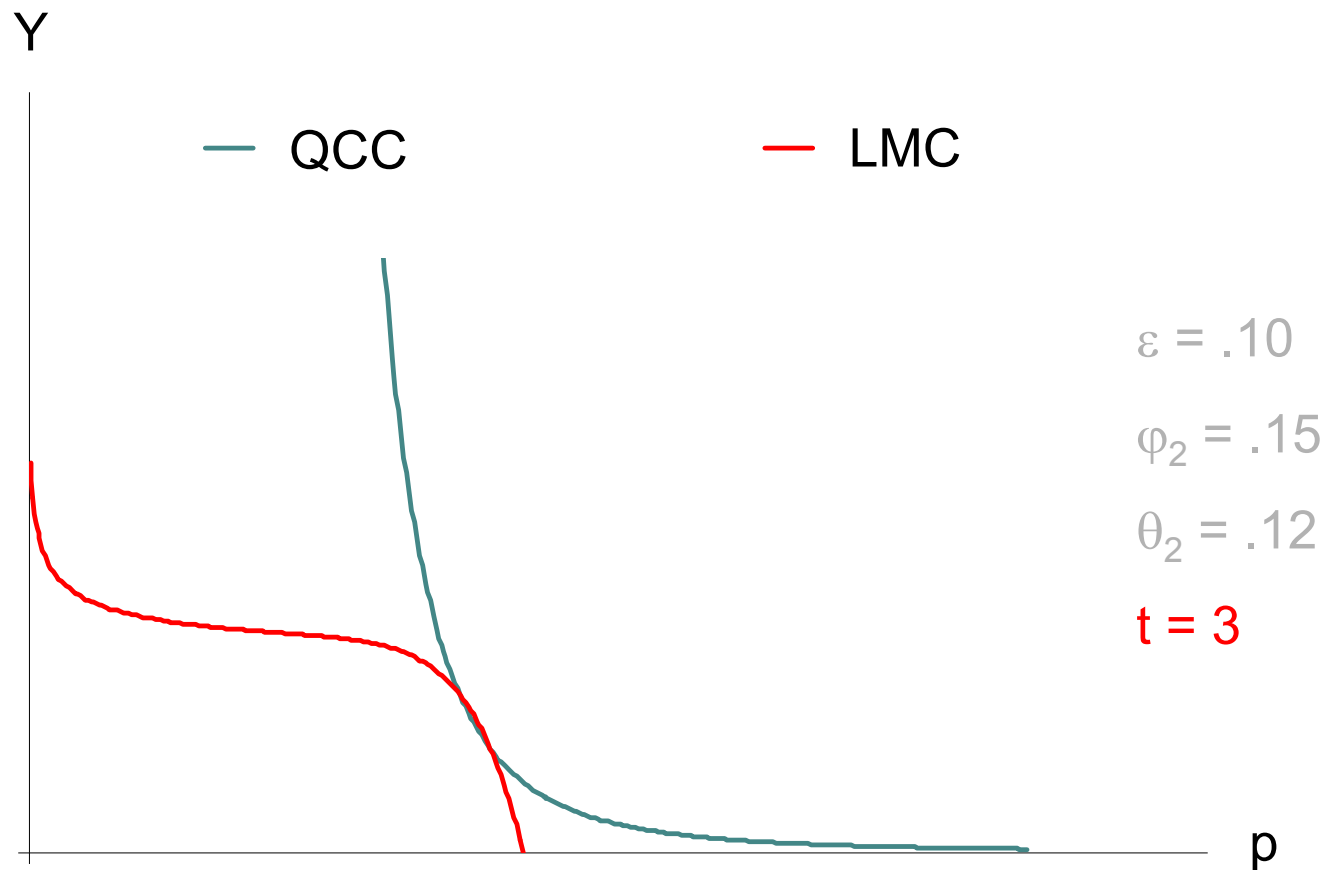
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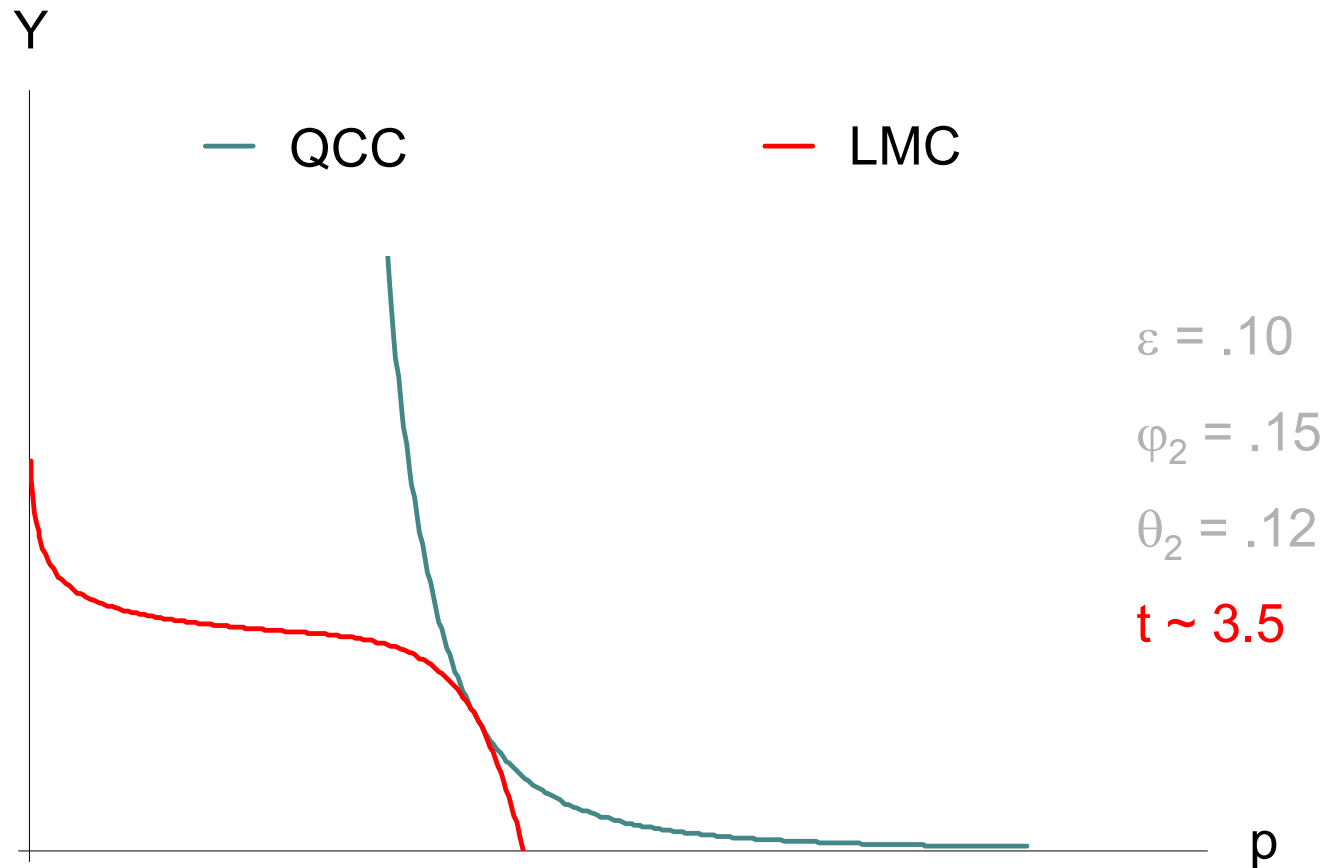
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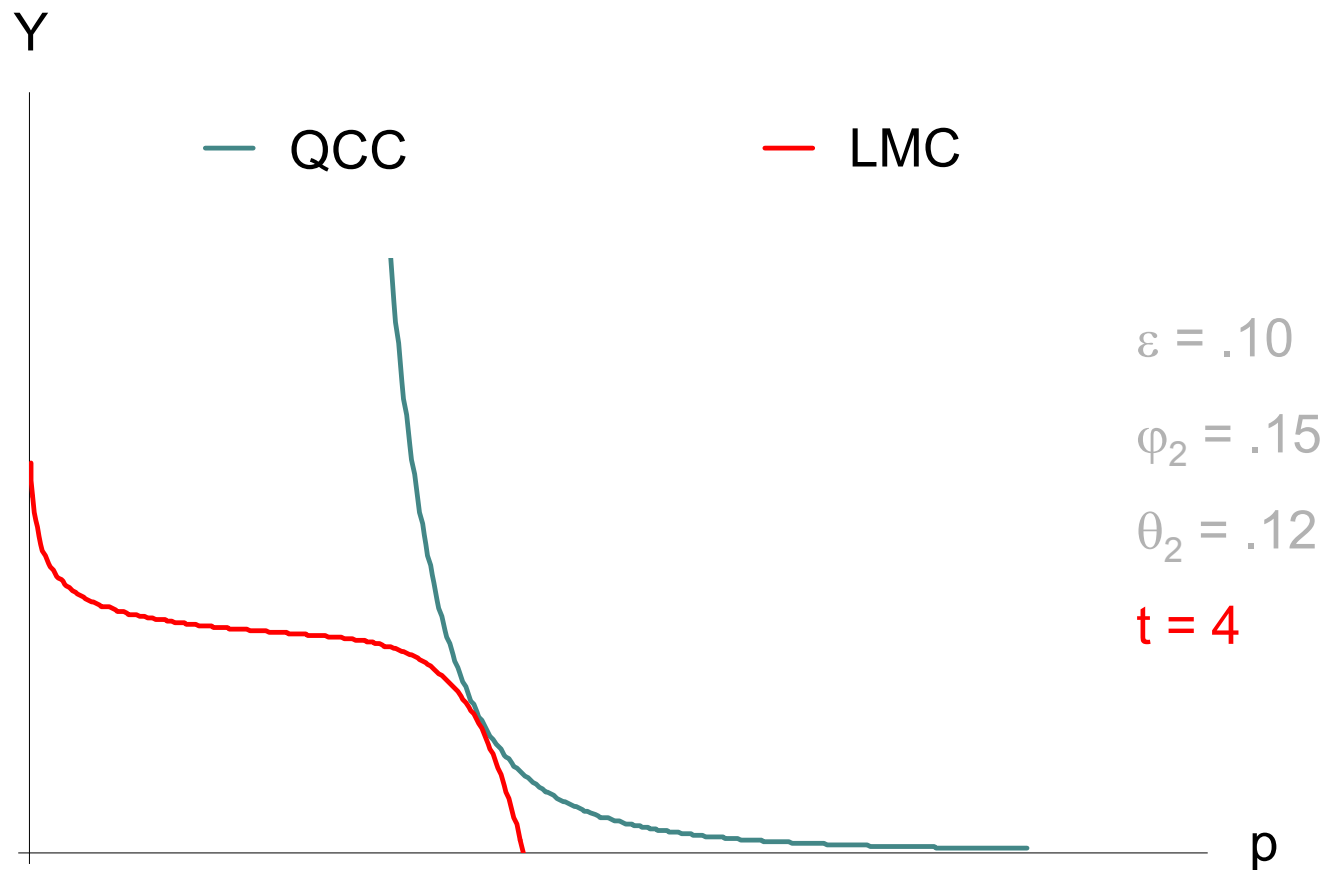
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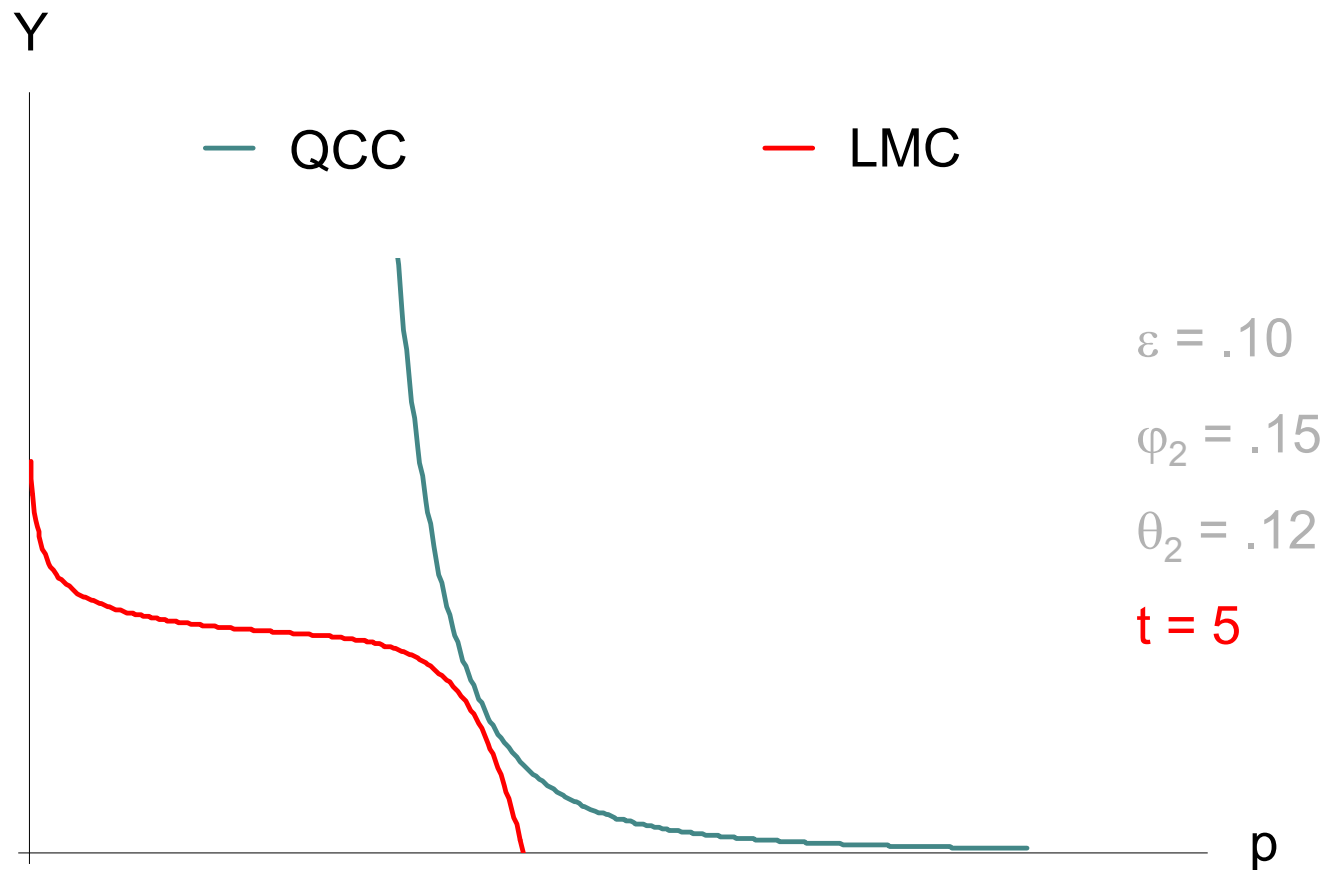
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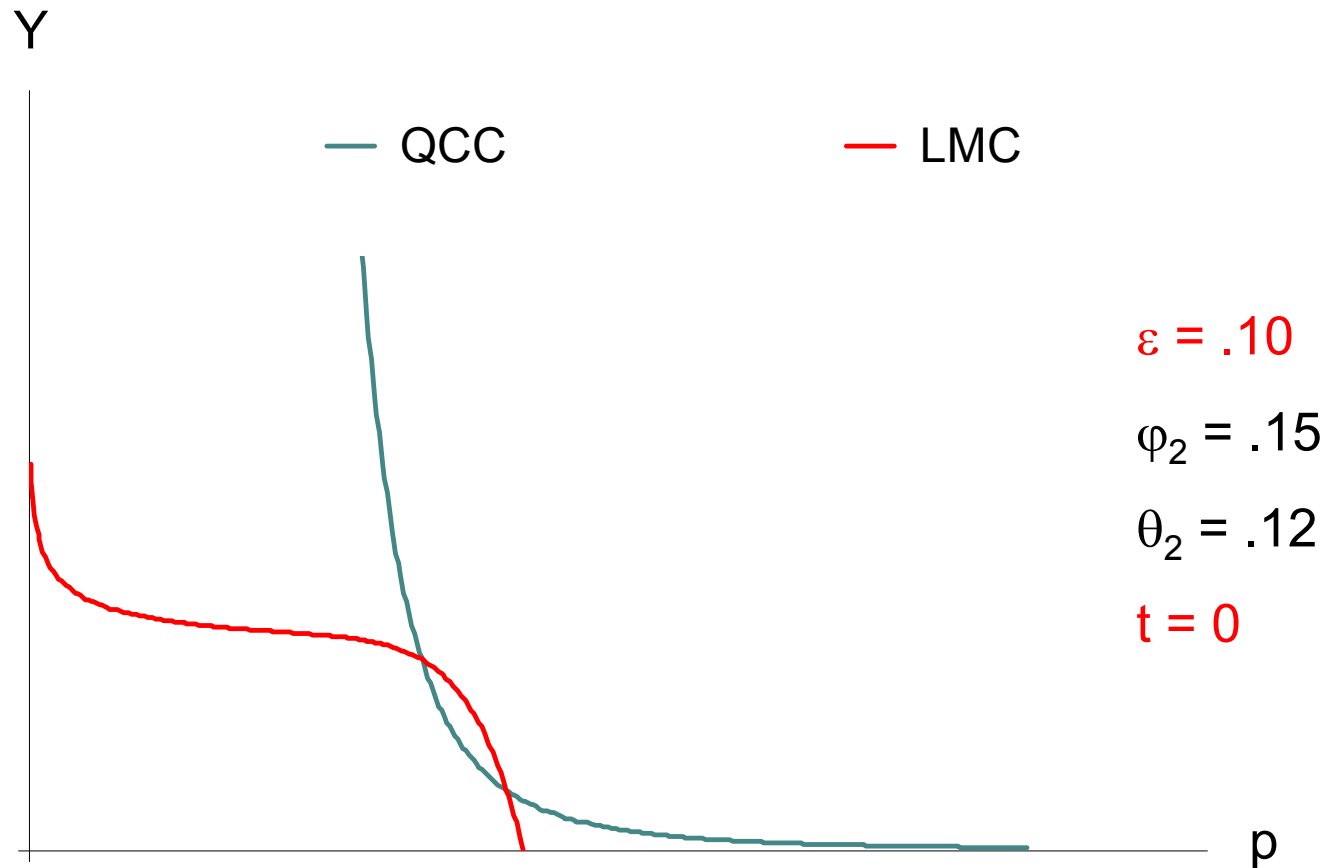
Robustness to policy analysis jeopardized

- TP dominating DR \Rightarrow output decrease triggers increase in factor costs, i.e. the tax is not the only source of price increase anymore
- Hence, price increases are not fully compensated by lump-sum recycling (as when DR dominates TP)
- Beyond some point pressure on households too strong, no budget balance possible anymore
- **Factor substitution** only delays the turning point

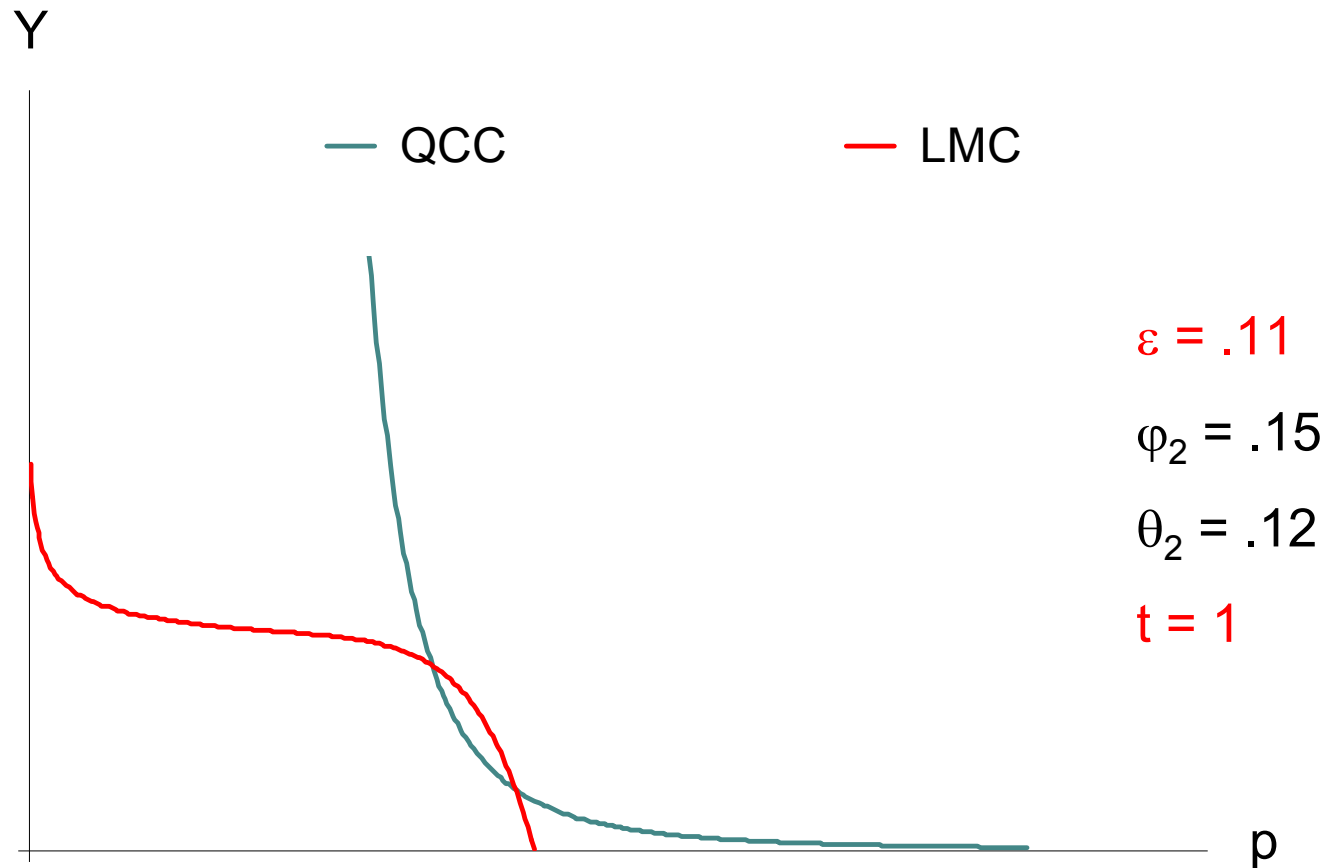
Ways out of the deadlock

- ‘Pathological’ case characterised by massively increased output losses: 26% in the tangency case, compared to 5% for the same tax with central values
- For a benign +1,5% shock (ex-ante), suggests extreme ‘vulnerability’ of baseline equilibrium
- Can it imply that the particular set of parameters is bound to shift?
- e.g. increasingly tensed labour market

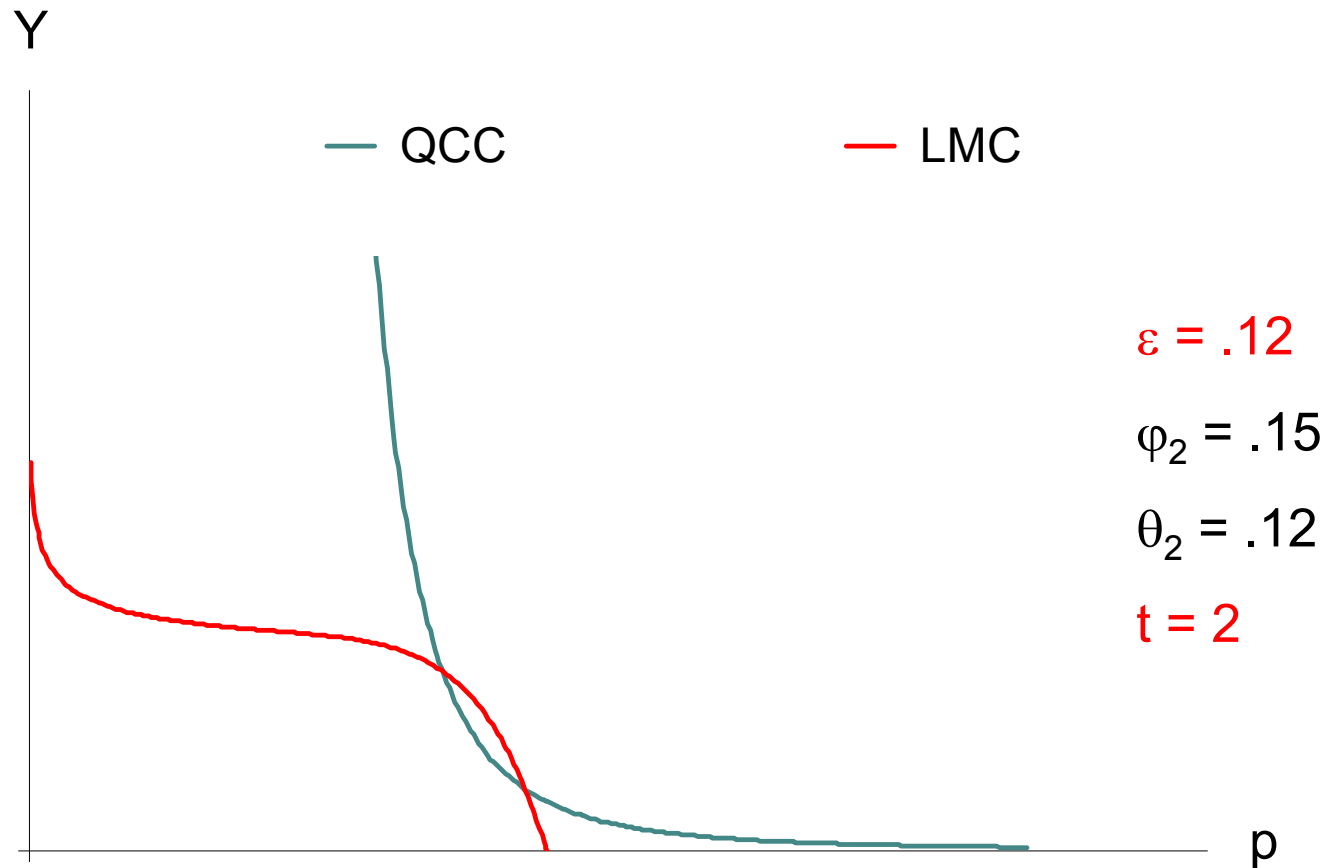
Pathological case with stiffening labour market



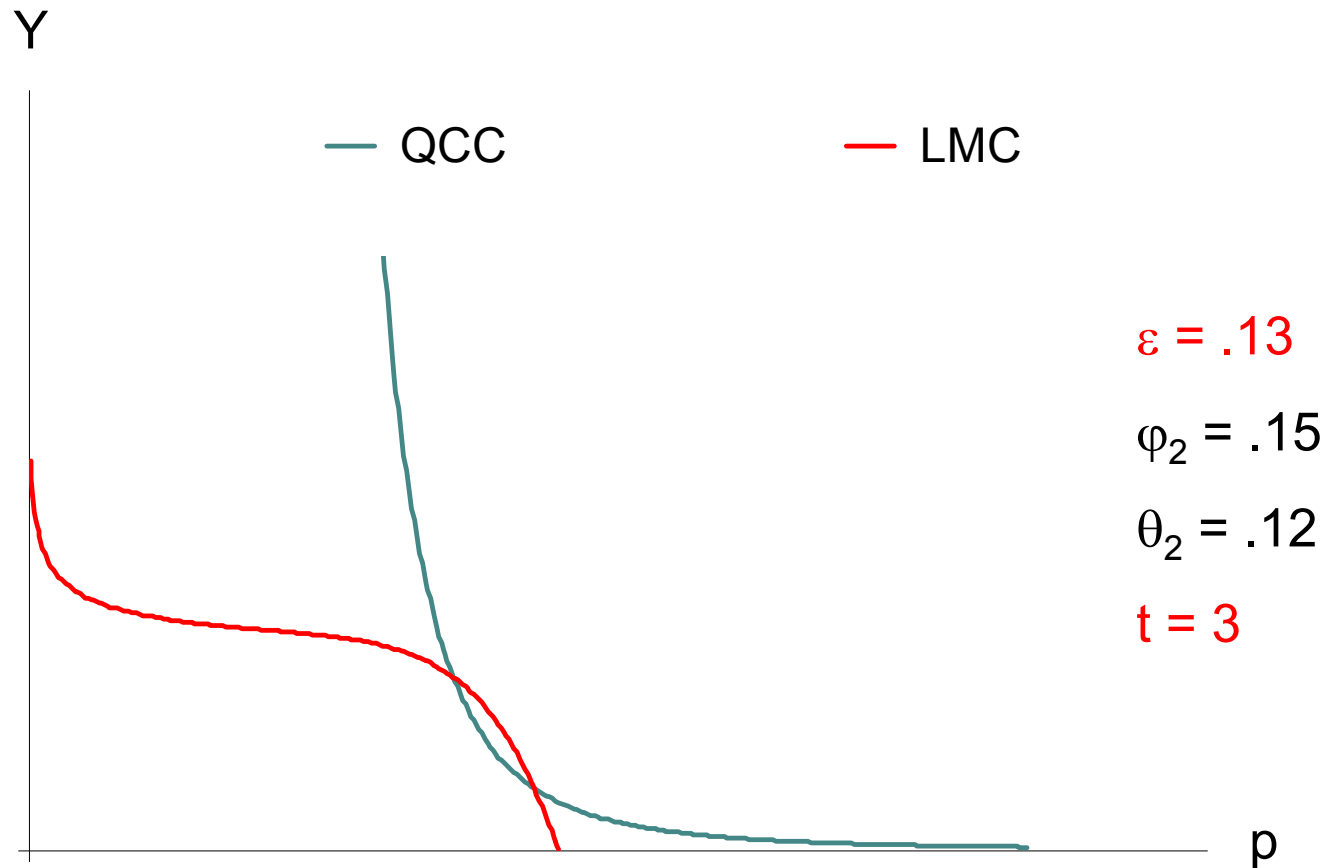
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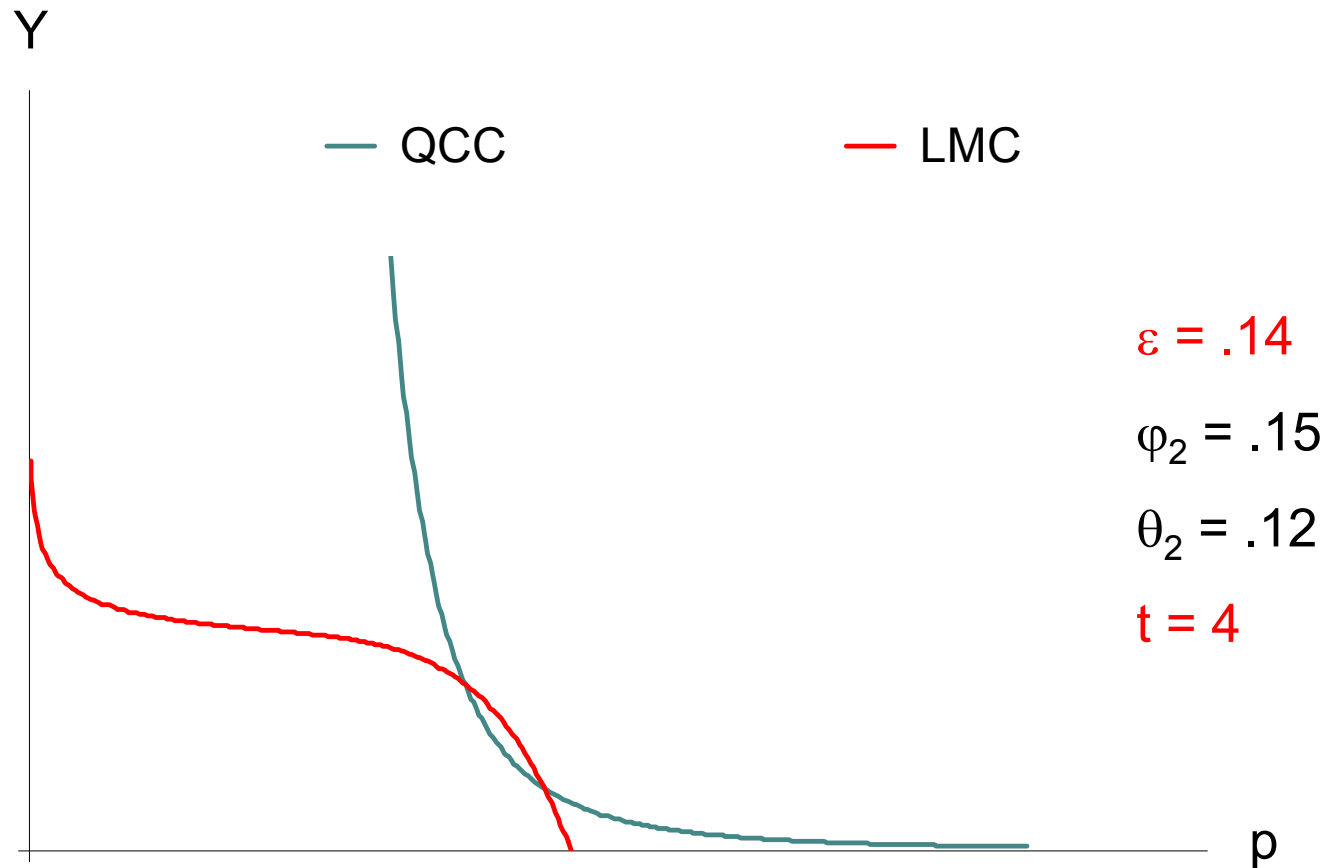
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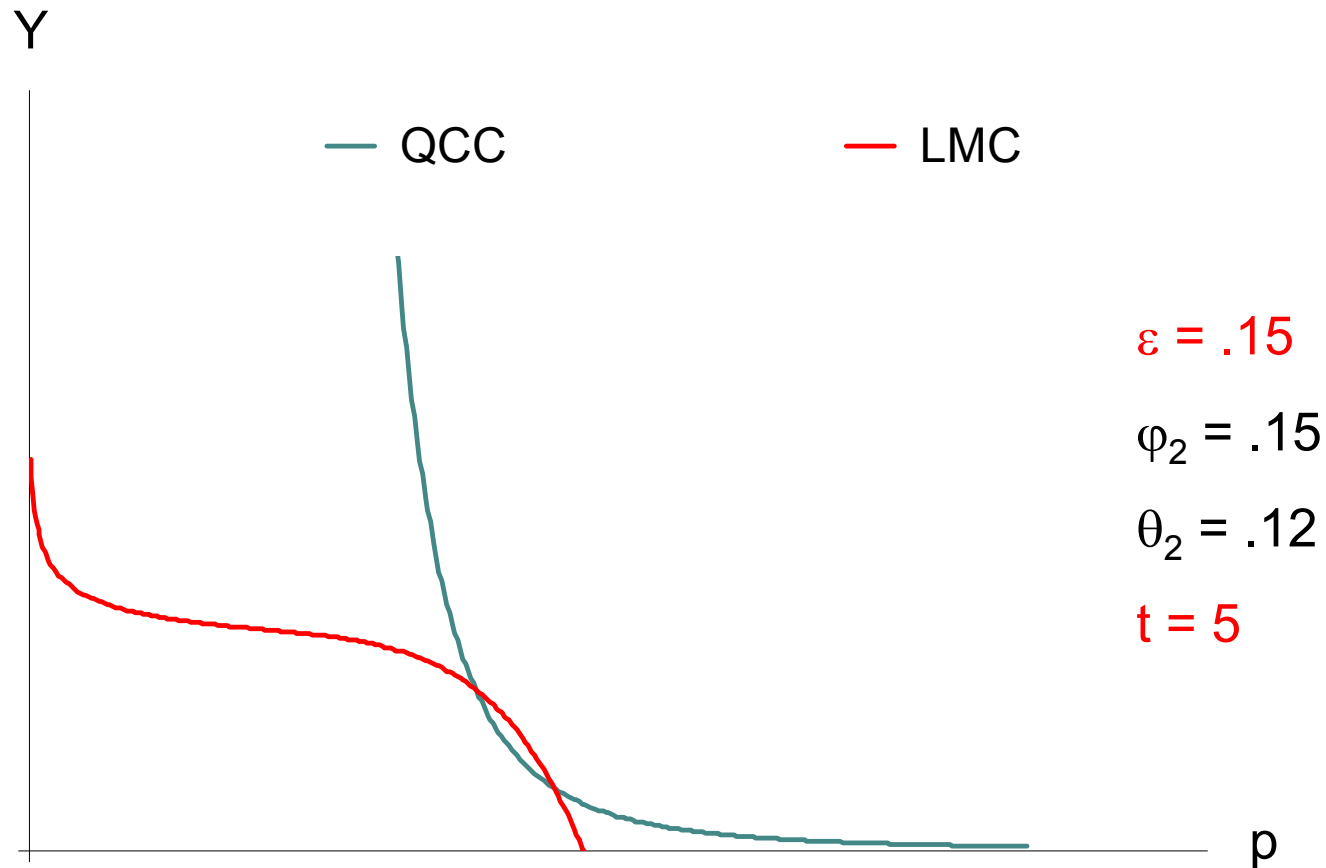
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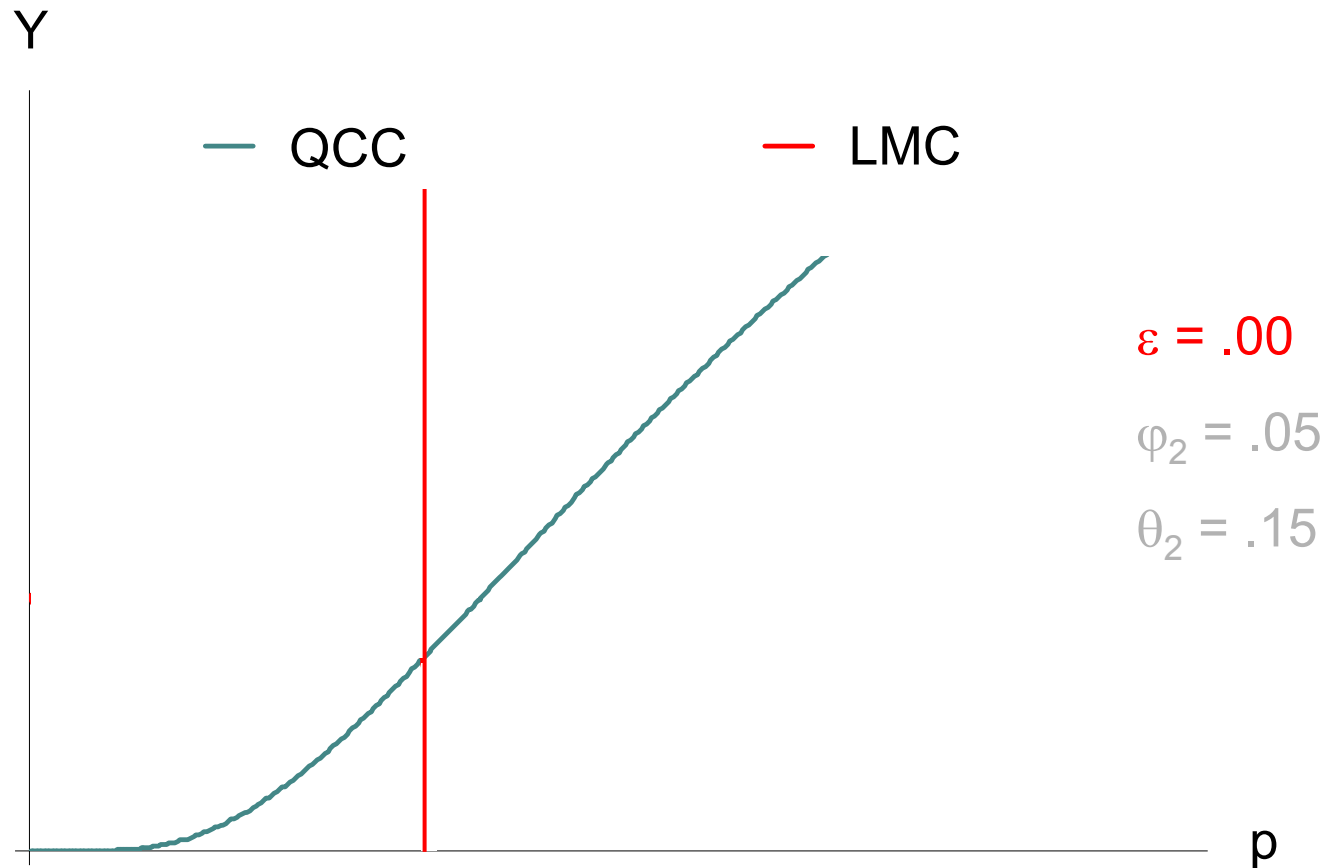
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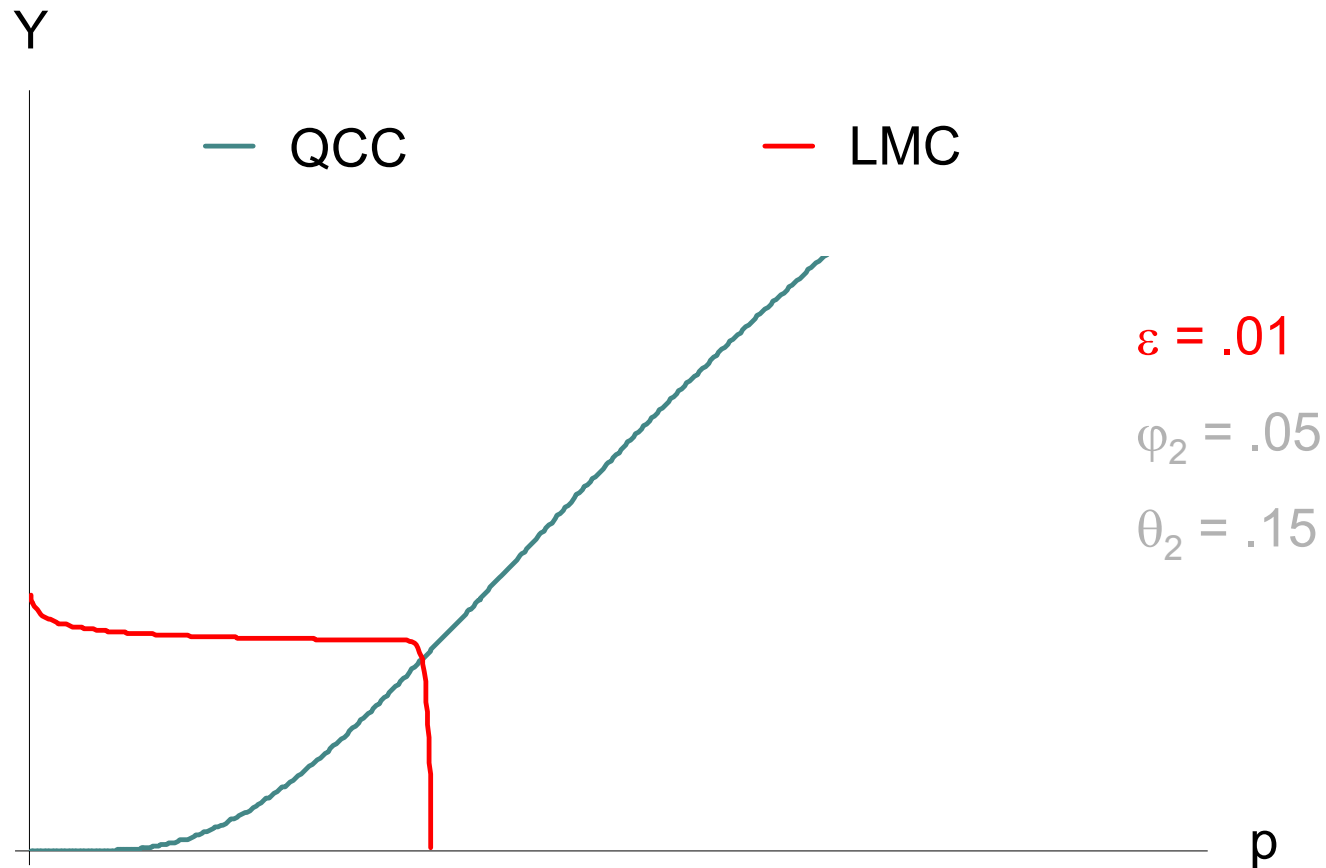
Thank you
for your attention

Florence, 12 juin 2007

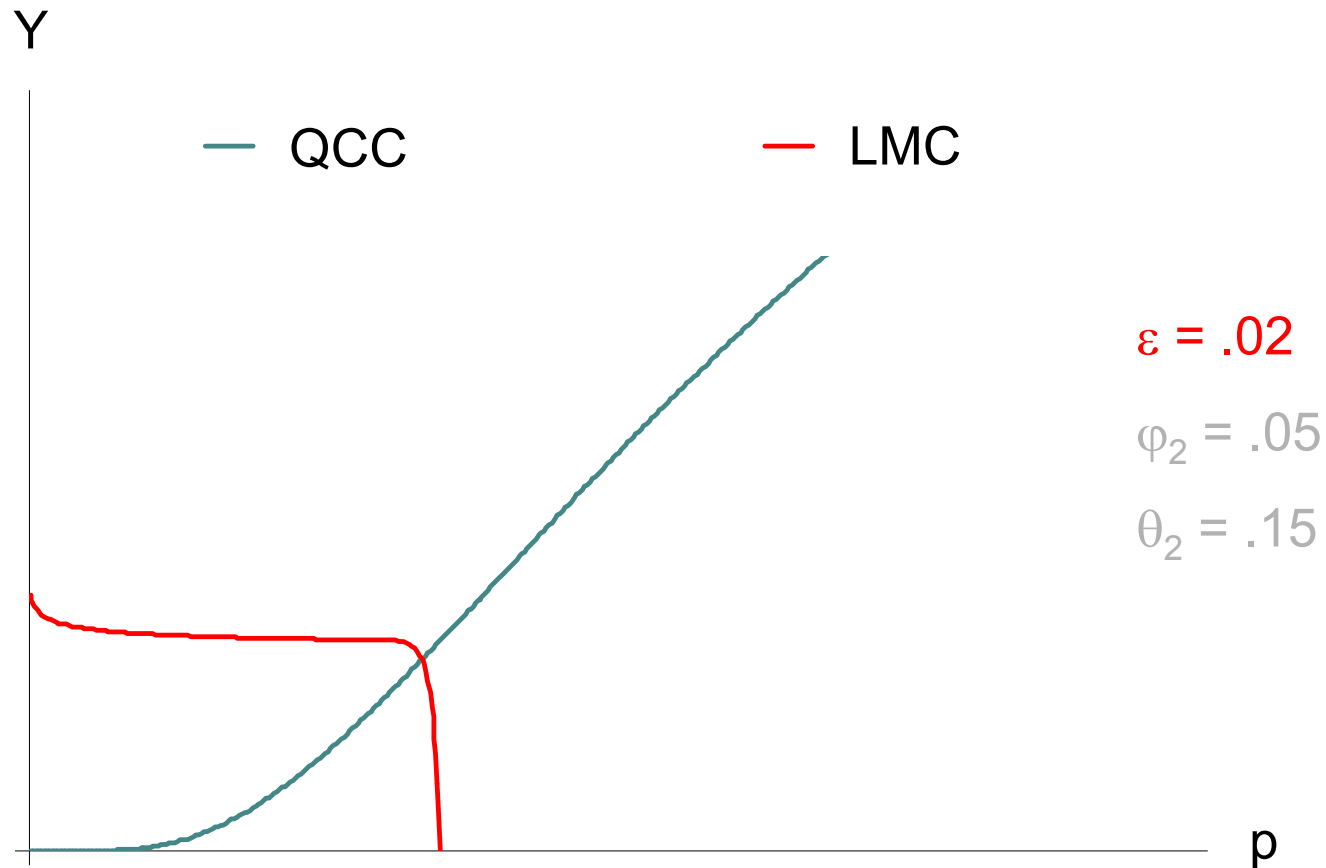
Sensitivity to wage elasticity ε



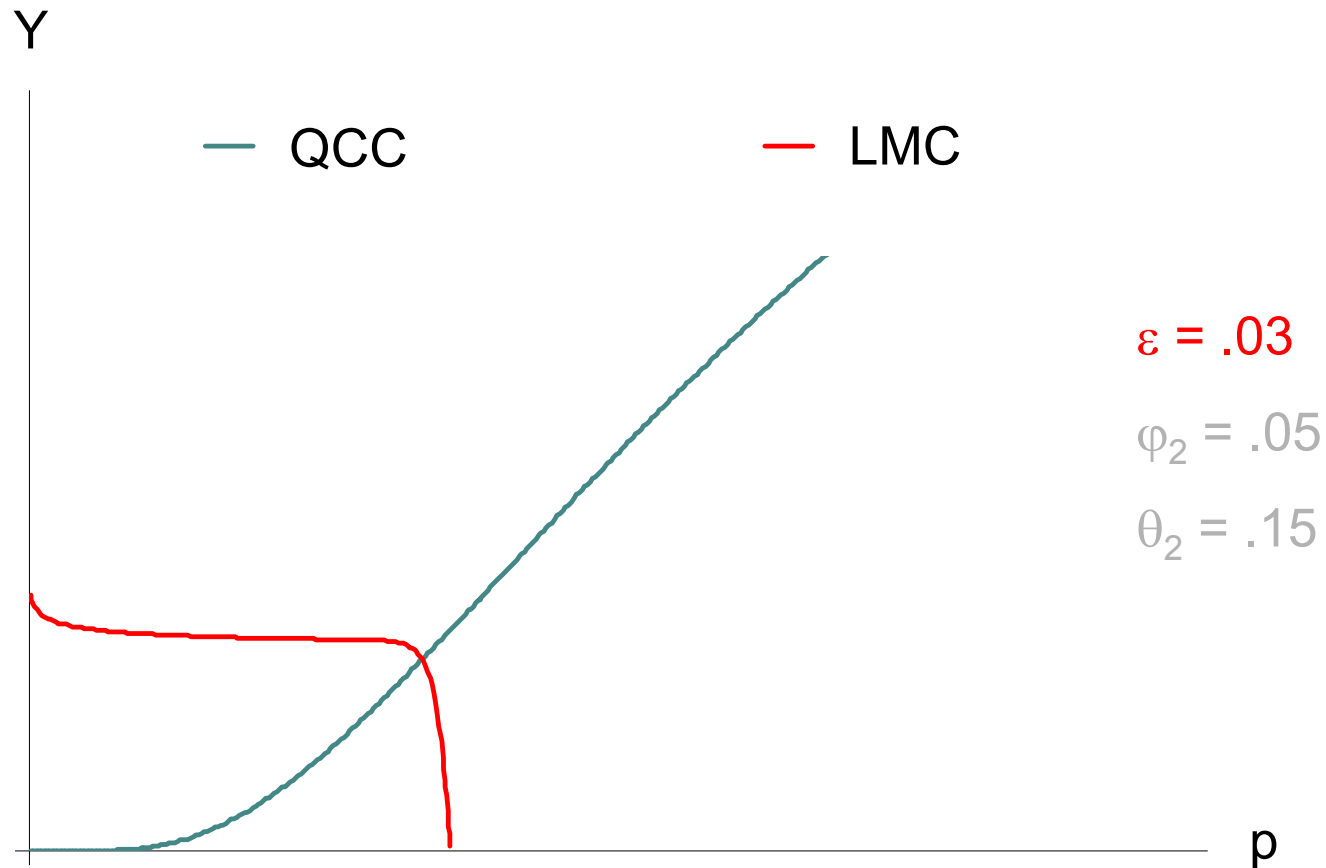
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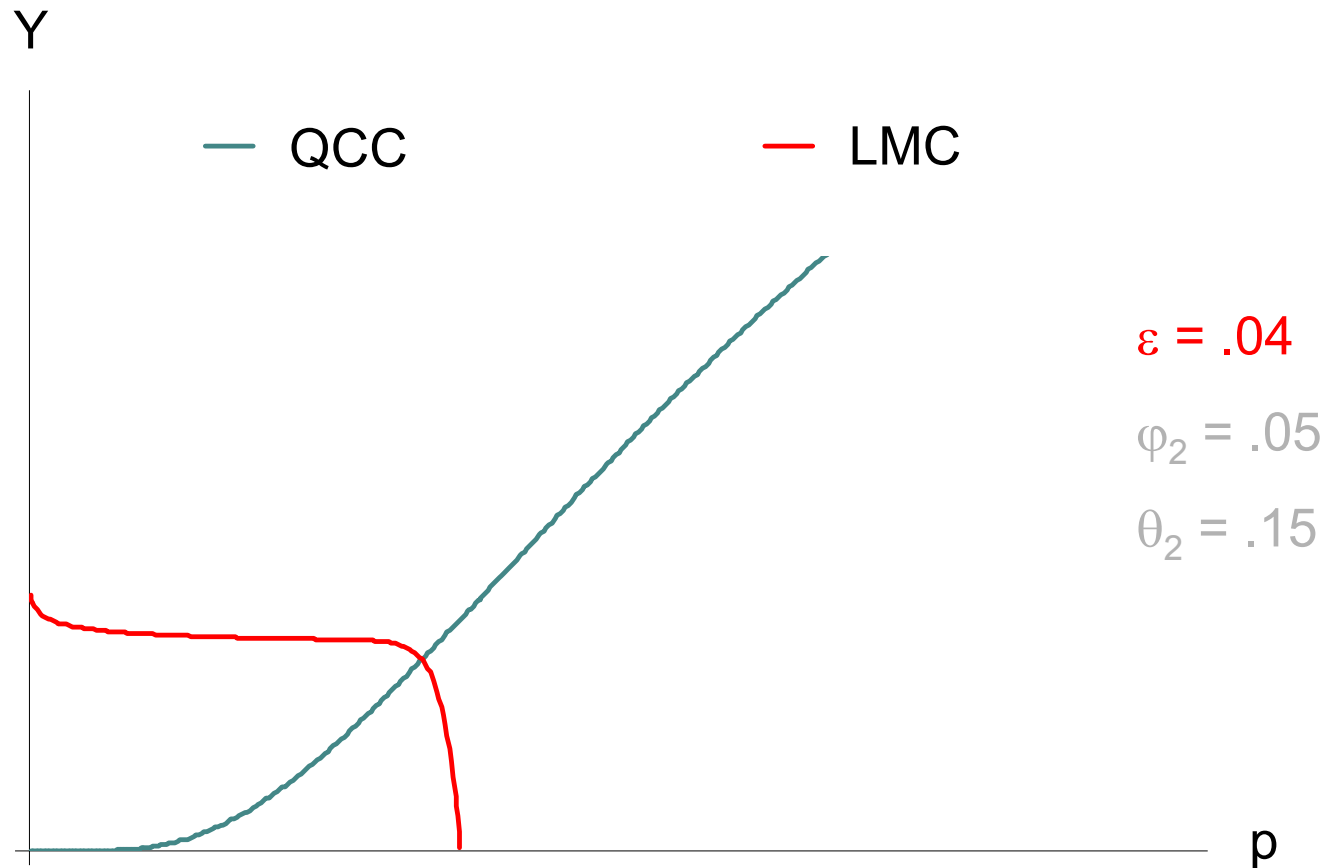
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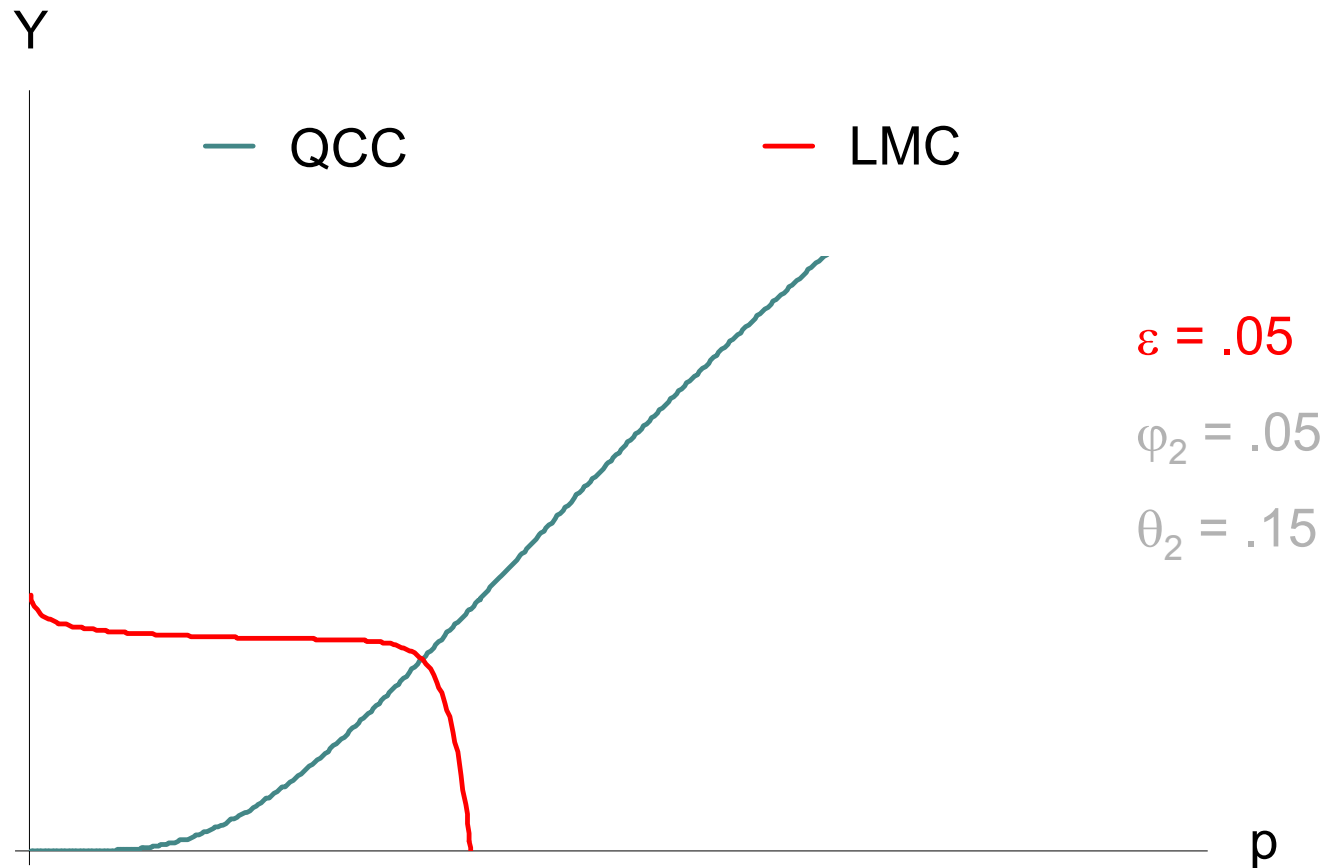
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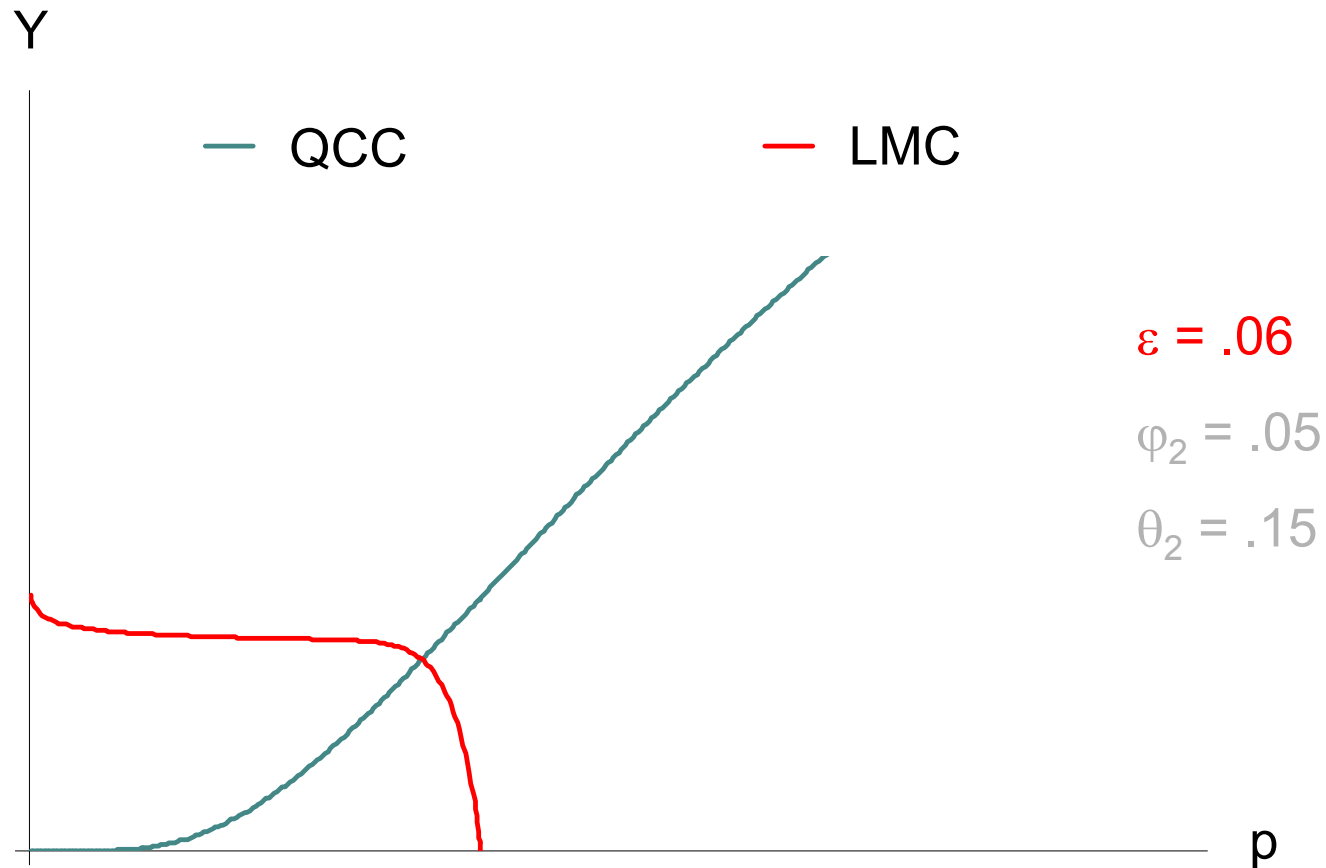
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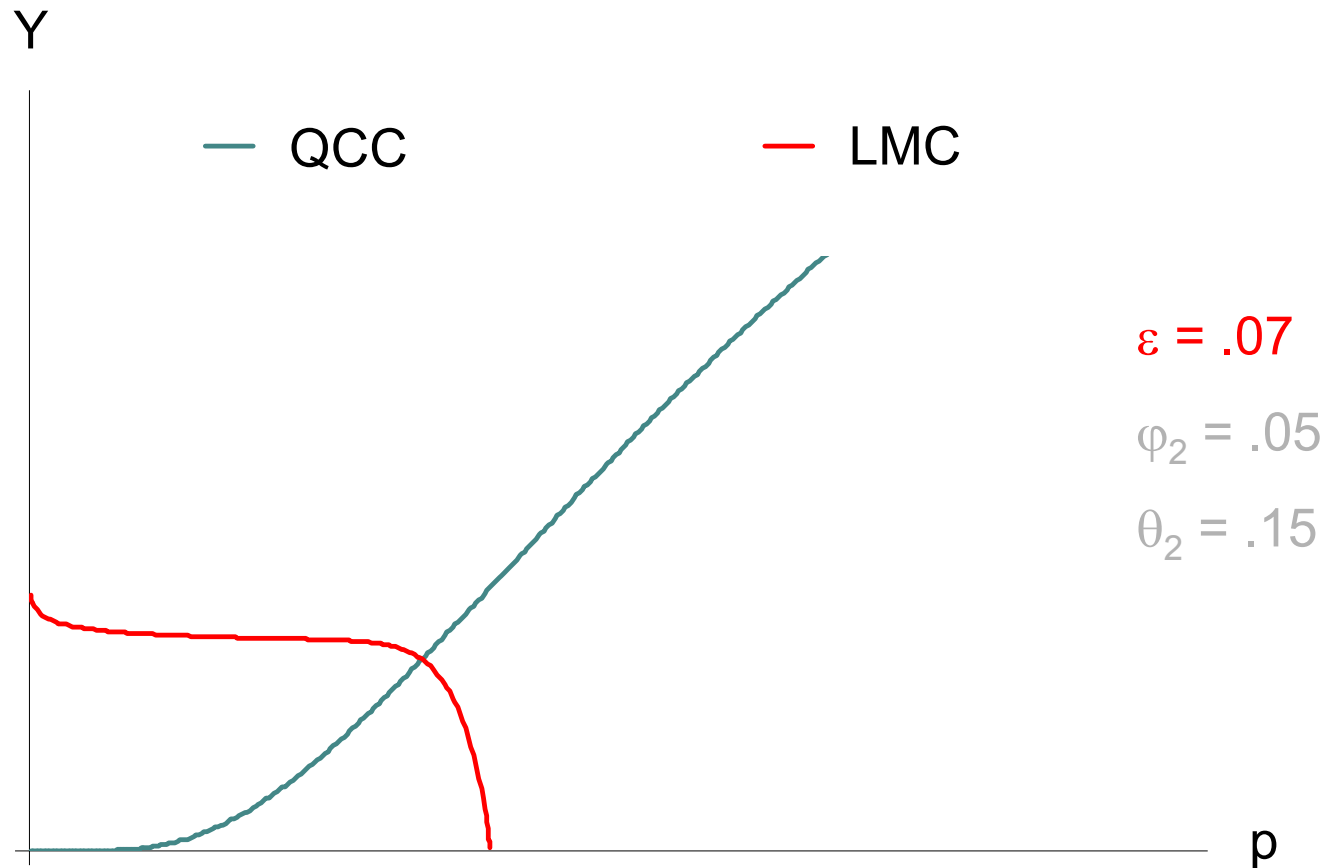
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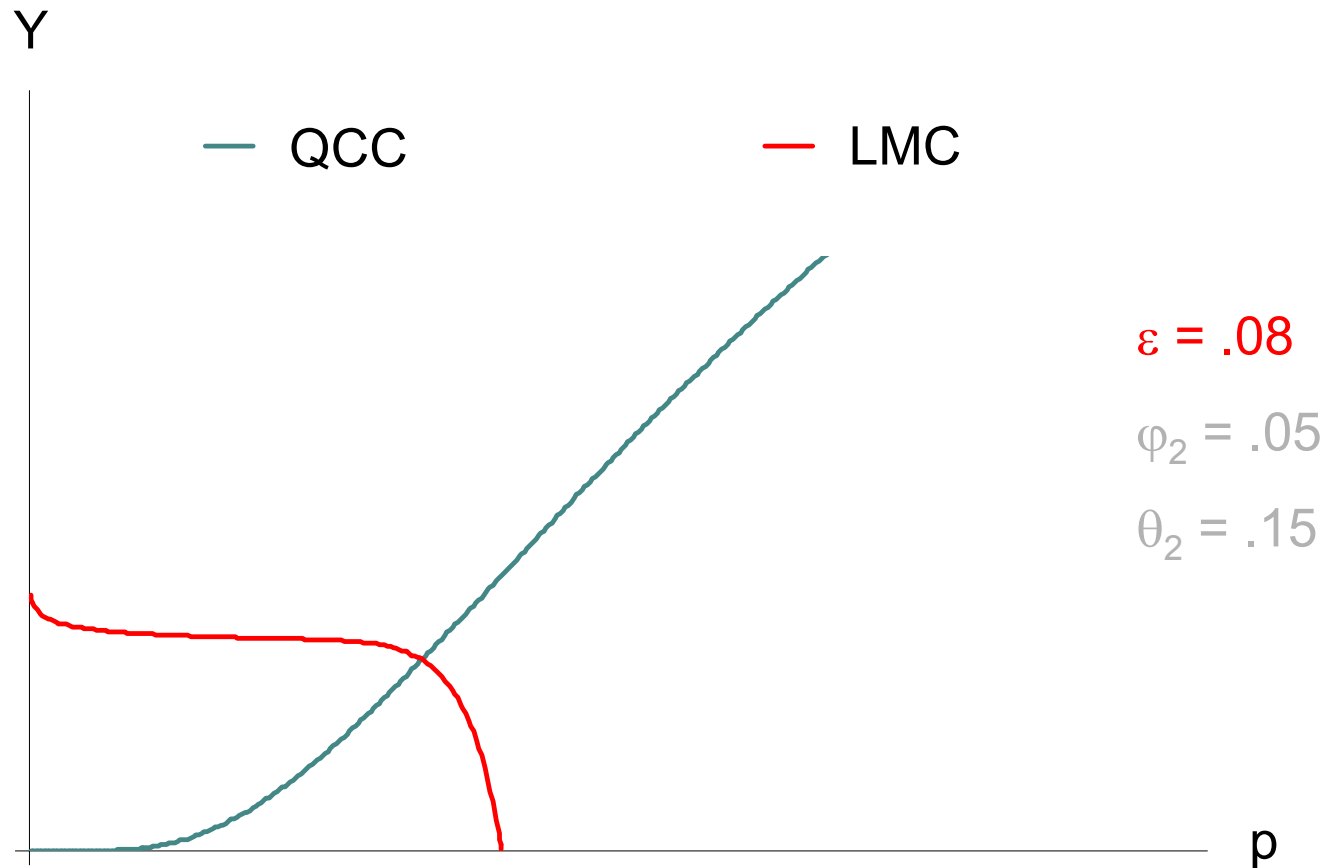
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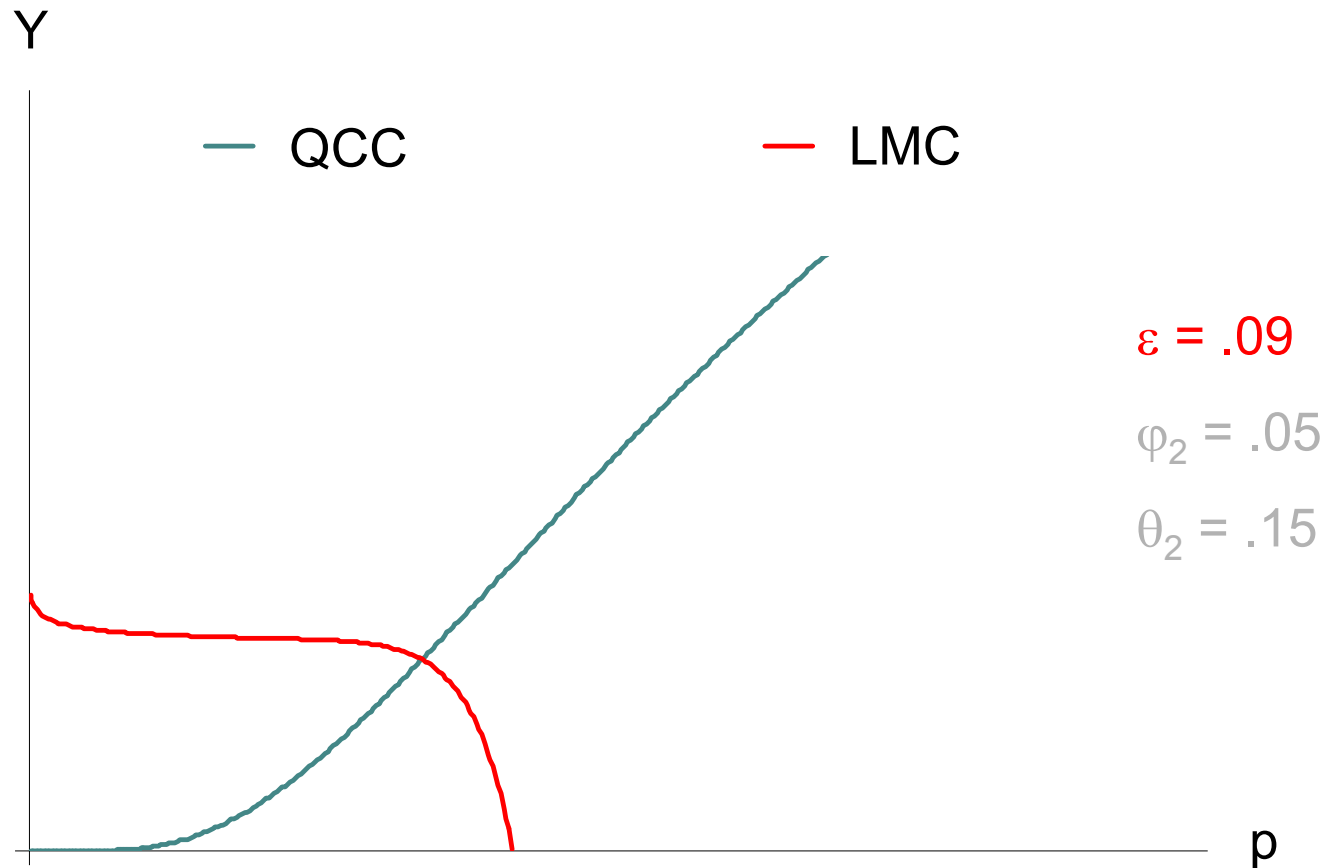
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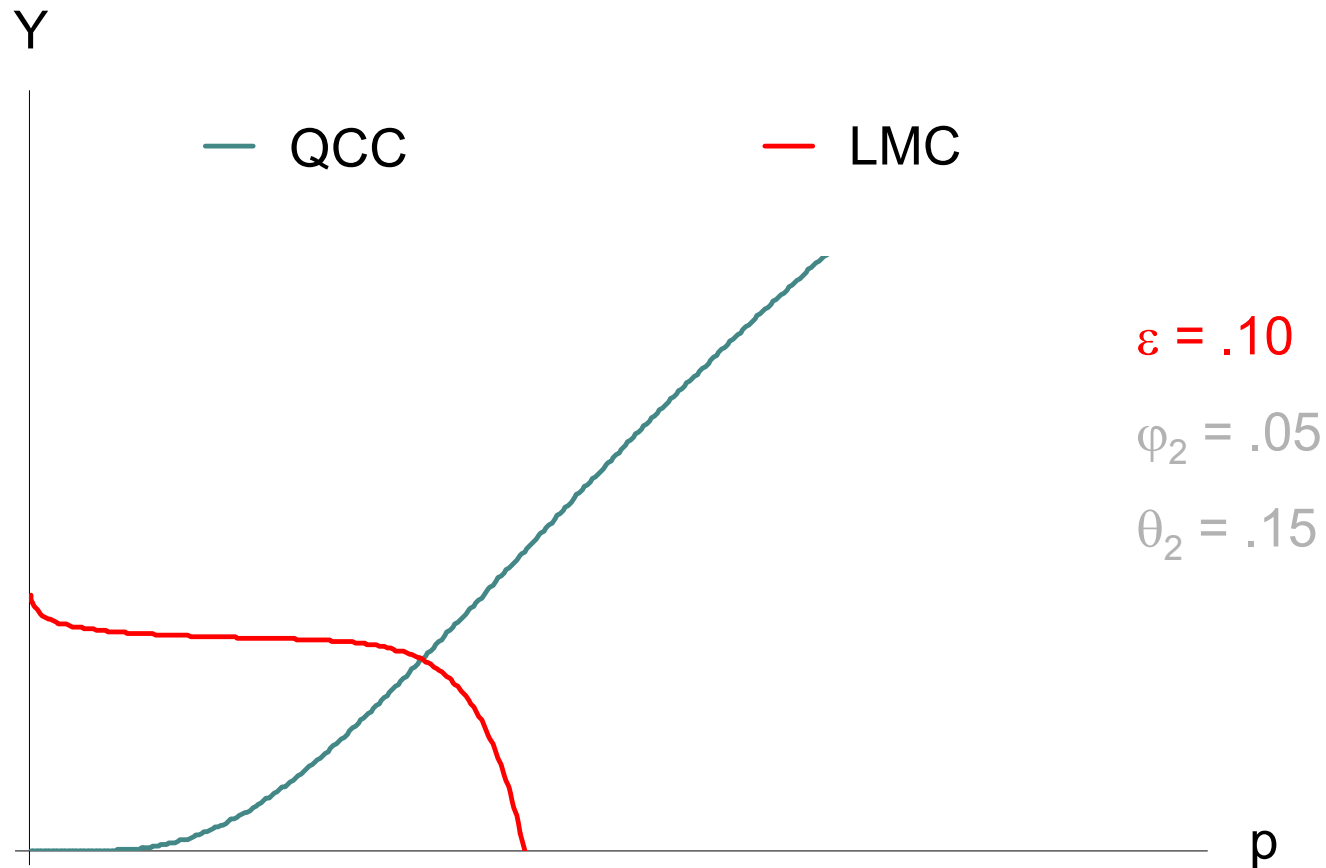
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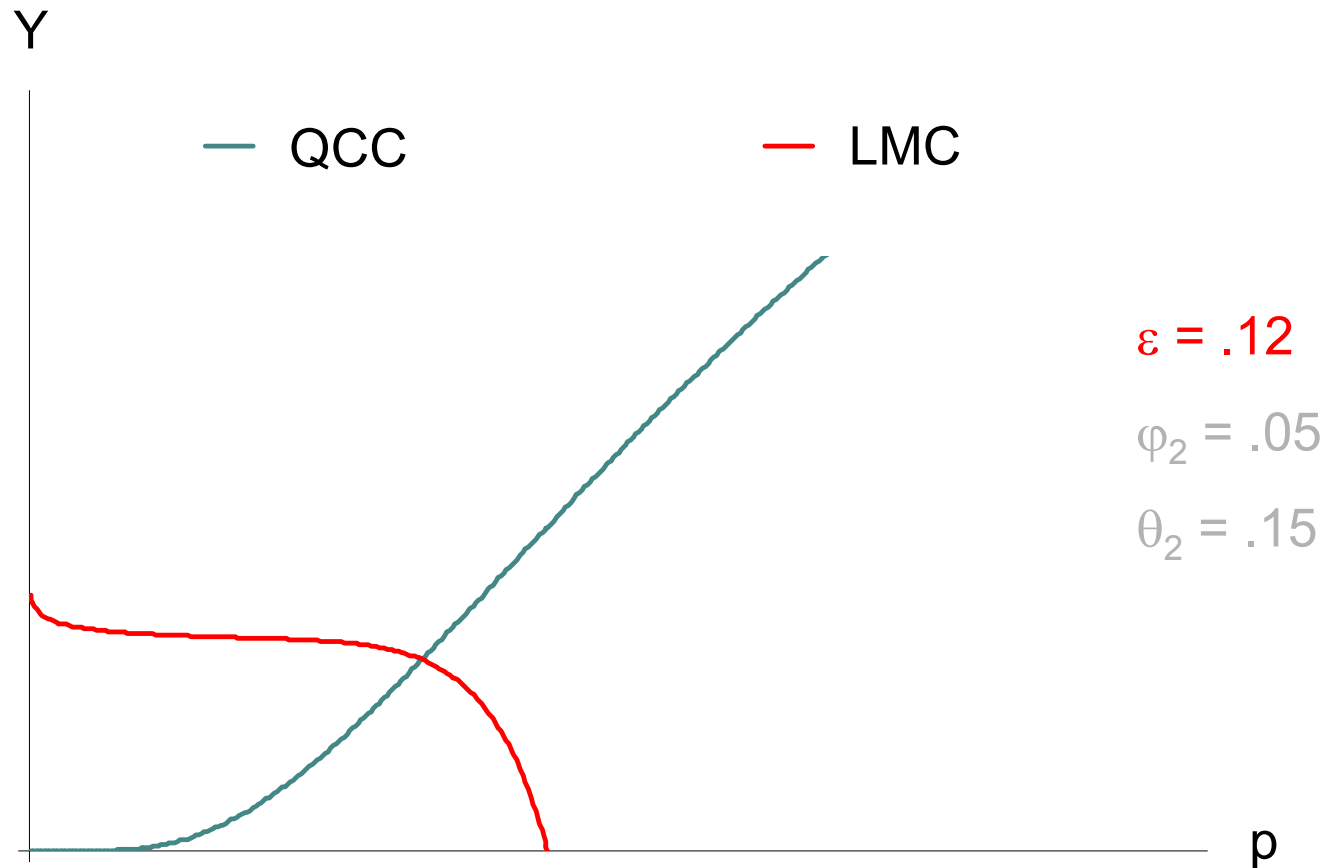
Sensitivity to wage elasticity ε



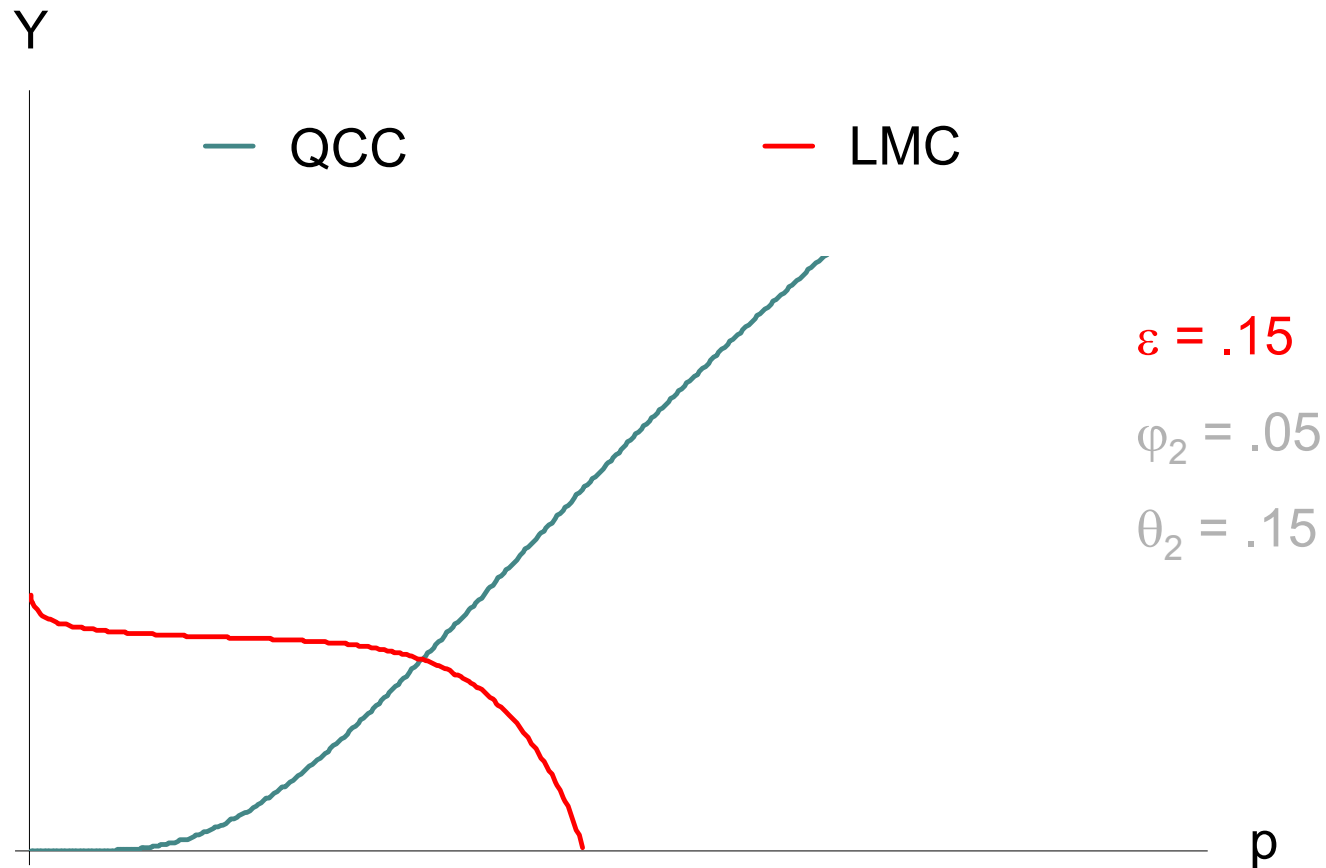
Sensitivity to wage elasticity ε



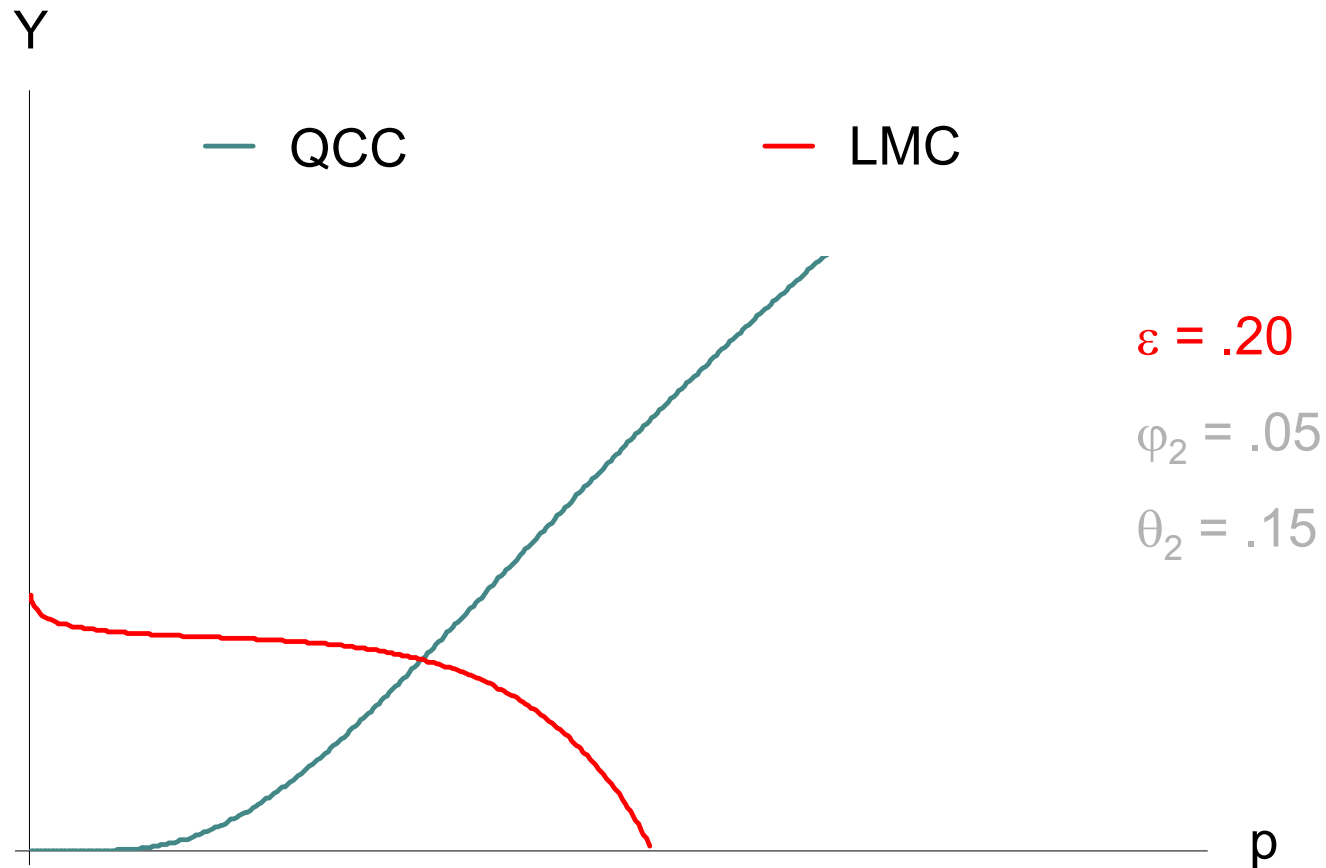
Sensitivity to wage elasticity ε



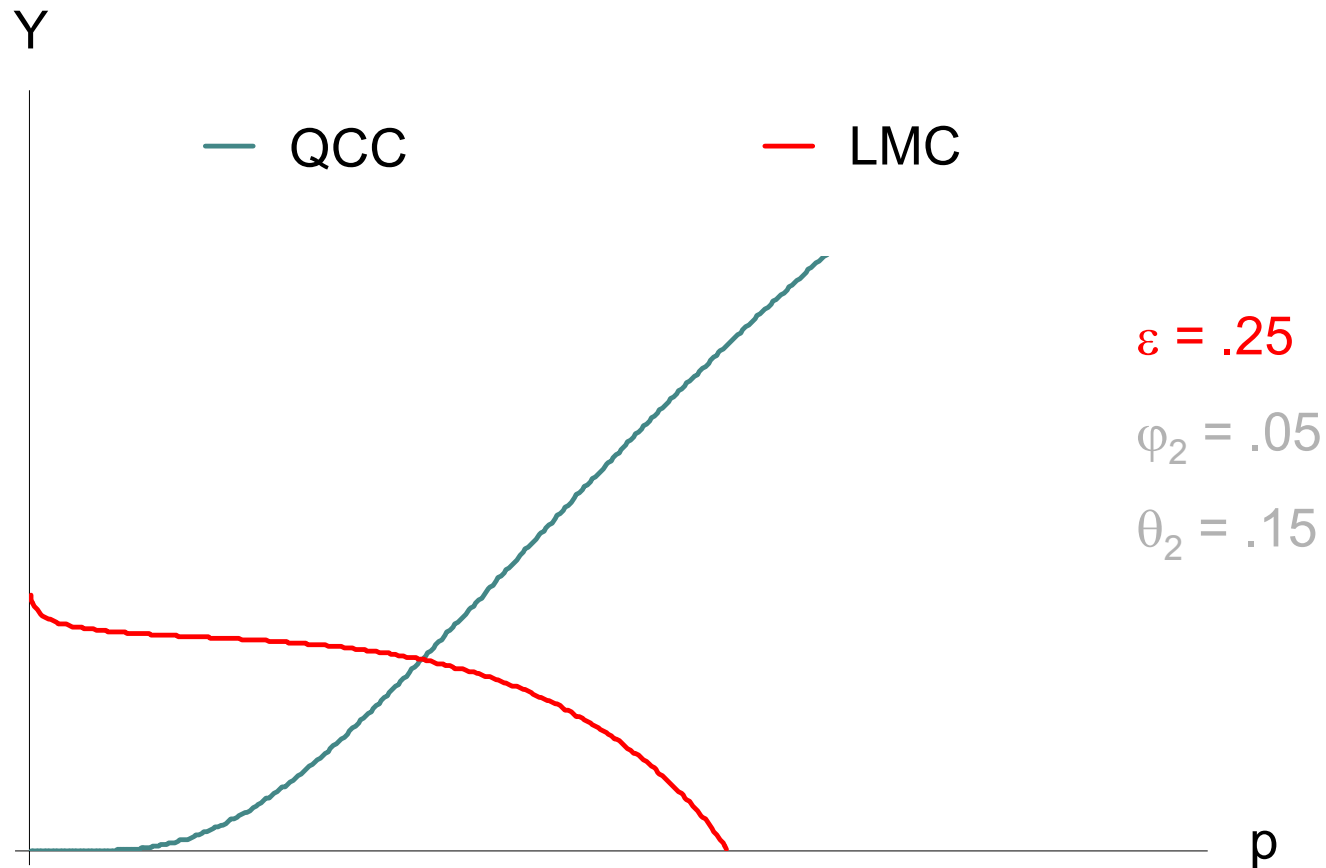
Sensitivity to wage elasticity ε



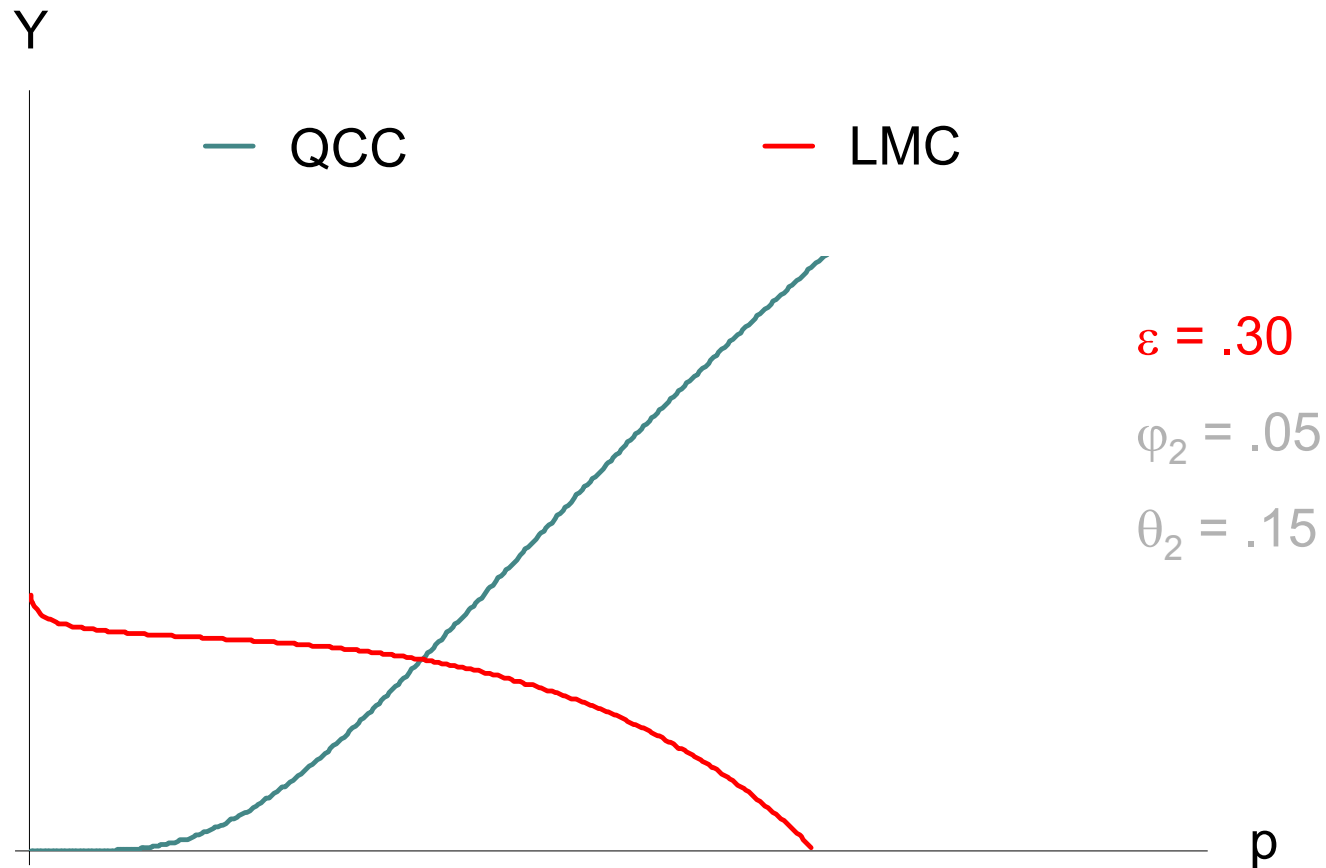
Sensitivity to wage elasticity ε



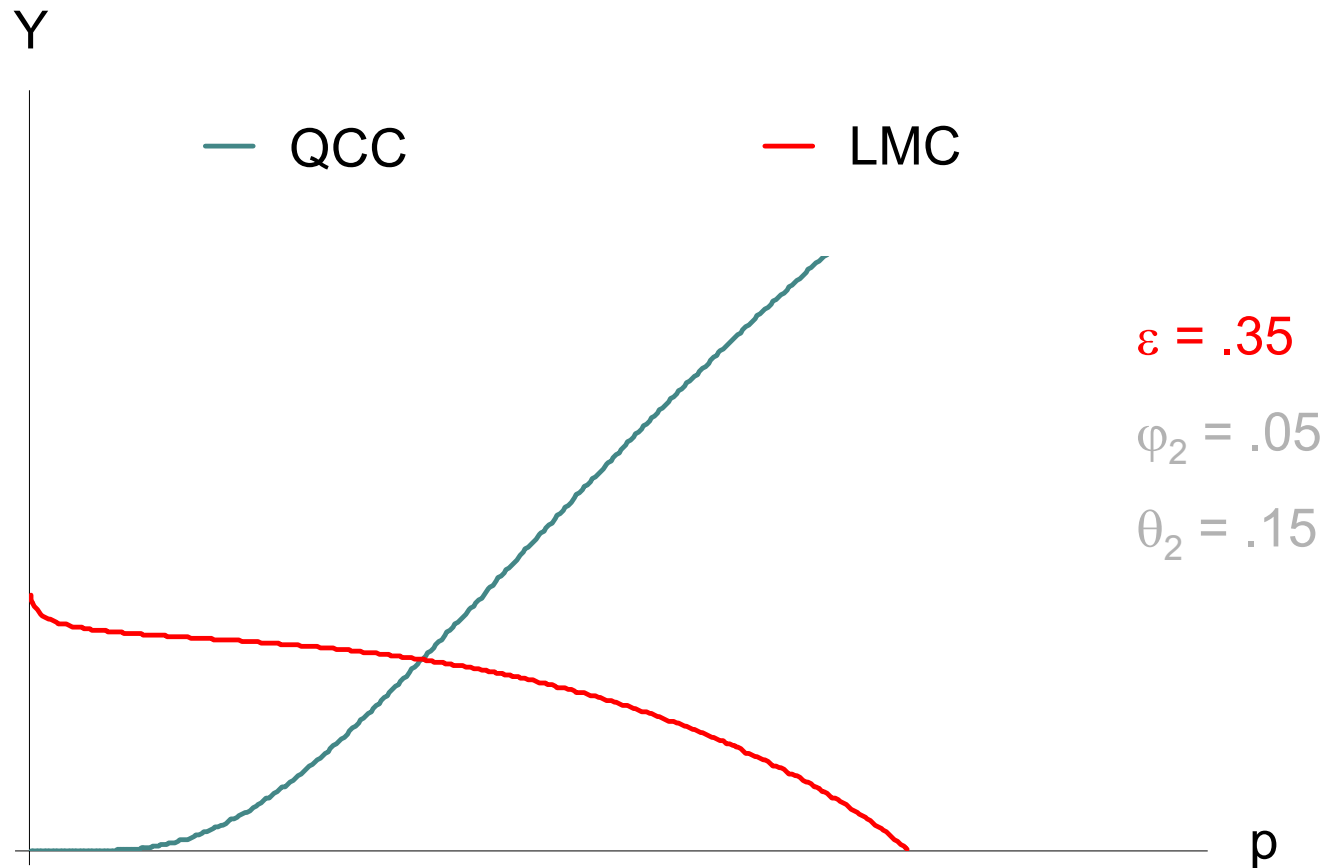
Sensitivity to wage elasticity ε



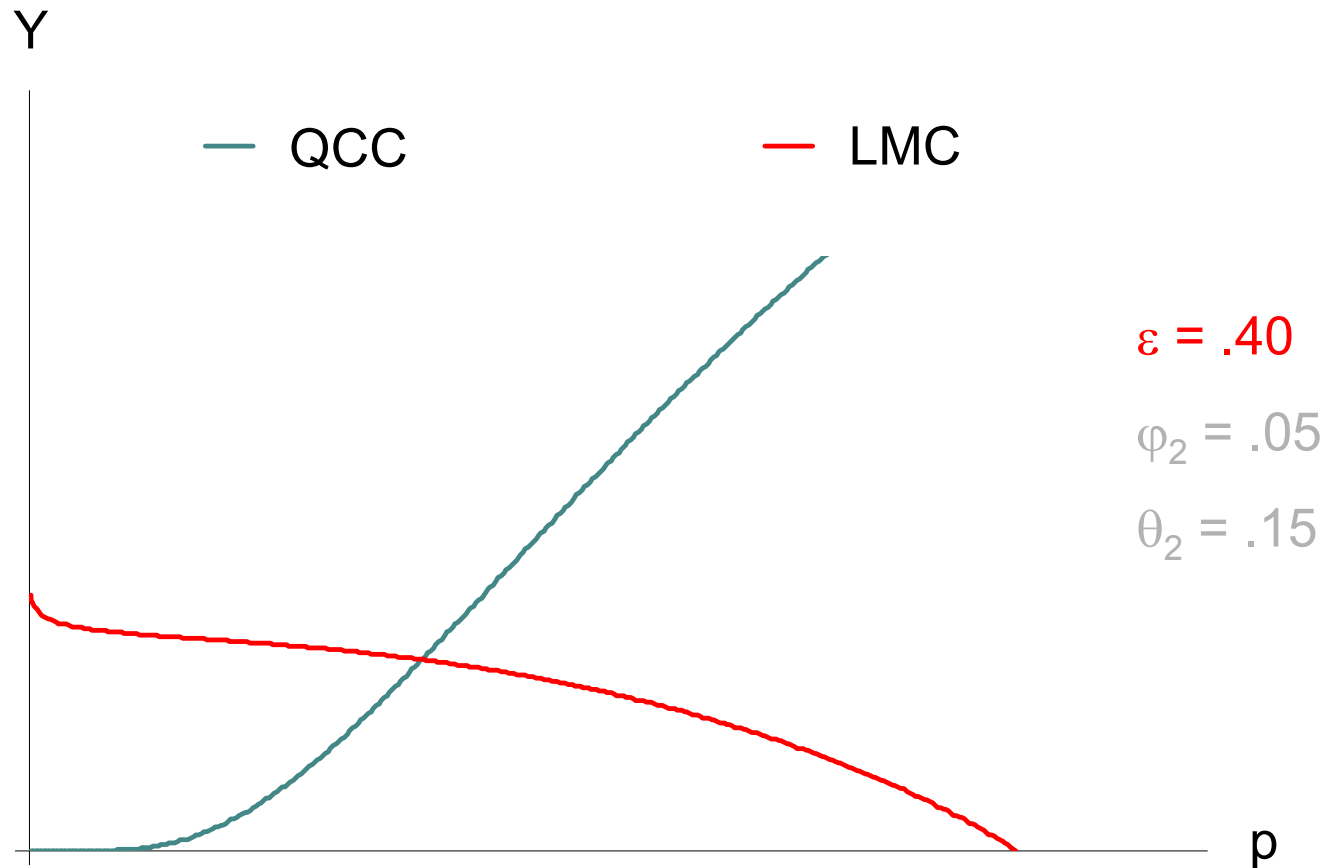
Sensitivity to wage elasticity ε



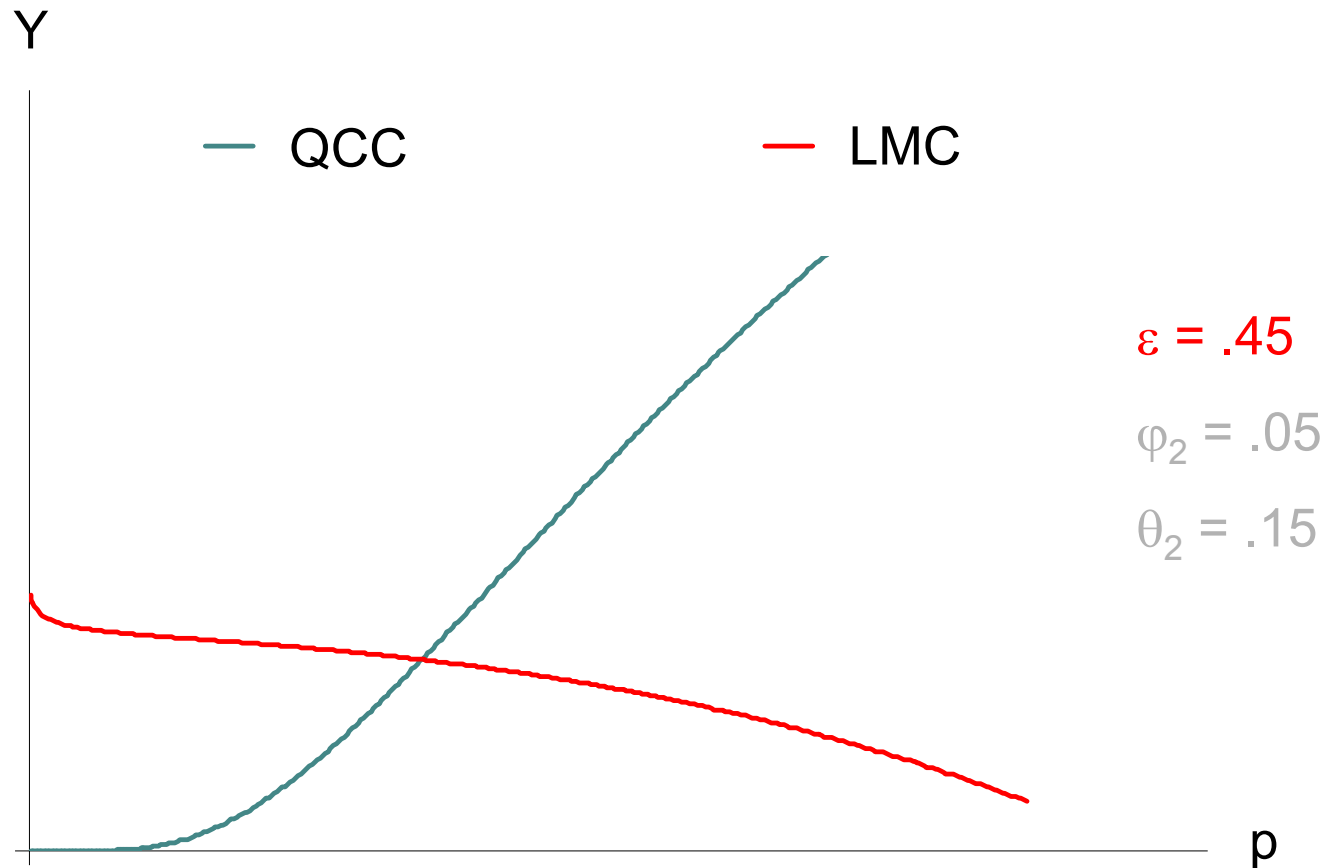
Sensitivity to wage elasticity ε



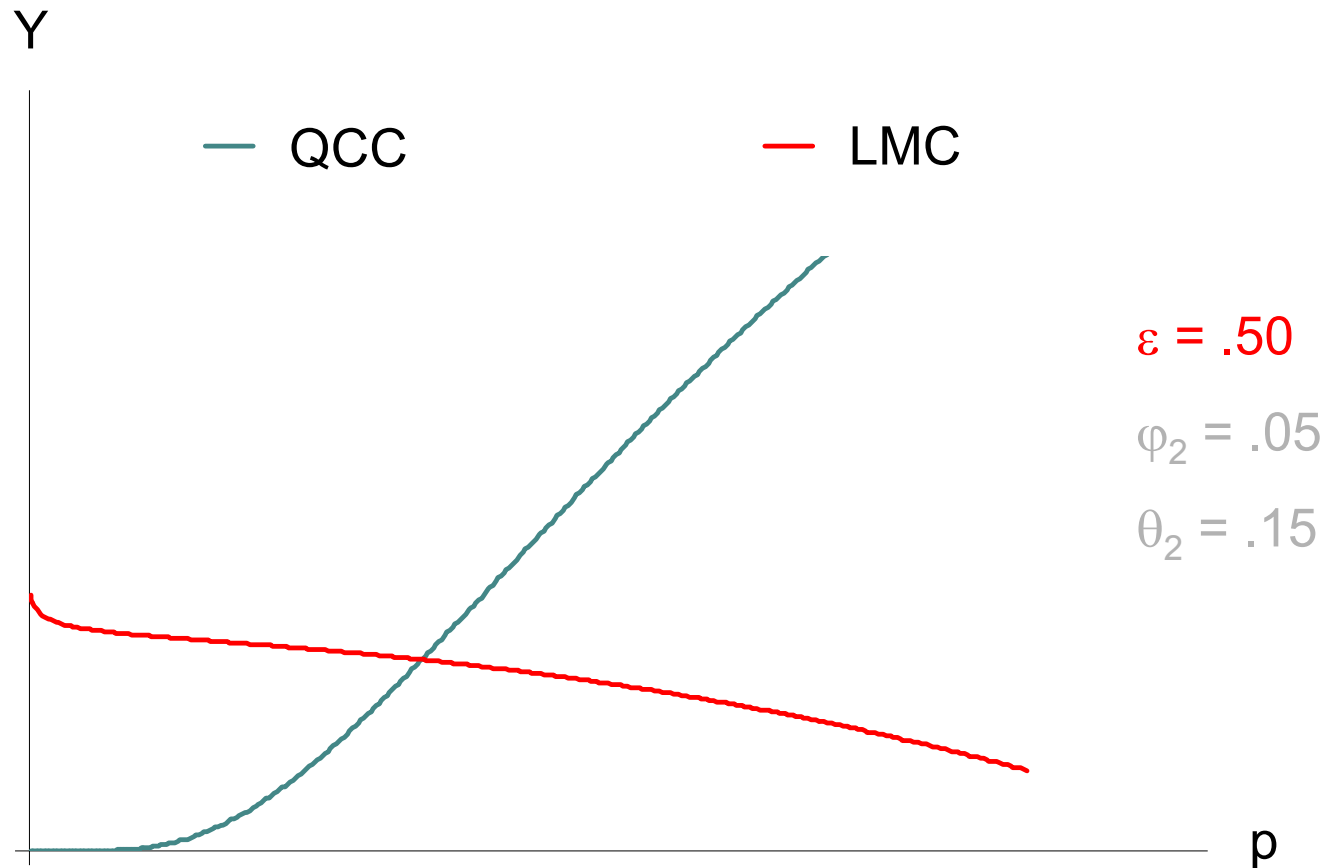
Sensitivity to wage elasticity ε



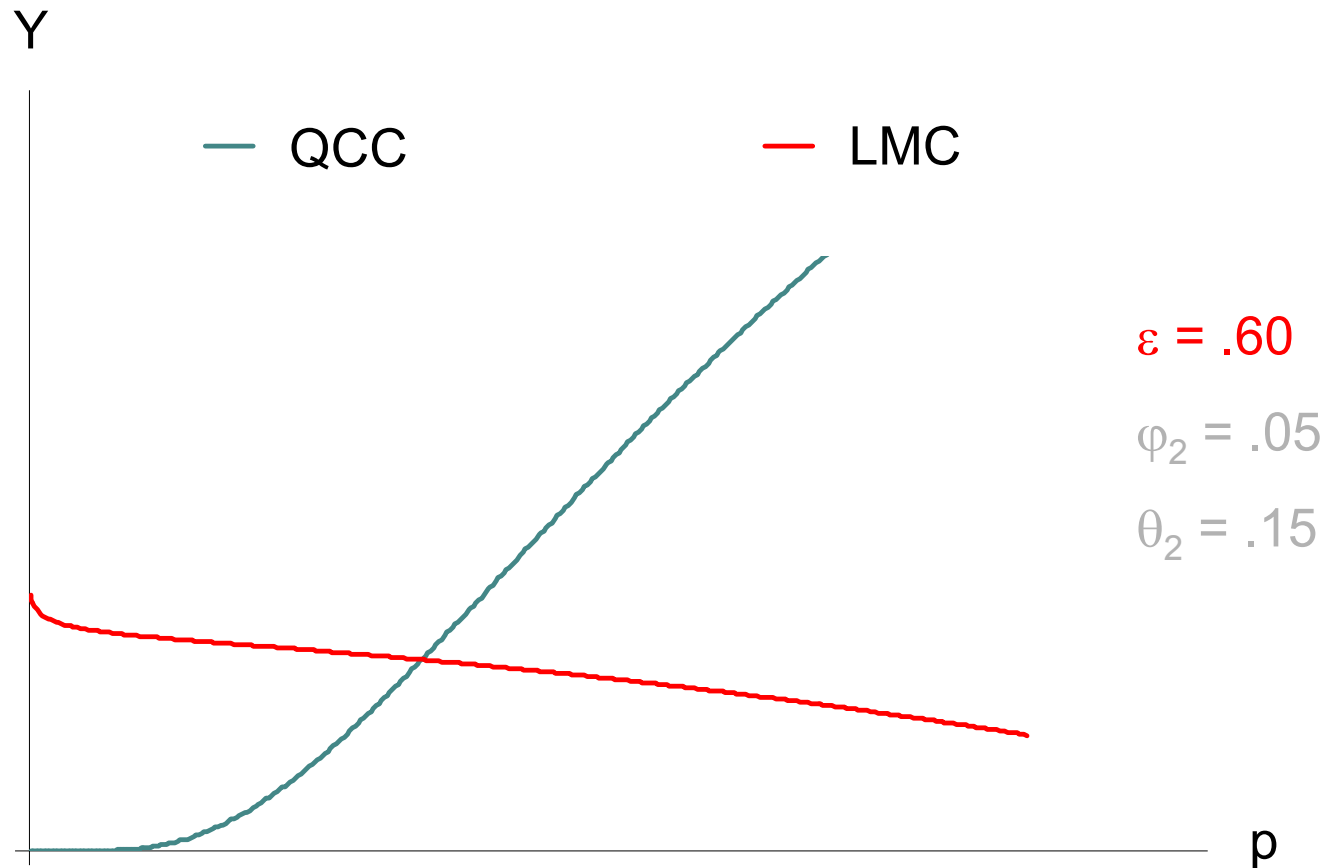
Sensitivity to wage elasticity ε



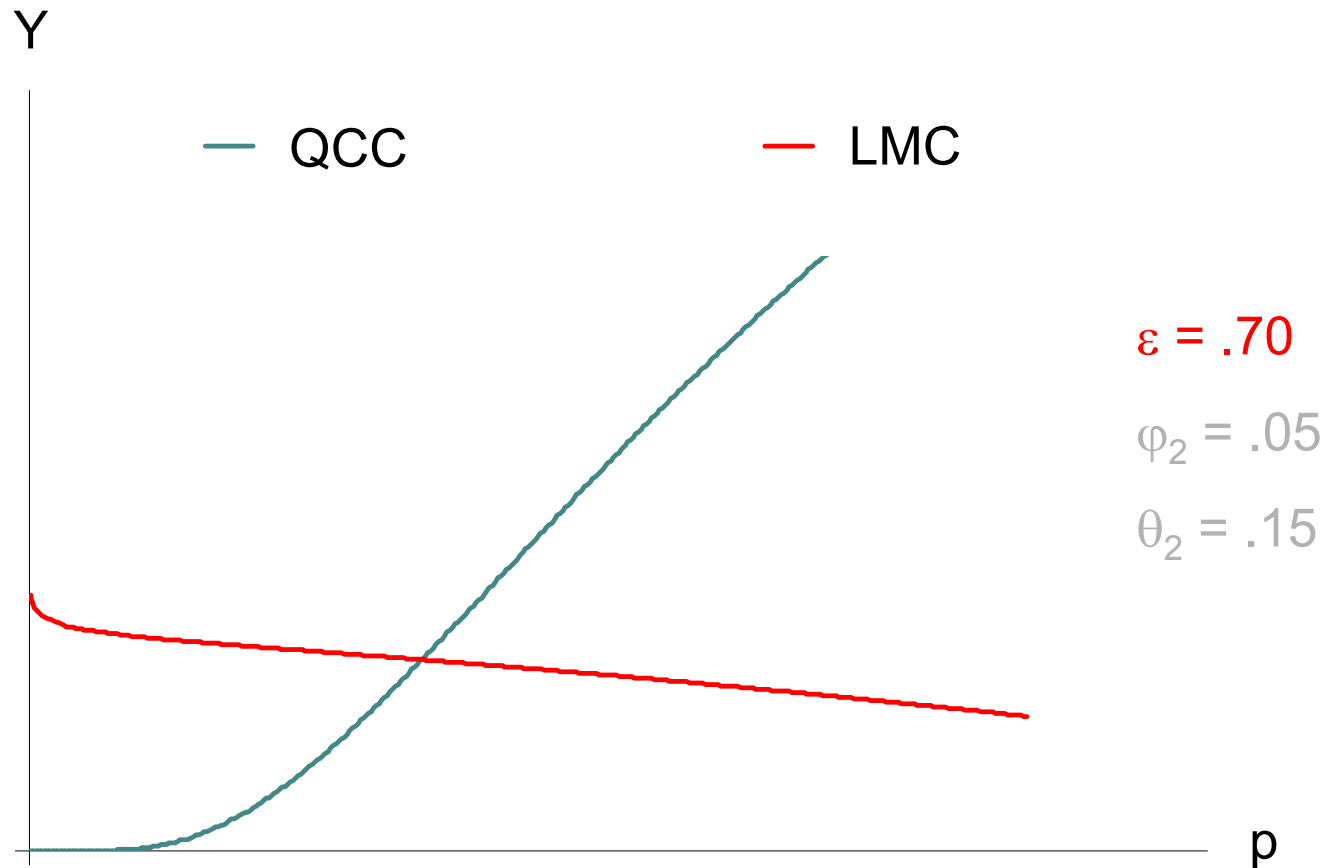
Sensitivity to wage elasticity ε



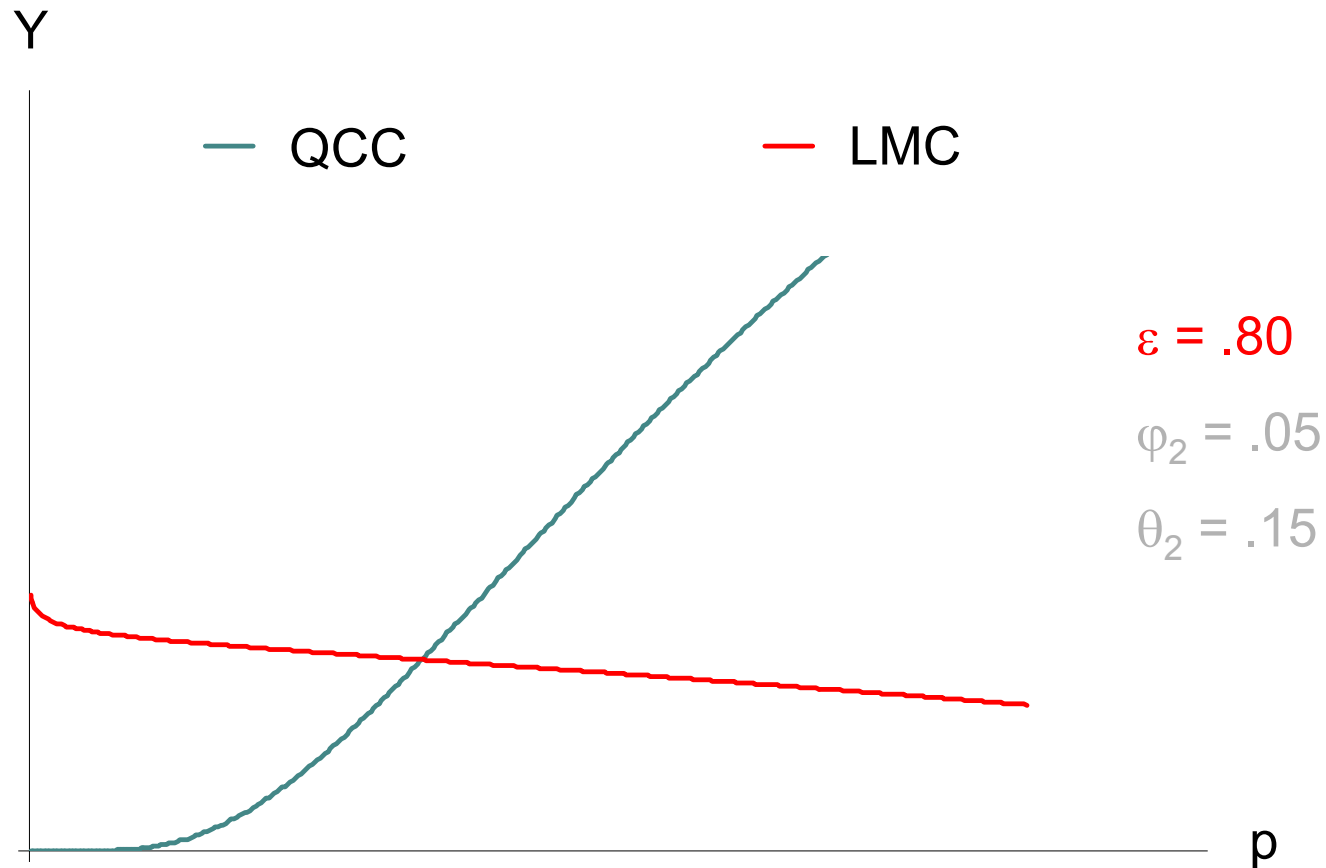
Sensitivity to wage elasticity ε



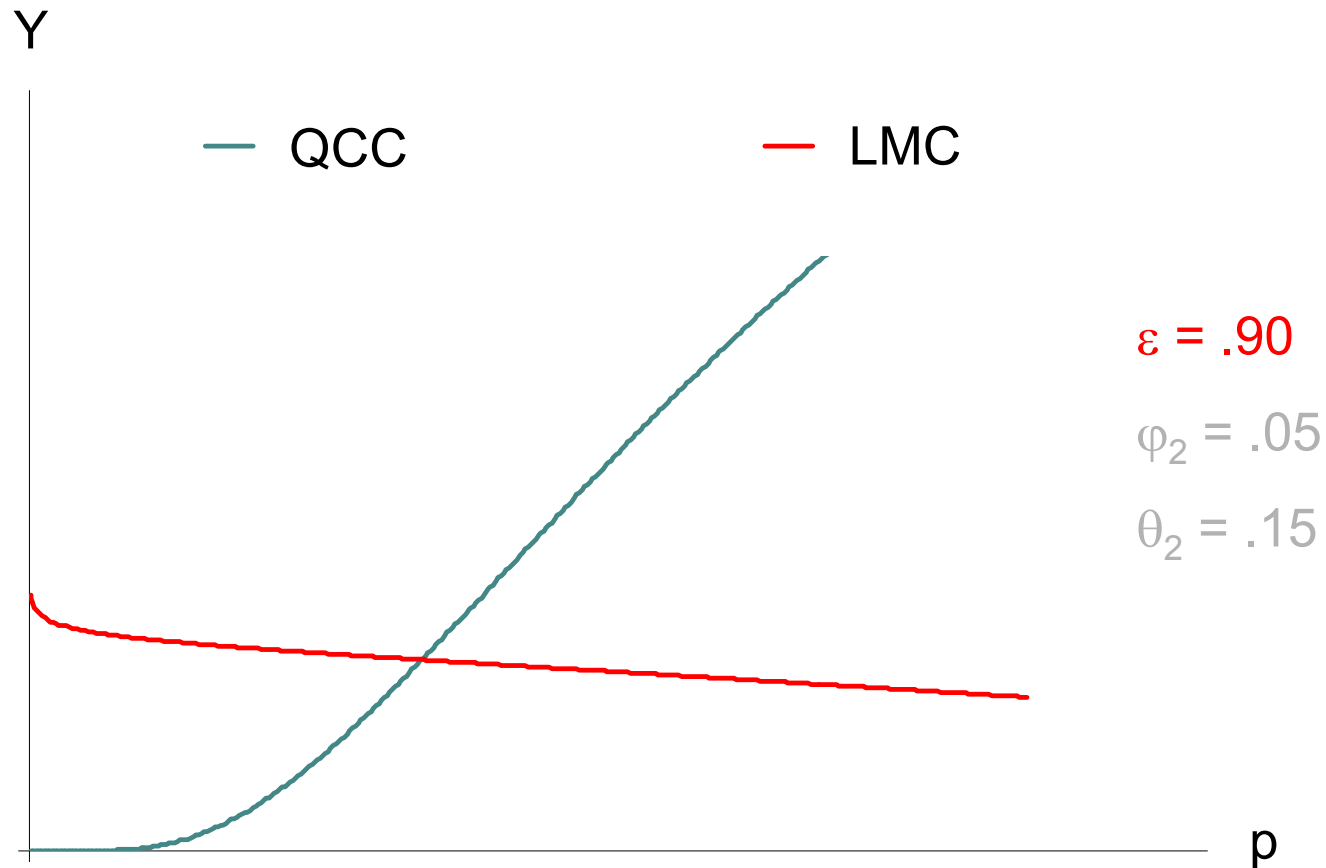
Sensitivity to wage elasticity ε



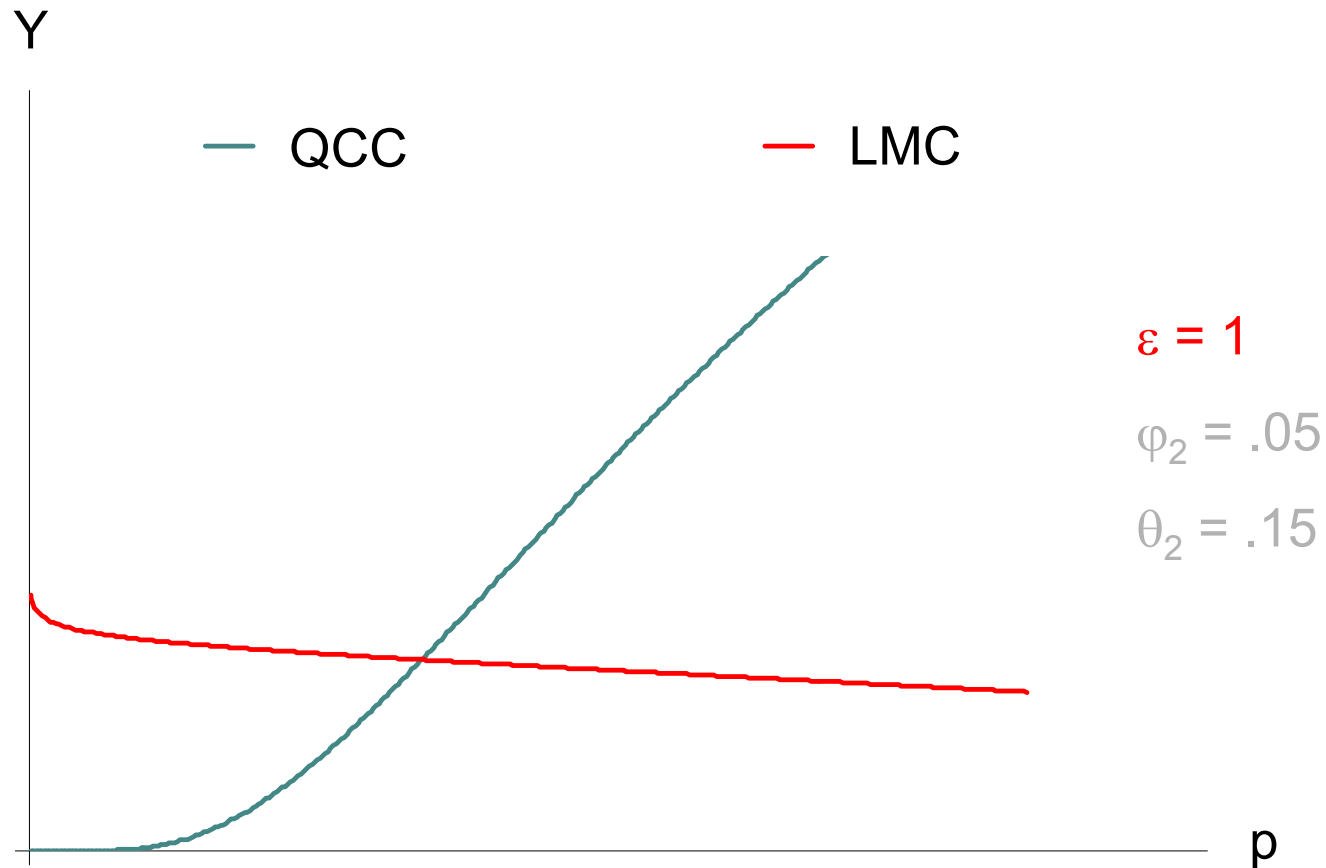
Sensitivity to wage elasticity ε



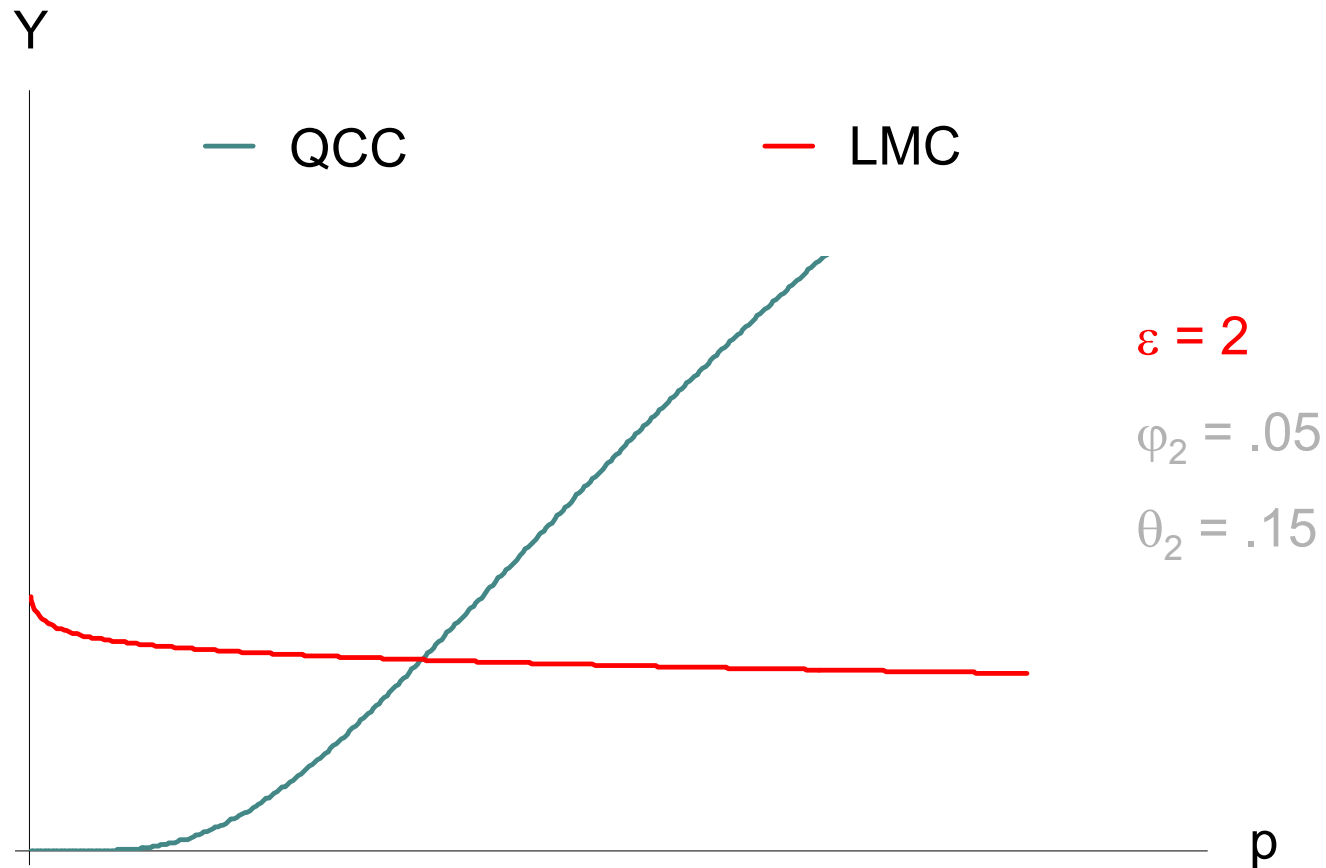
Sensitivity to wage elasticity ε



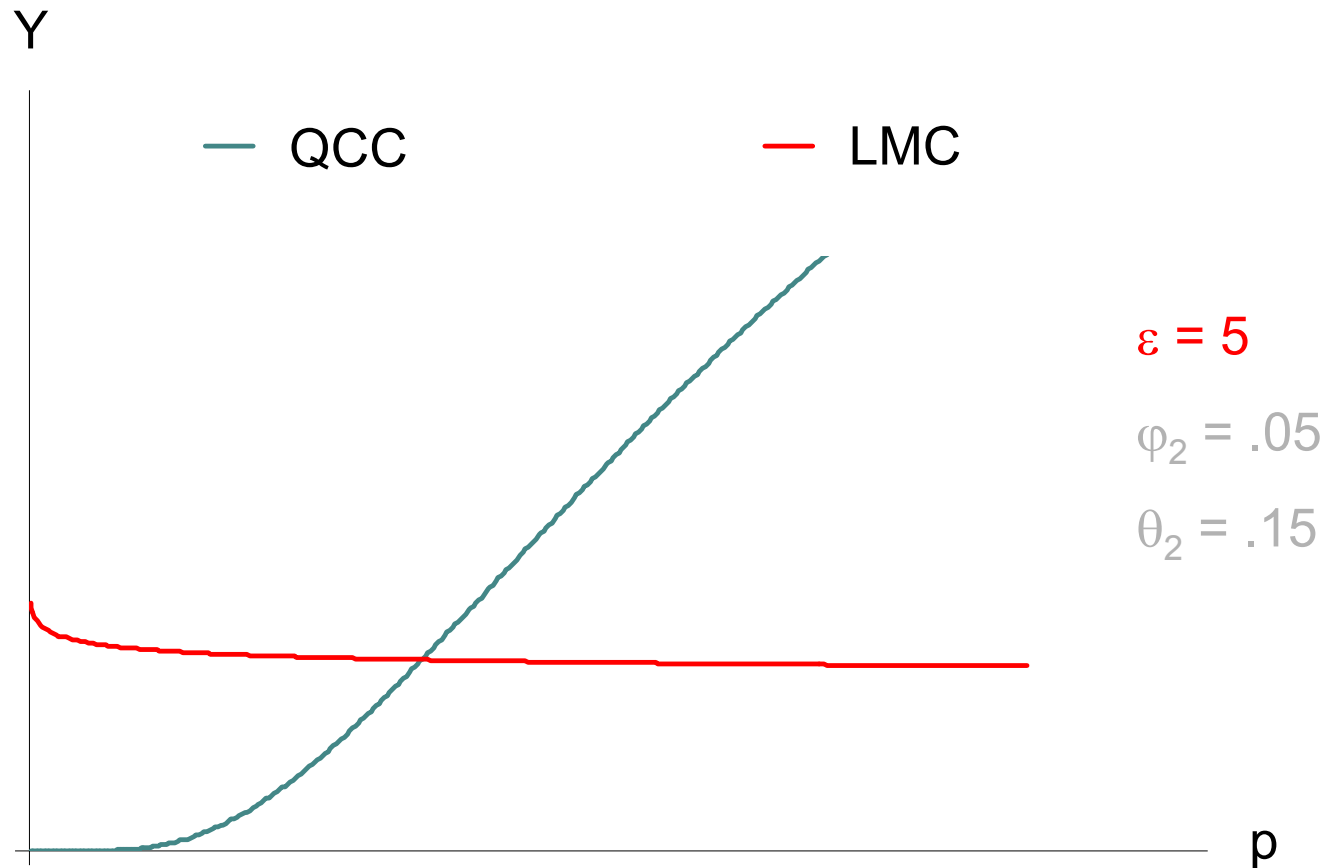
Sensitivity to wage elasticity ε



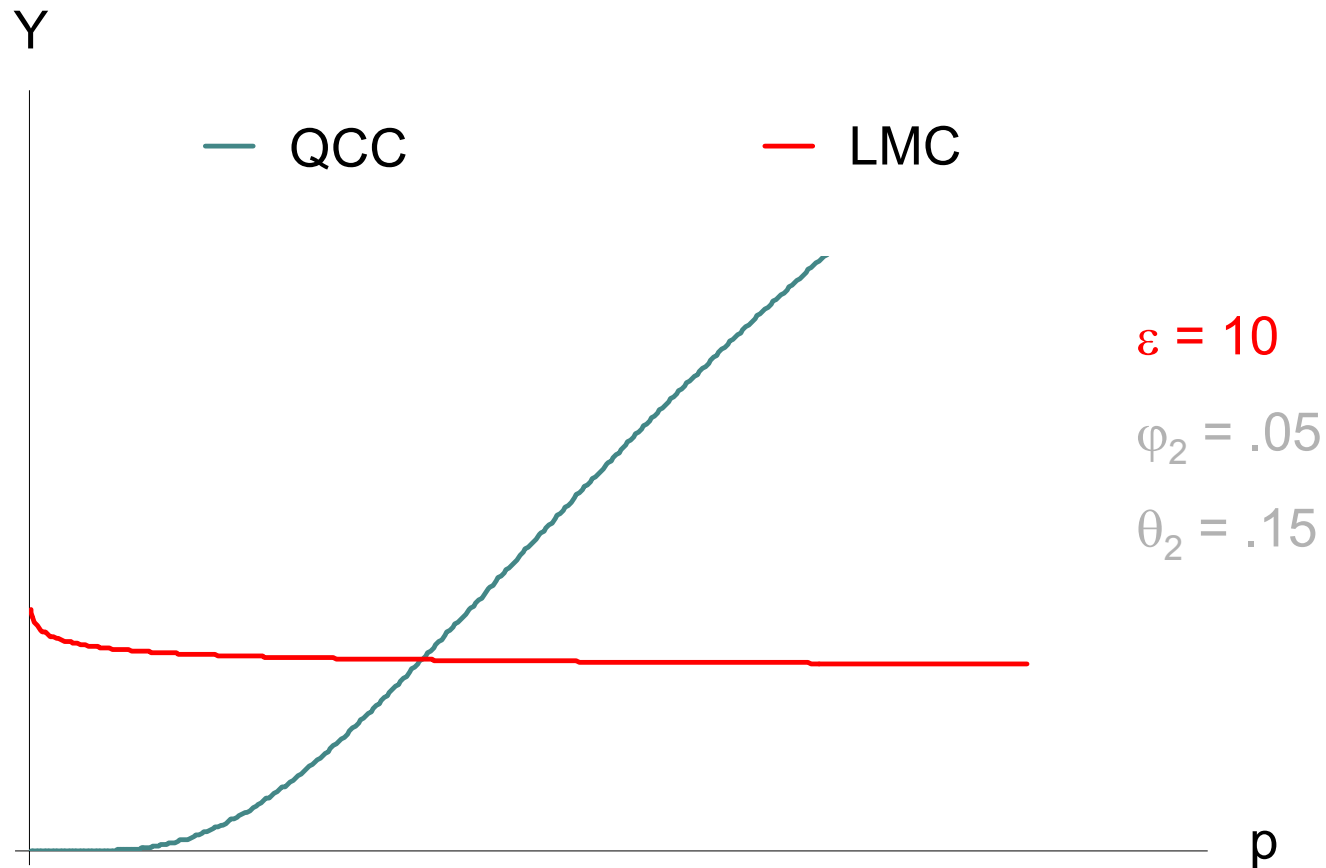
Sensitivity to wage elasticity ε



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Excise tax t , $\varphi_2 > \theta_2$

$$\varepsilon = .10$$

$$\varphi_2 = .15$$

$$\theta_2 = .12$$

$$t = 4$$

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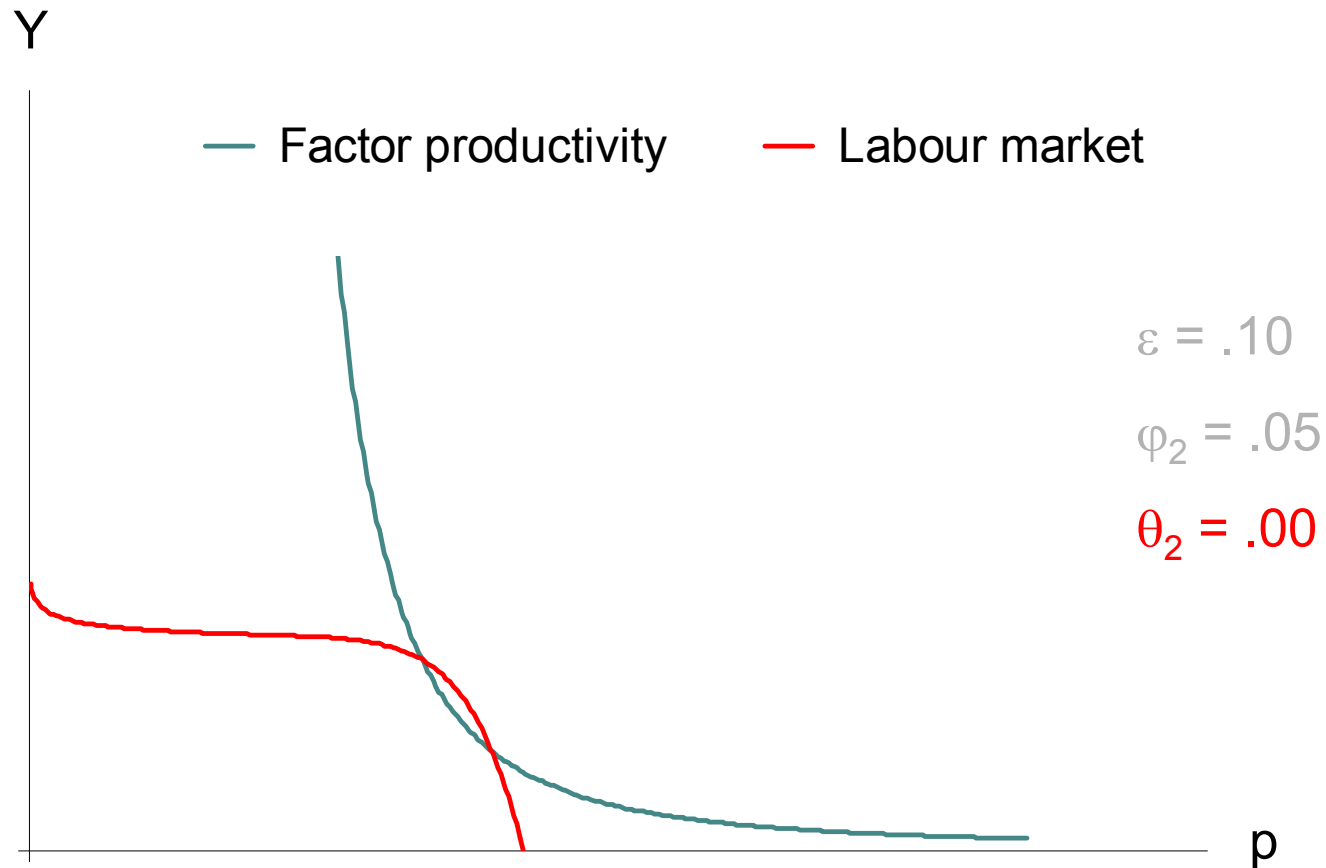
$$\varepsilon = .10$$

$$\varphi_2 = .15$$

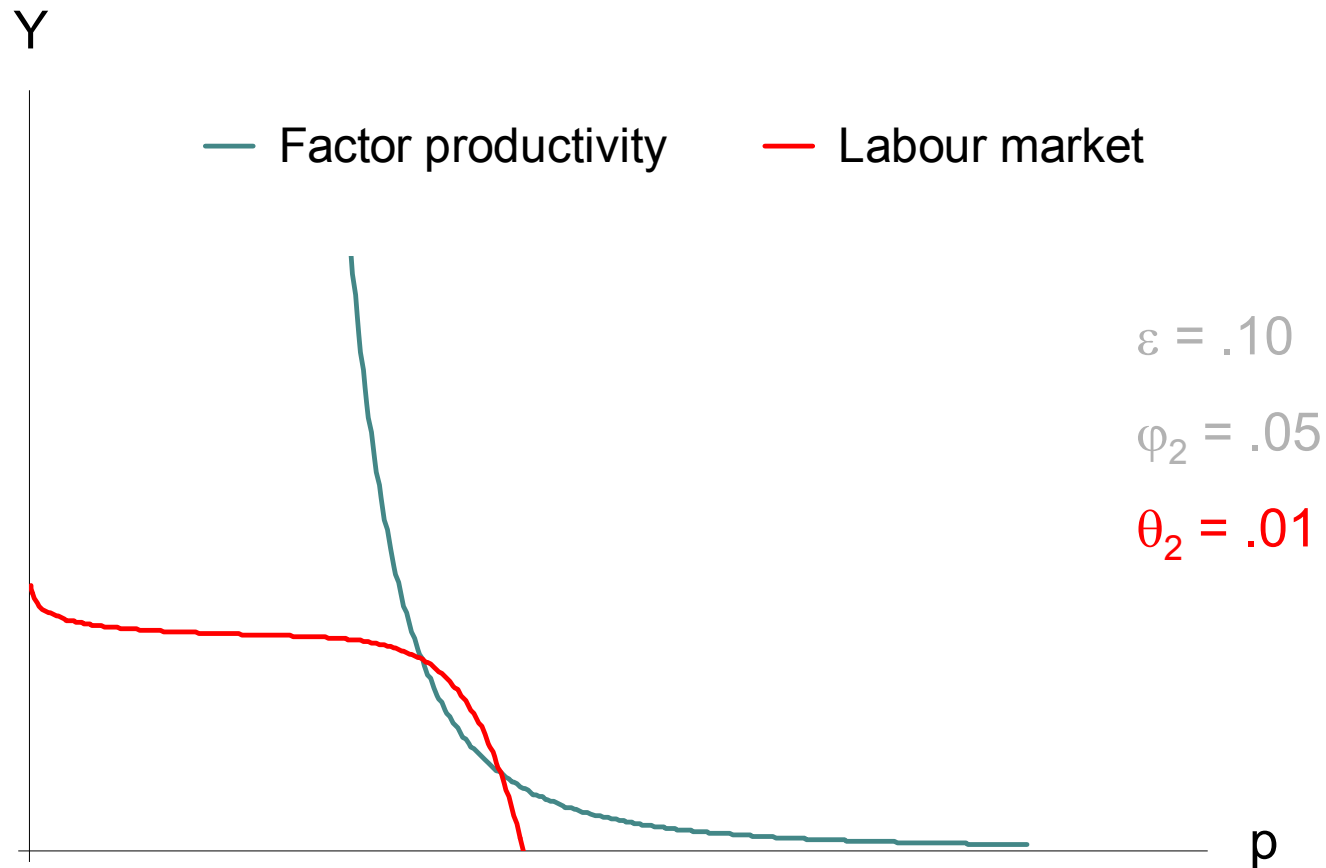
$$\theta_2 = .12$$

$$t = 4$$

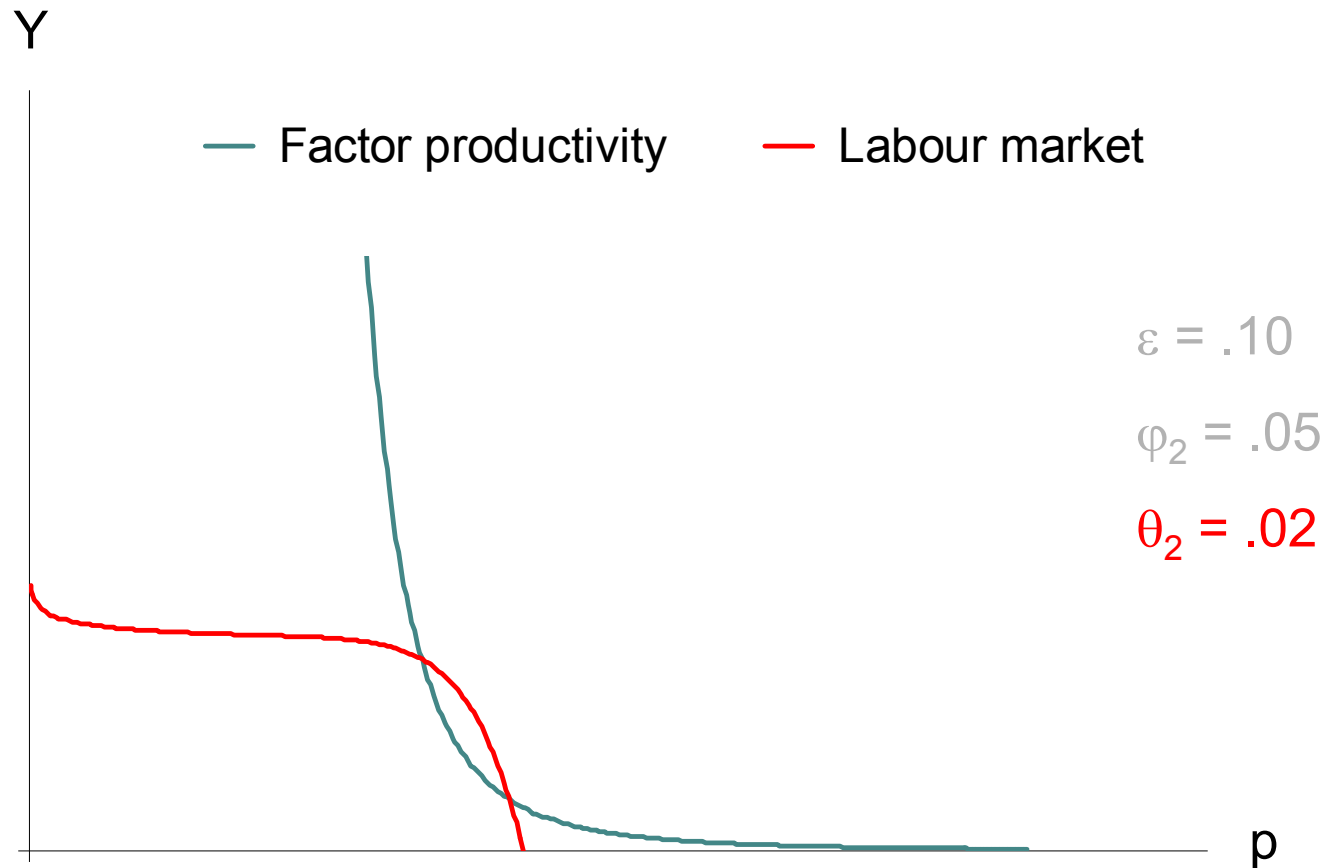
Sensitivity to DR elasticity θ_2



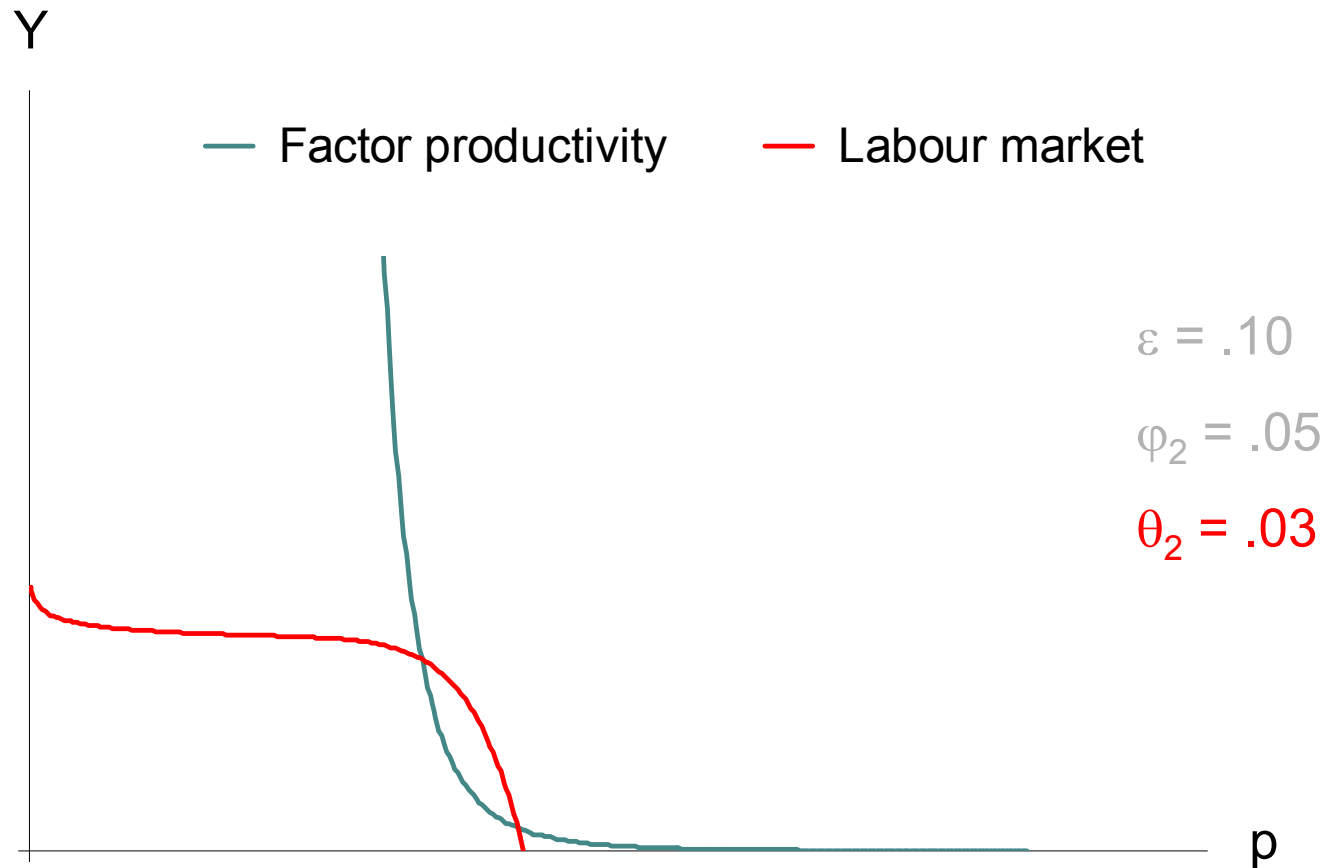
Sensitivity to DR elasticity θ_2



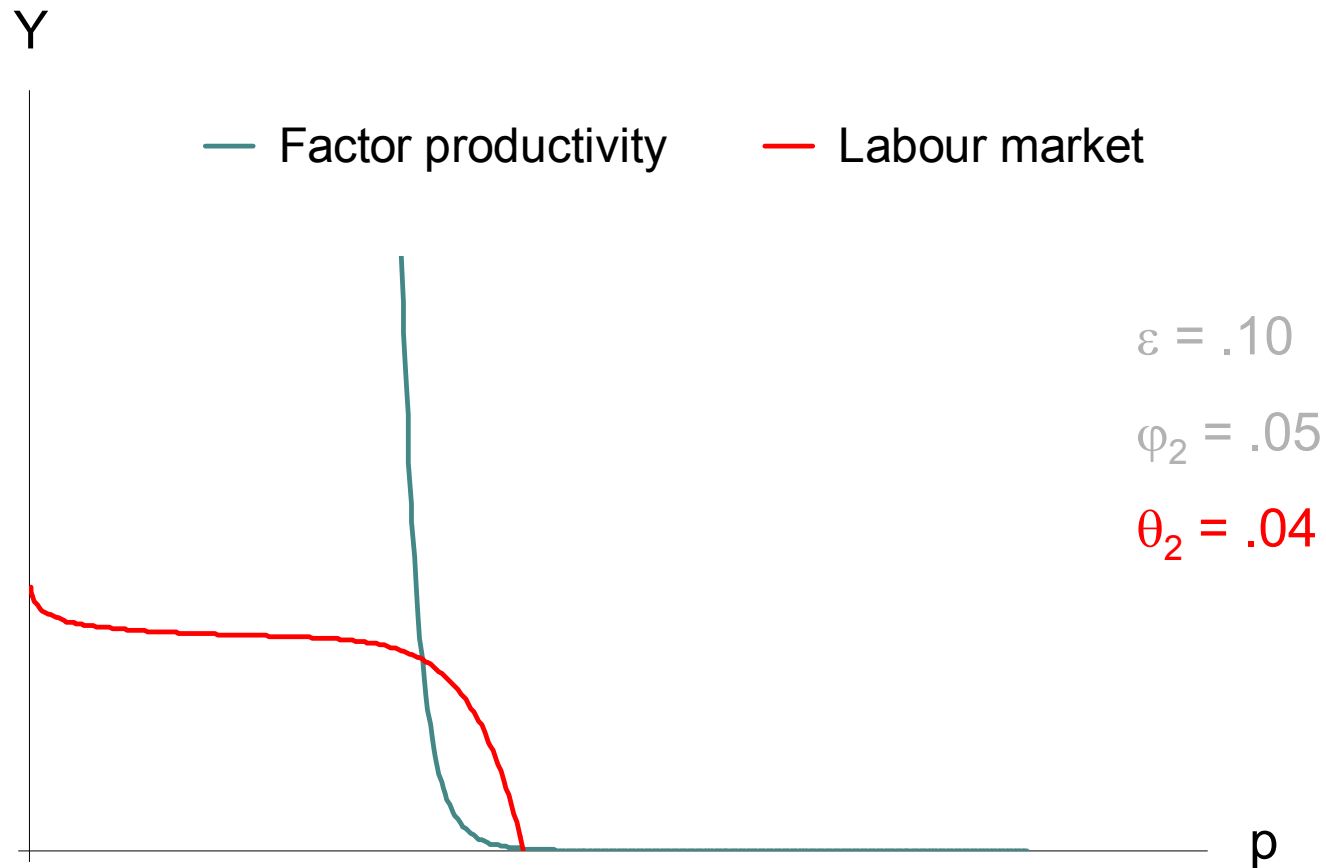
Sensitivity to DR elasticity θ_2



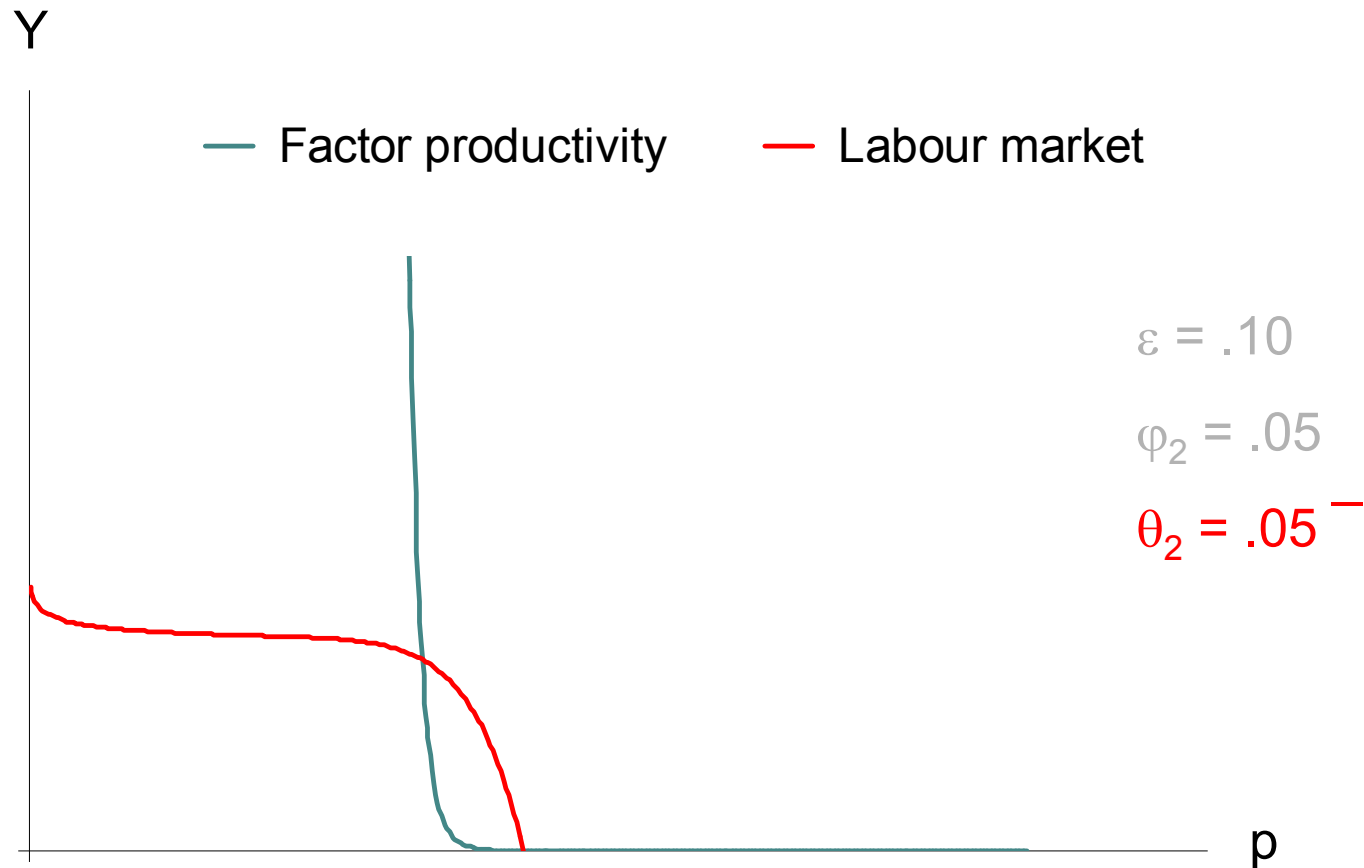
Sensitivity to DR elasticity θ_2



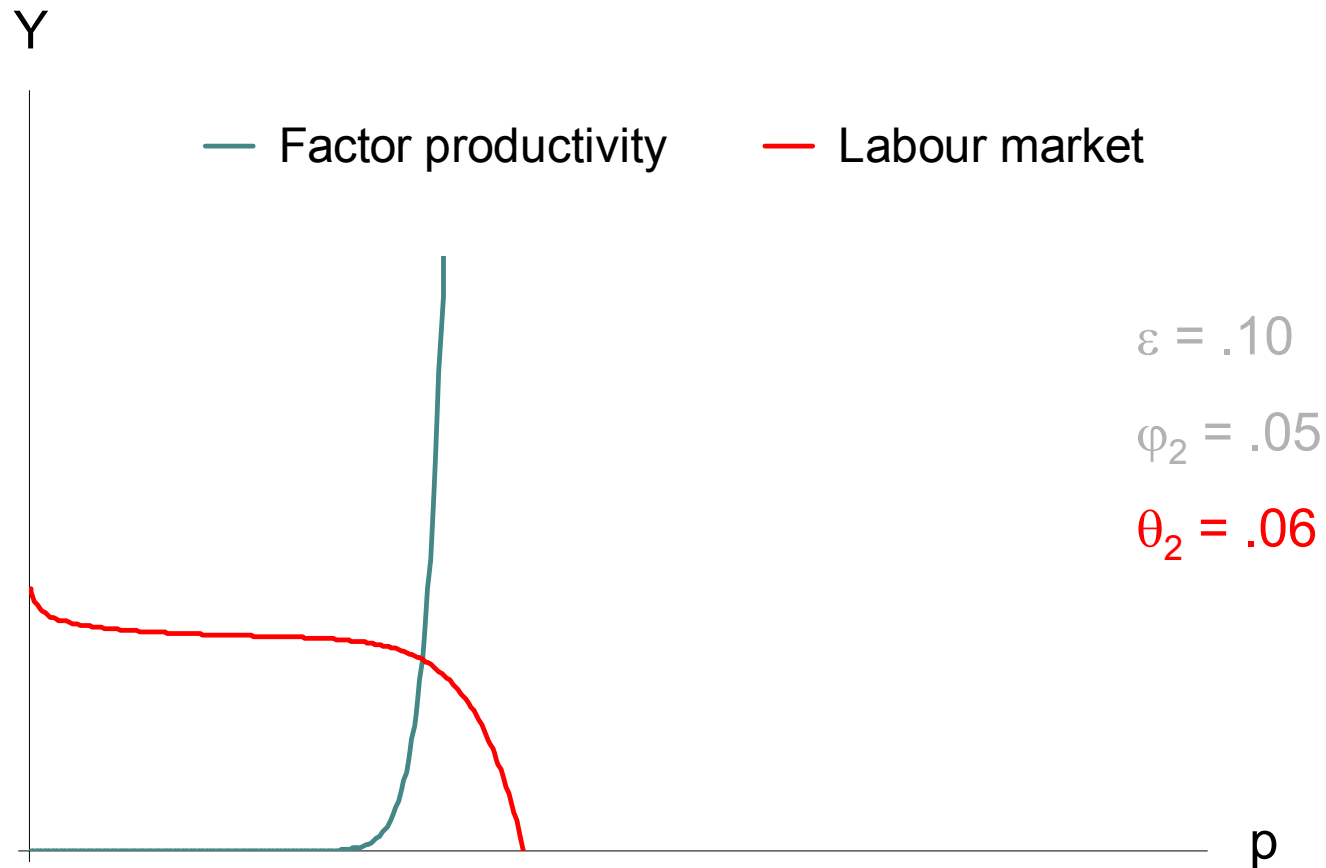
Sensitivity to DR elasticity θ_2



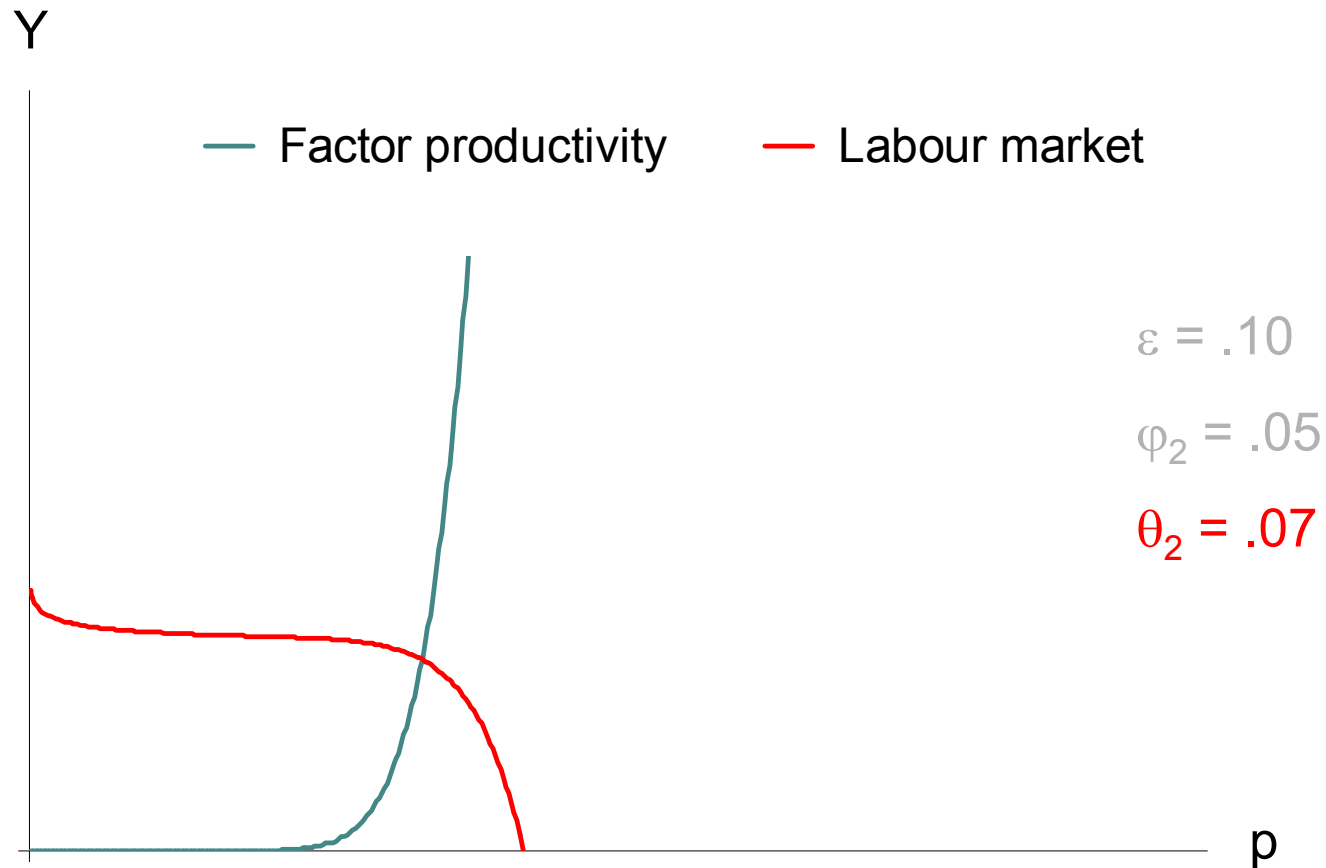
Sensitivity to DR elasticity θ_2



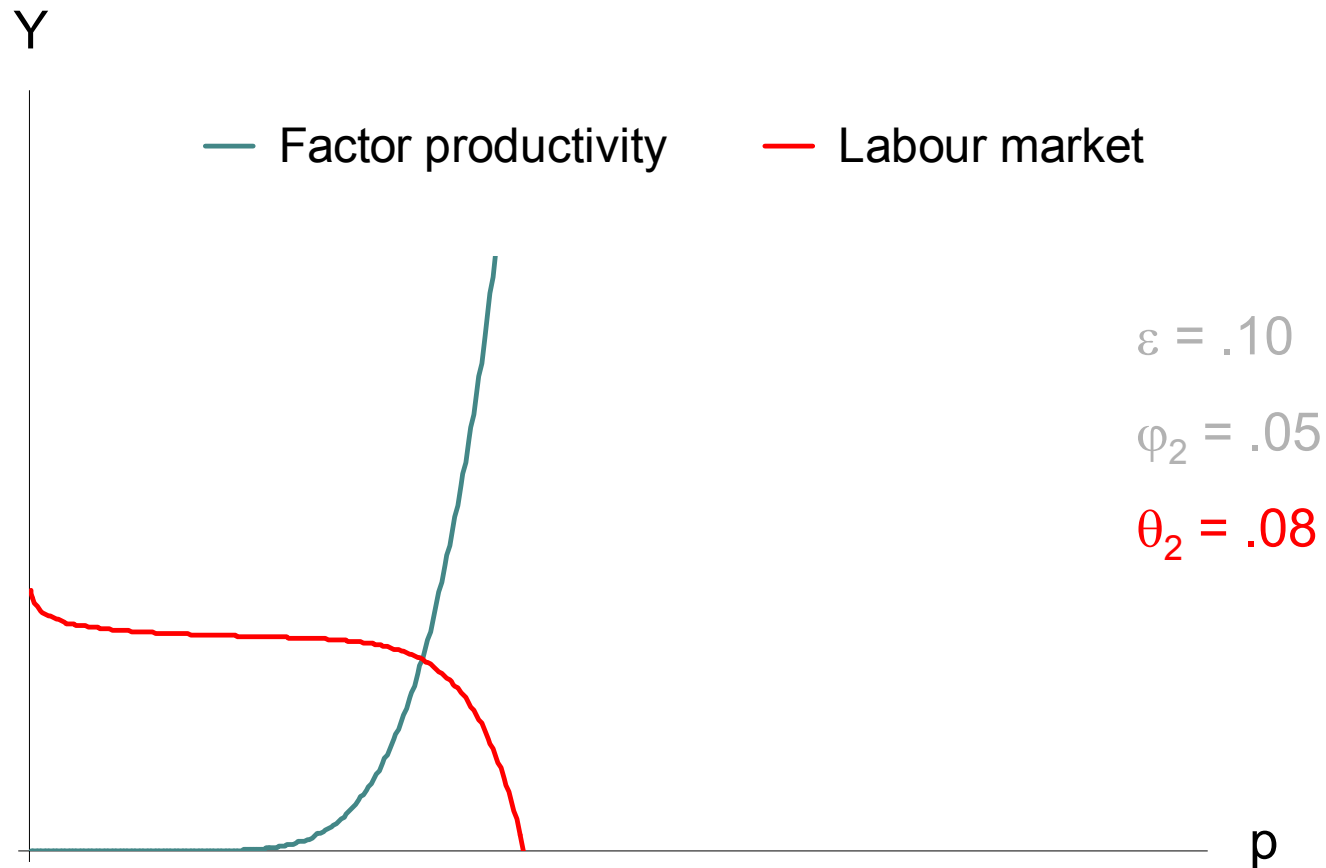
Sensitivity to DR elasticity θ_2



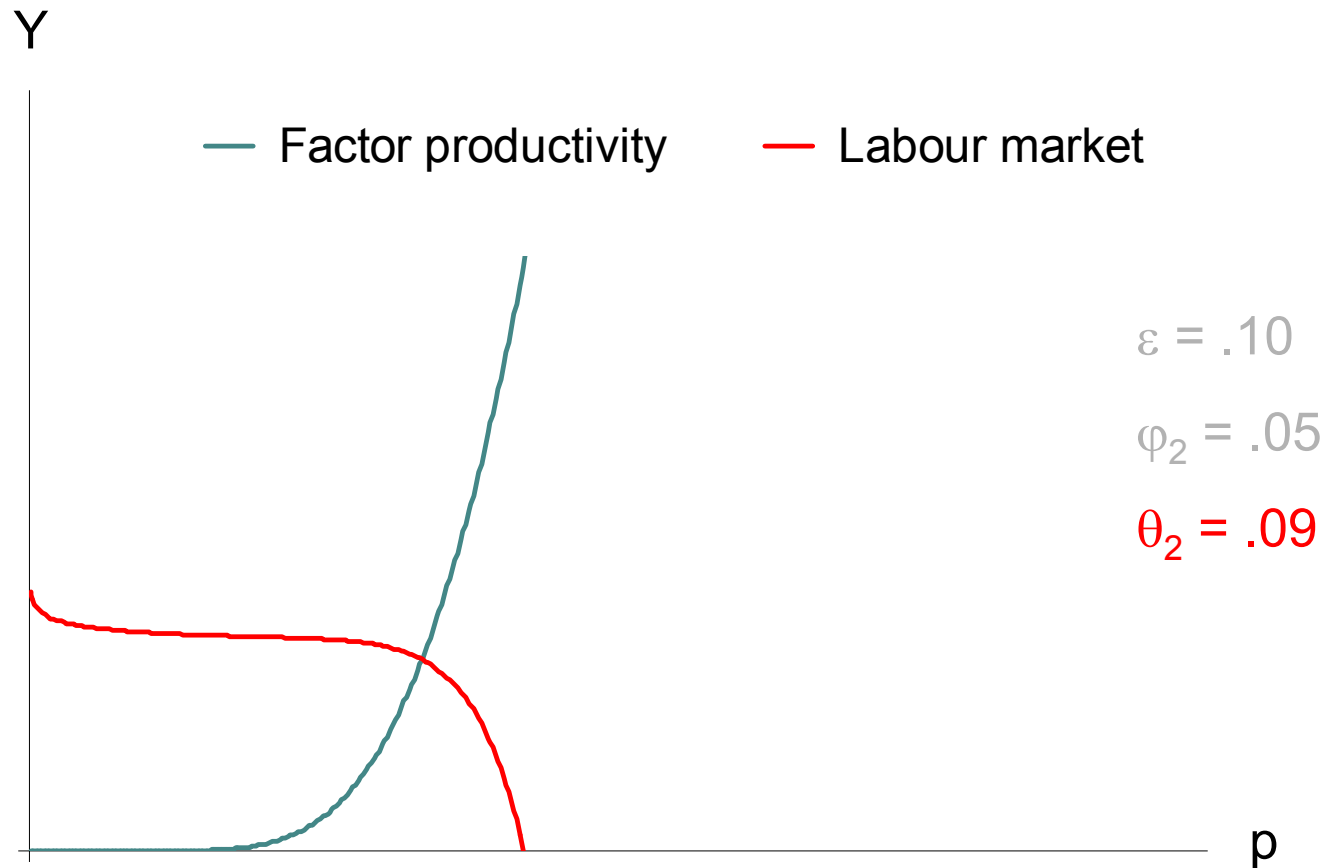
Sensitivity to DR elasticity θ_2



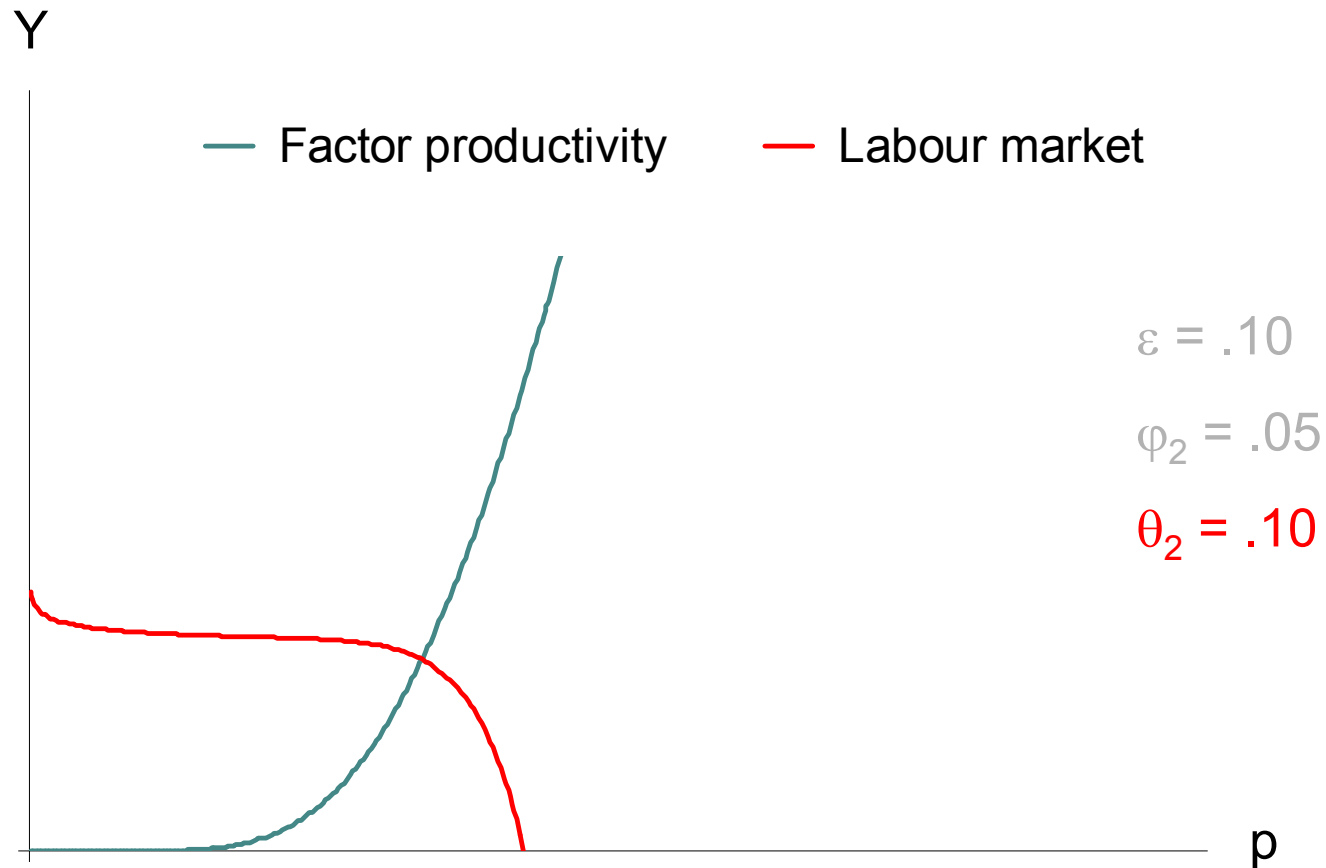
Sensitivity to DR elasticity θ_2



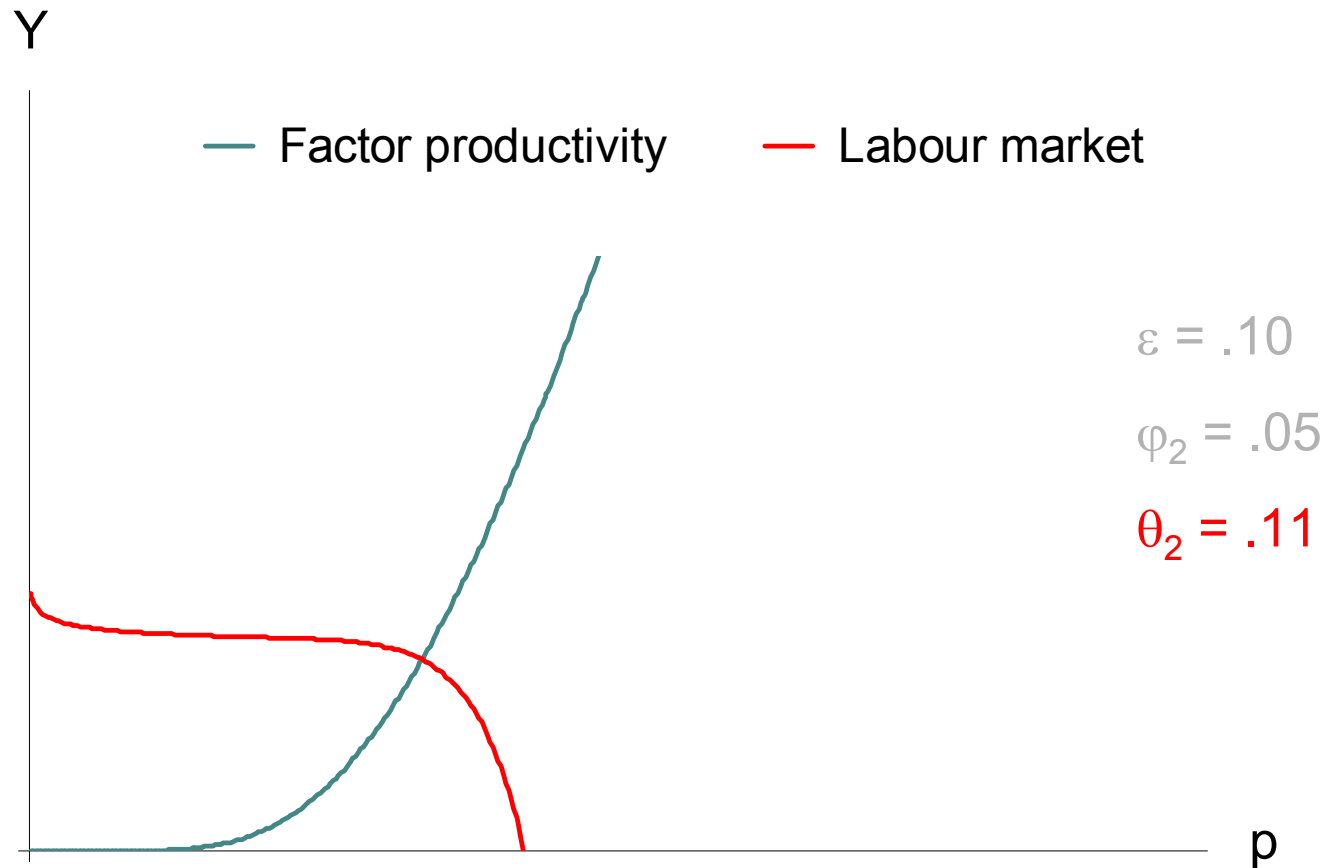
Sensitivity to DR elasticity θ_2



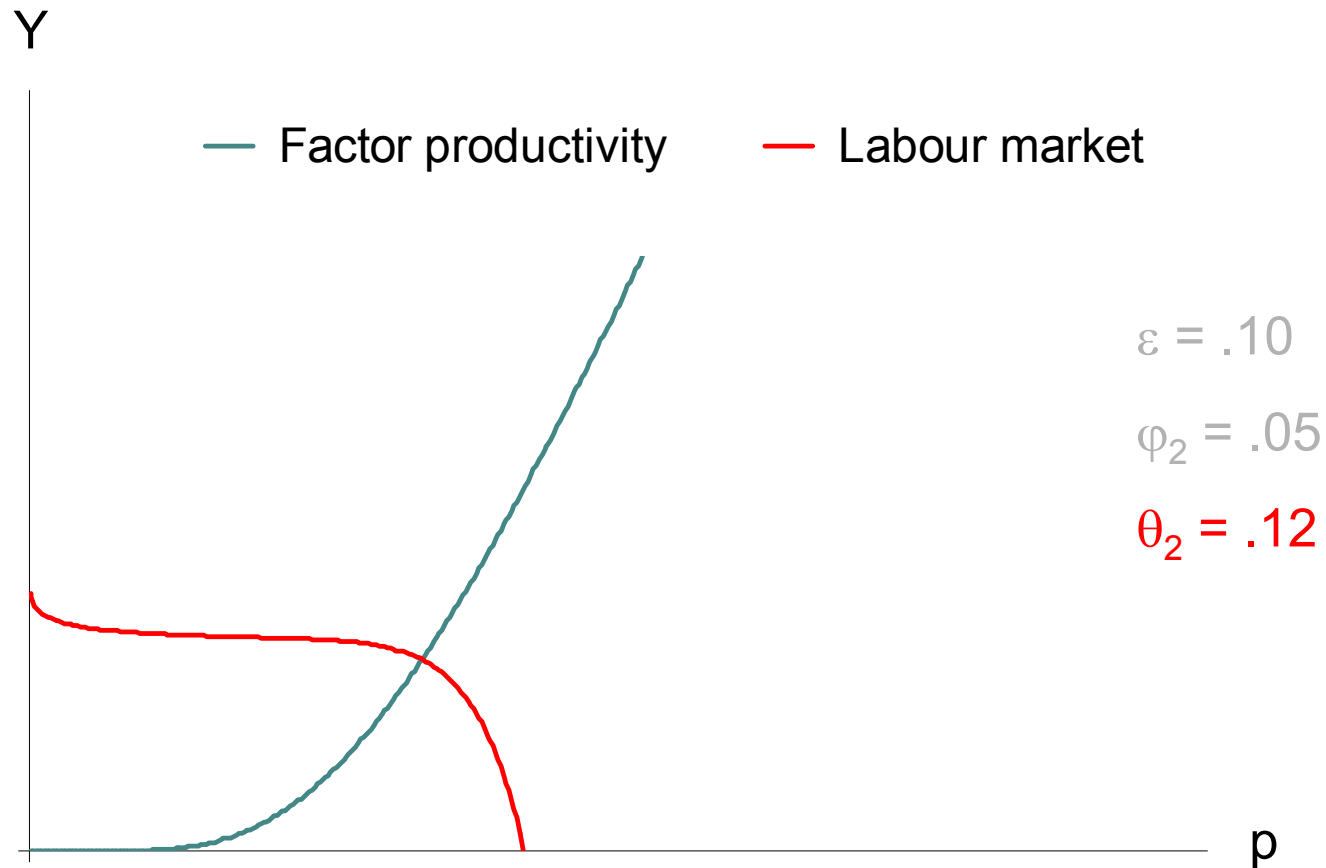
Sensitivity to DR elasticity θ_2



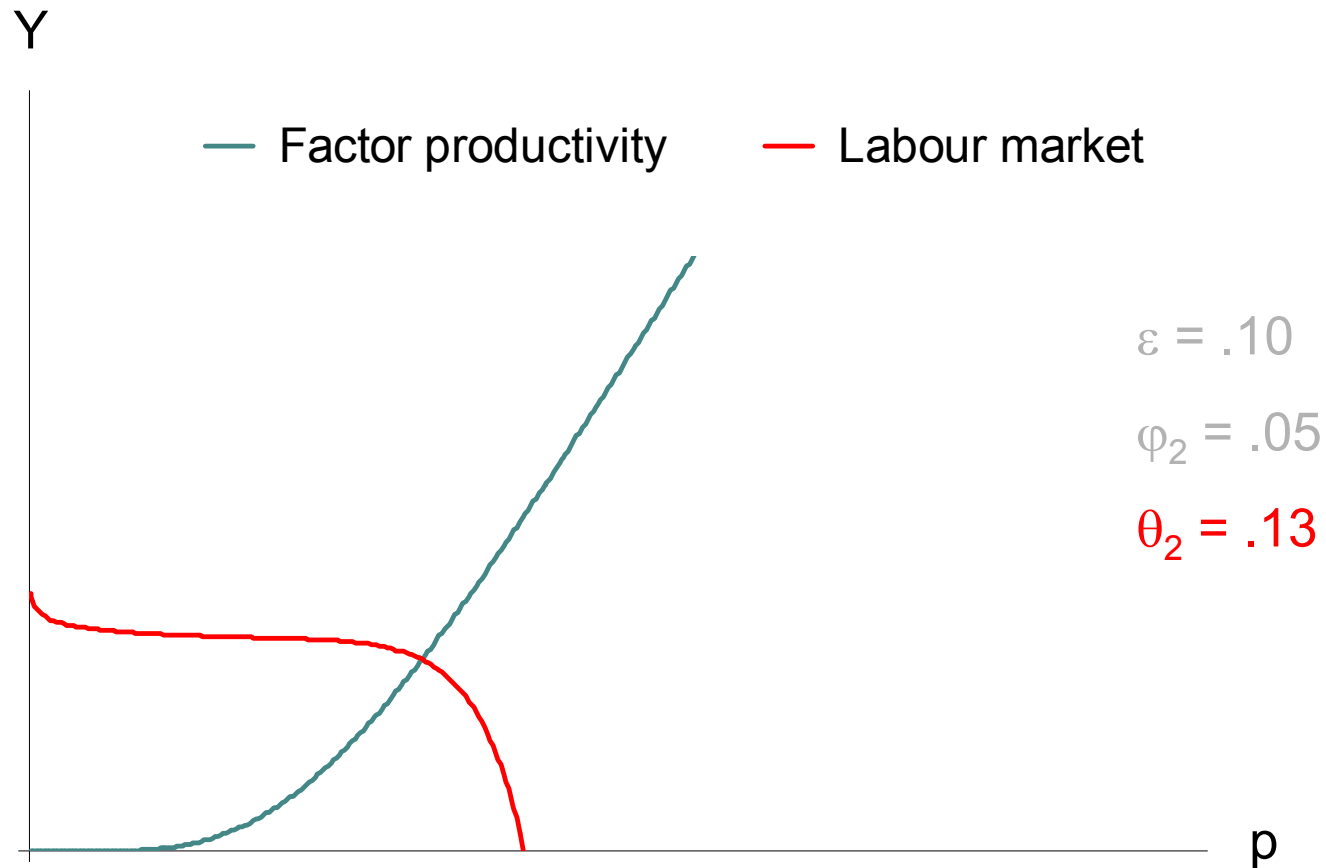
Sensitivity to DR elasticity θ_2



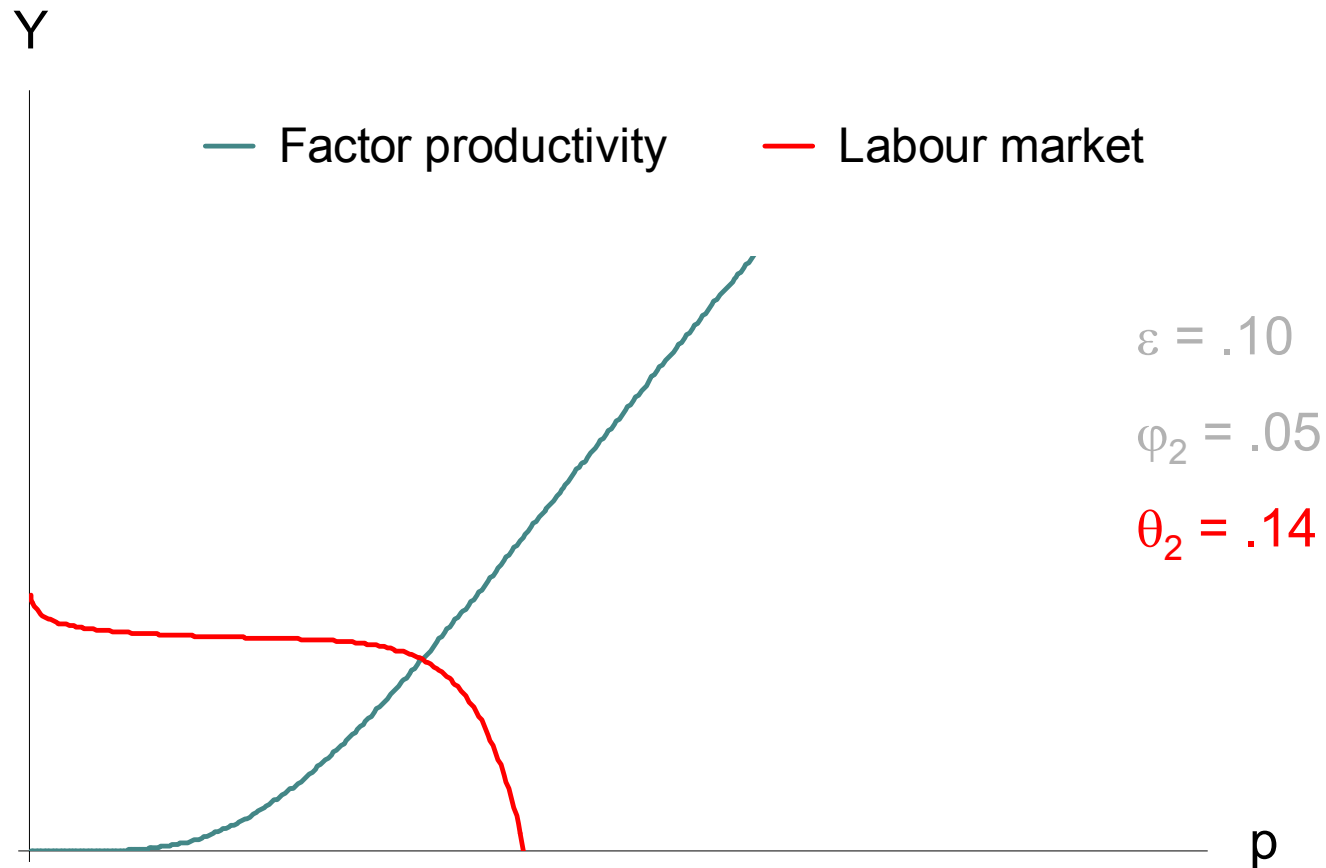
Sensitivity to DR elasticity θ_2



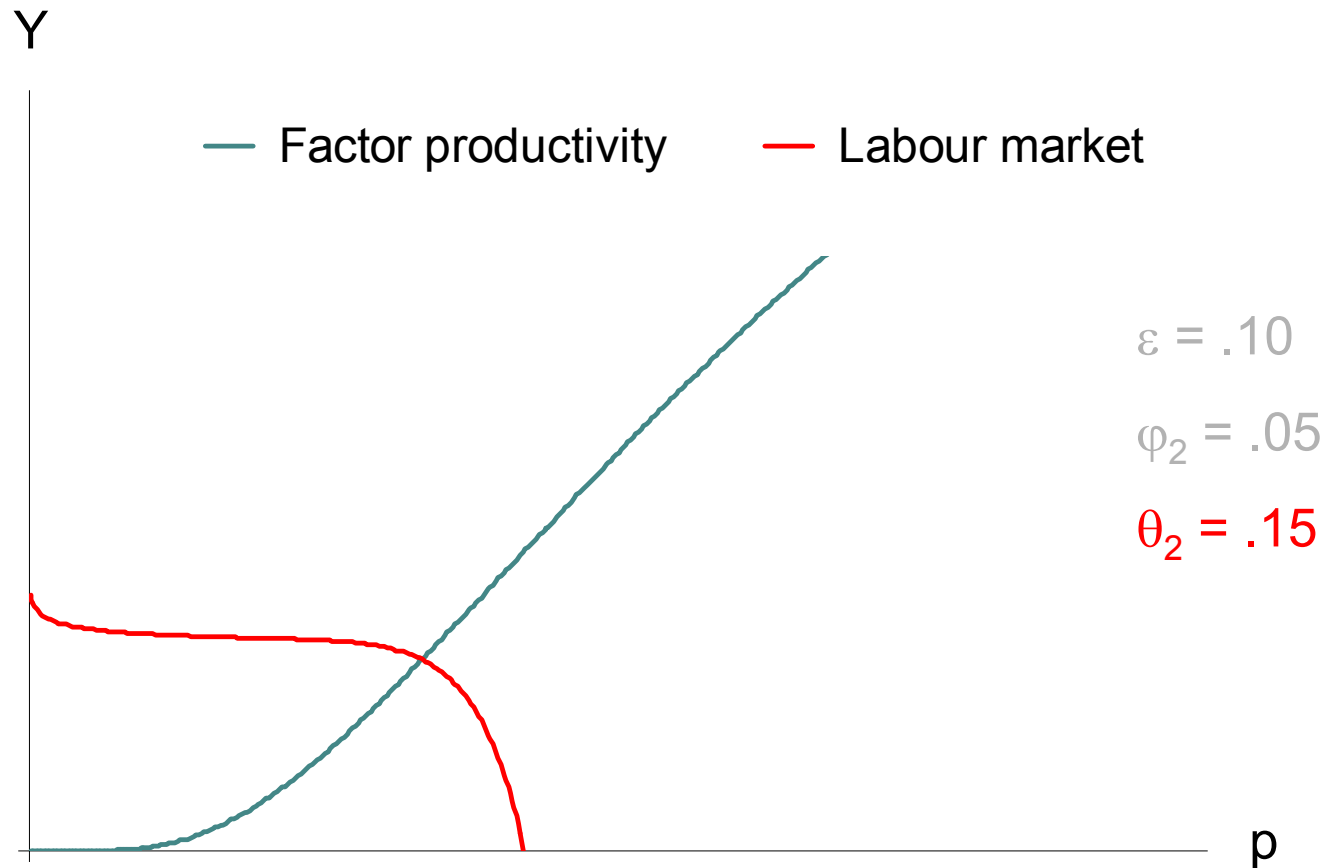
Sensitivity to DR elasticity θ_2



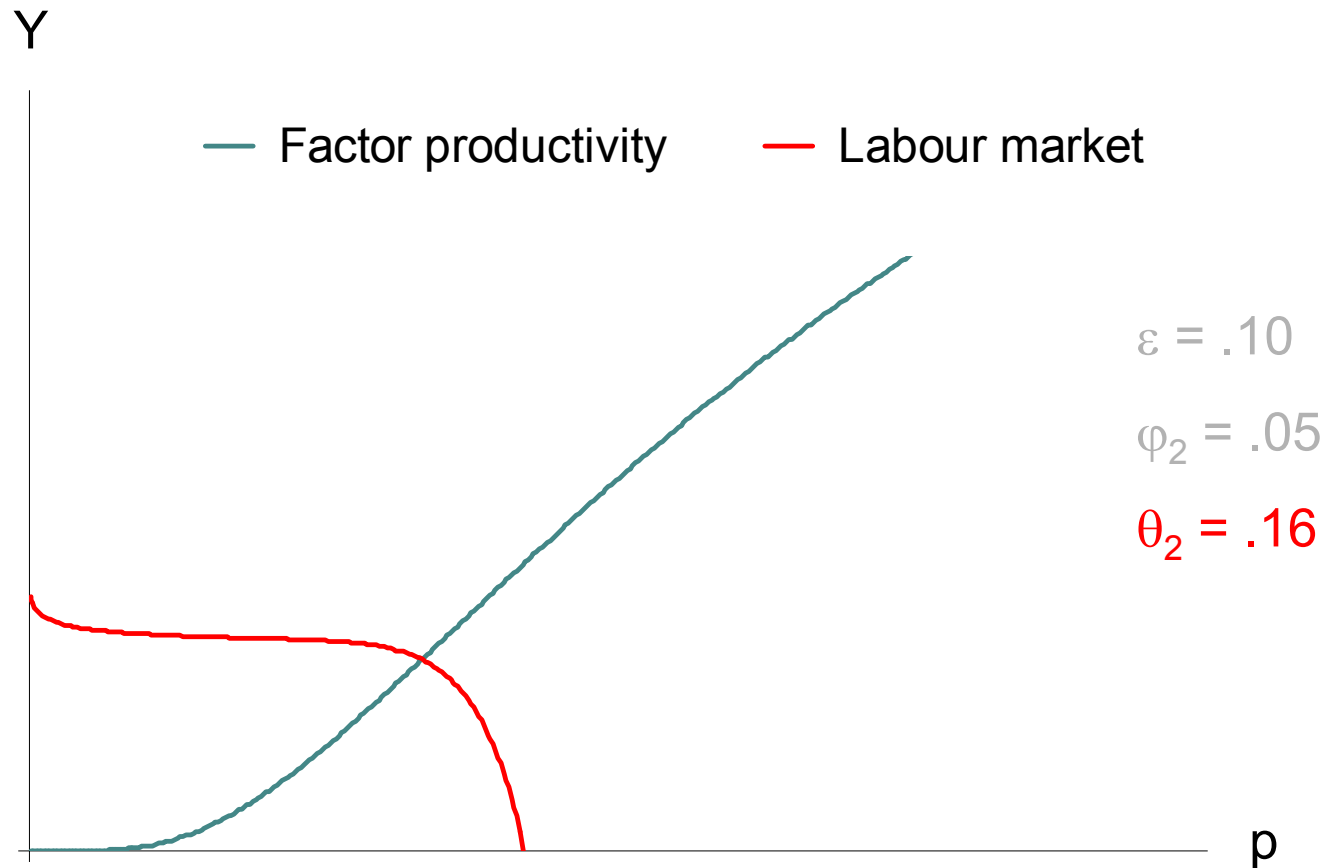
Sensitivity to DR elasticity θ_2



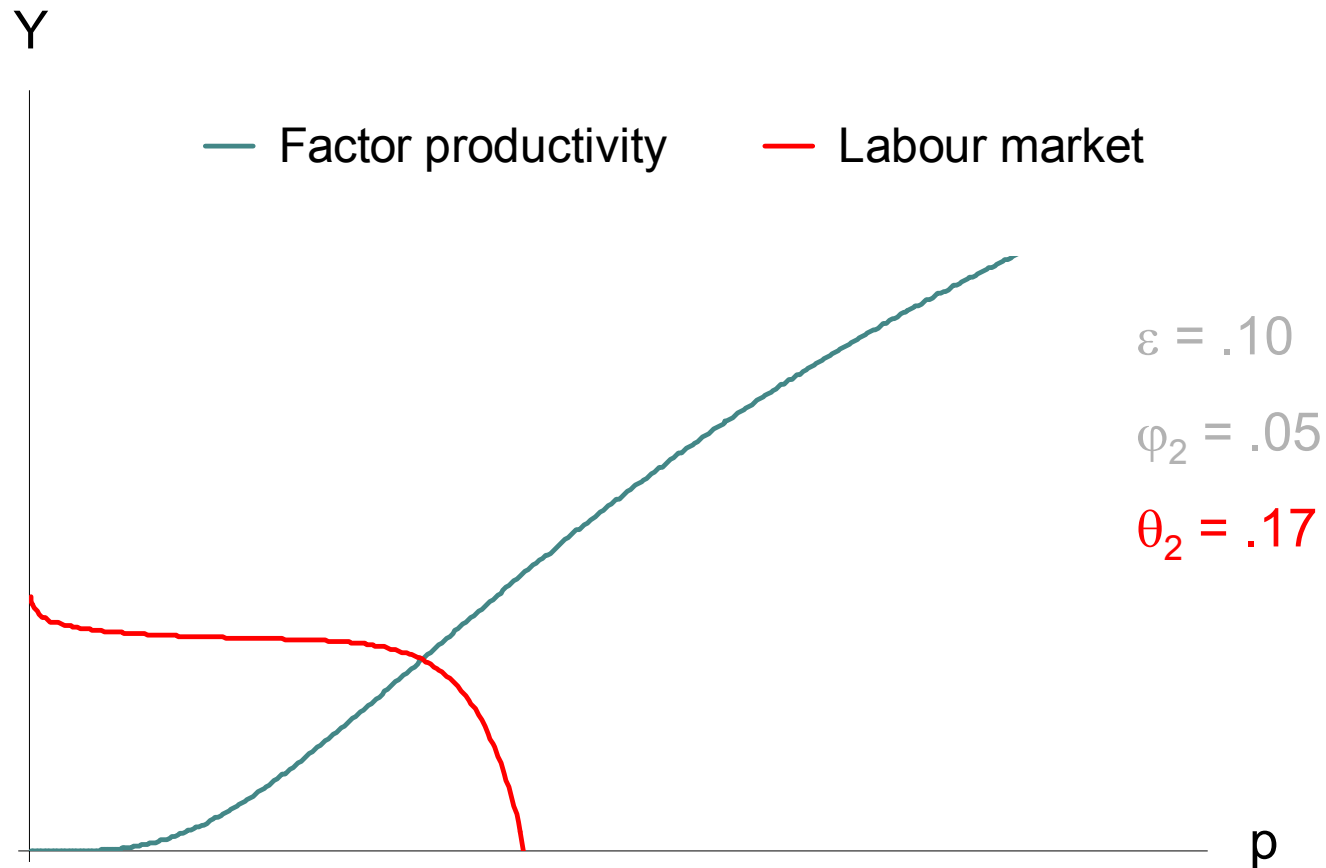
Sensitivity to DR elasticity θ_2



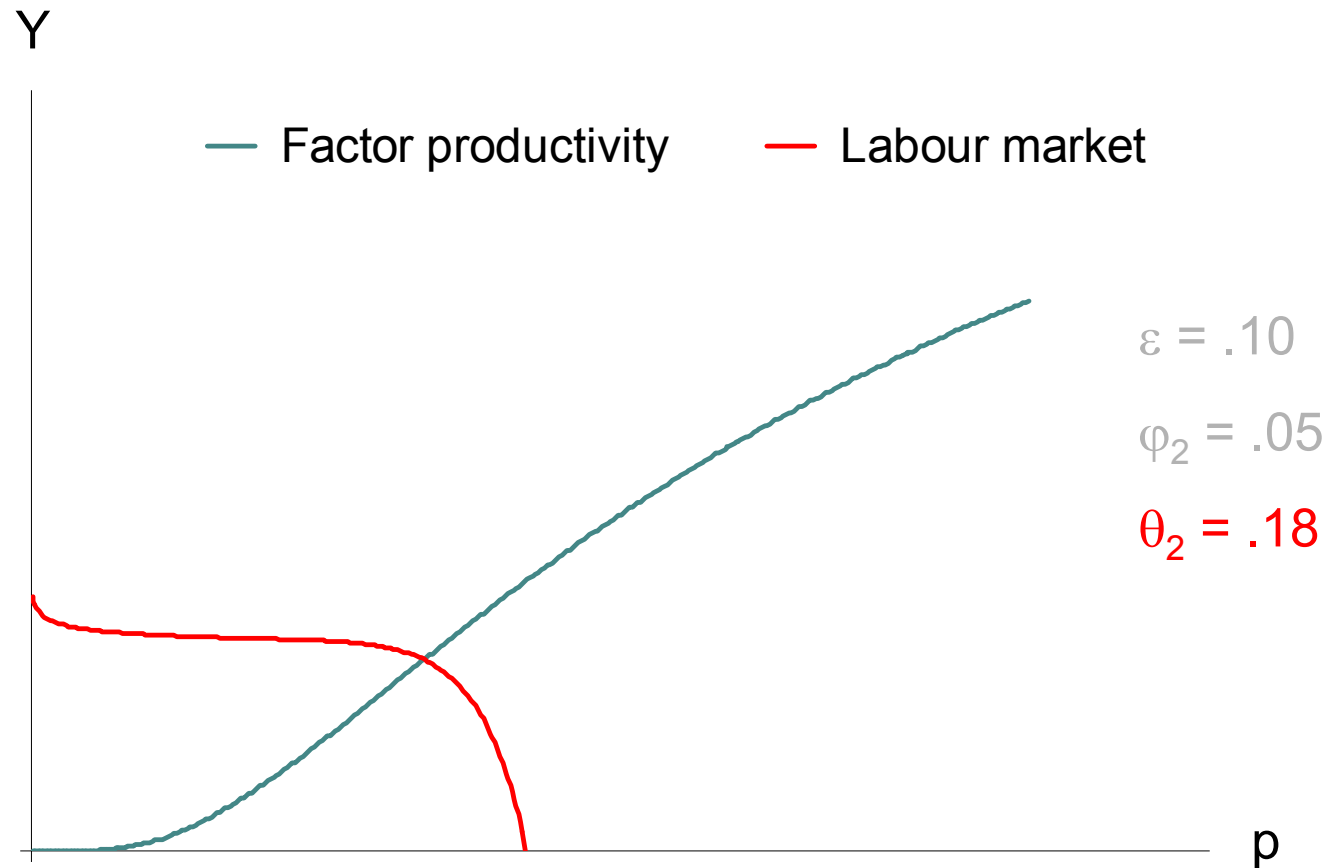
Sensitivity to DR elasticity θ_2



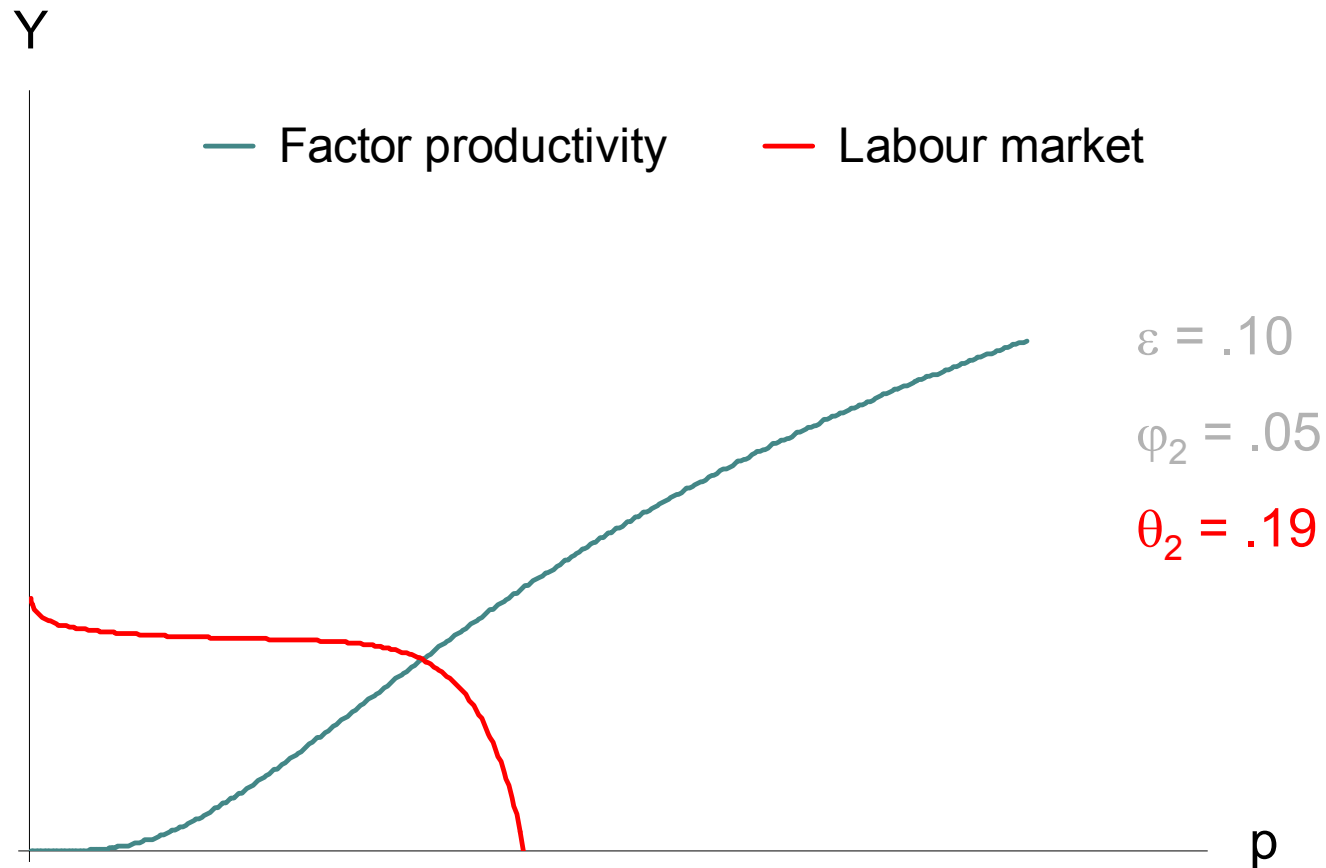
Sensitivity to DR elasticity θ_2



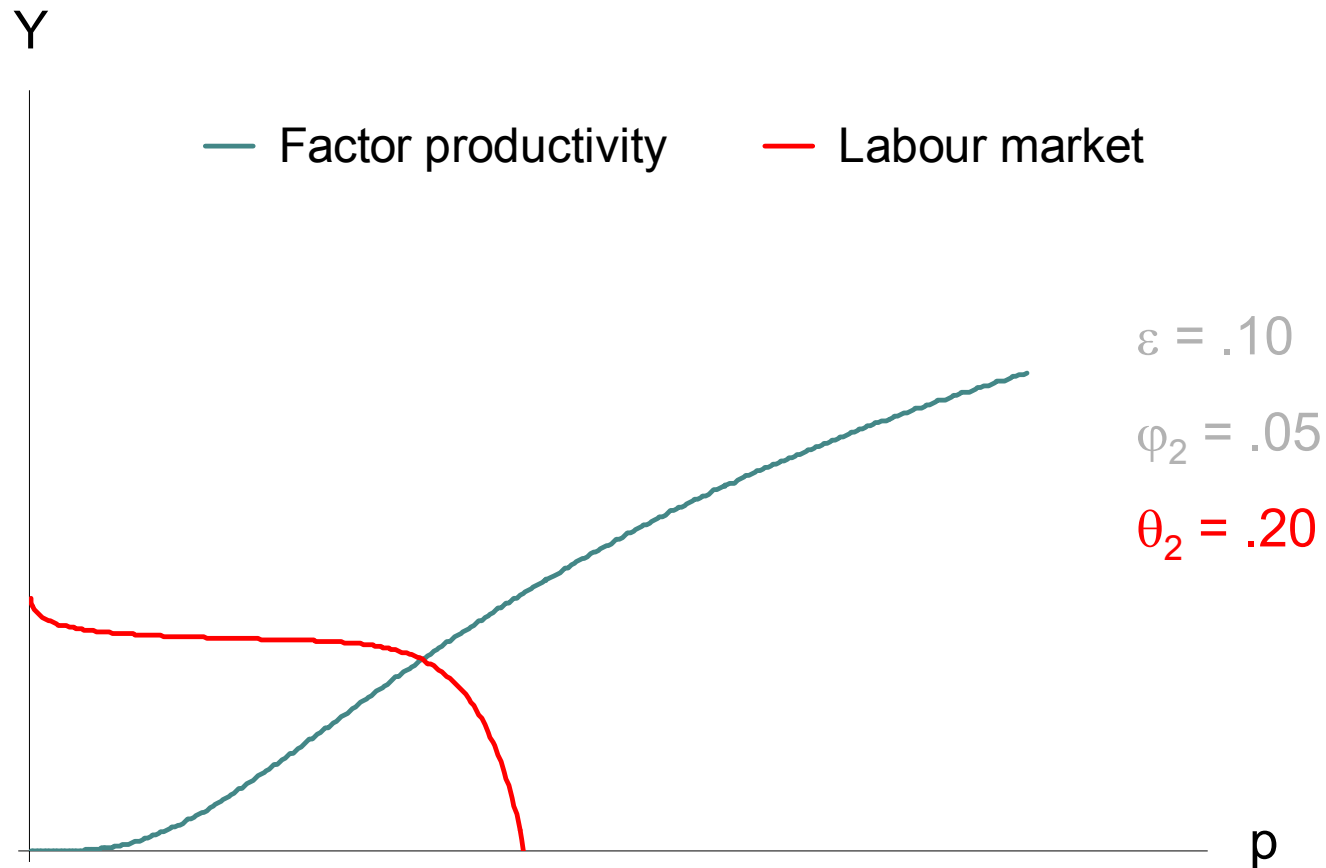
Sensitivity to DR elasticity θ_2



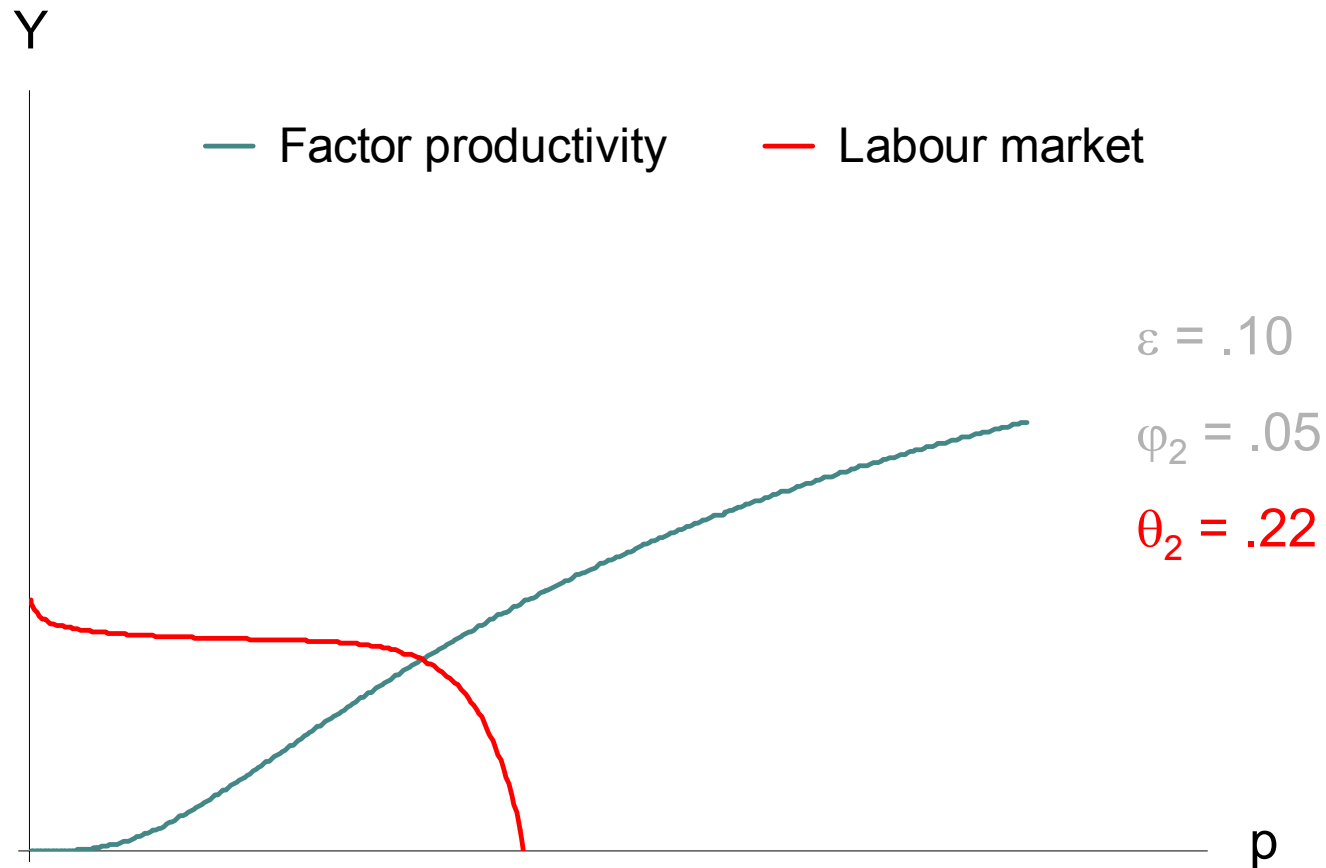
Sensitivity to DR elasticity θ_2



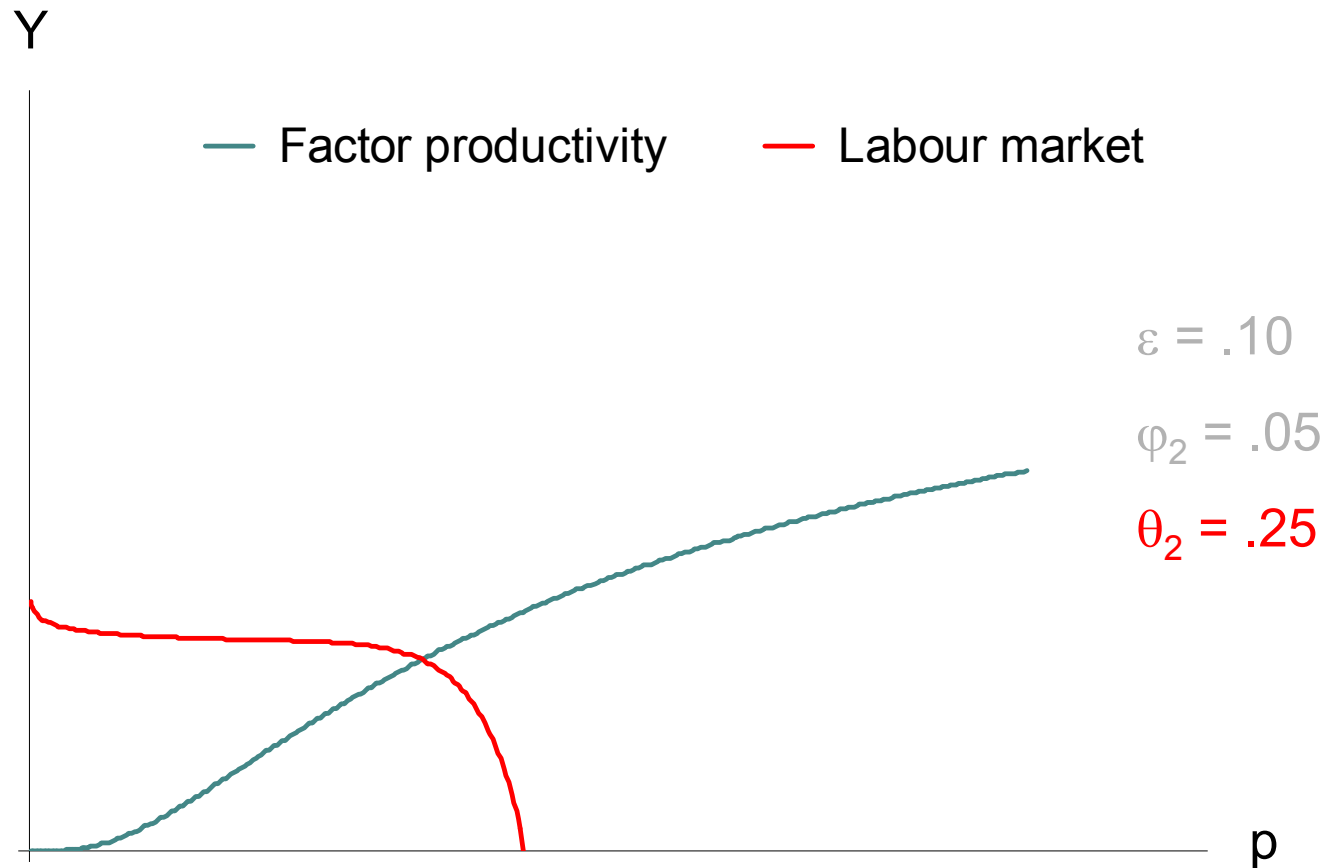
Sensitivity to DR elasticity θ_2



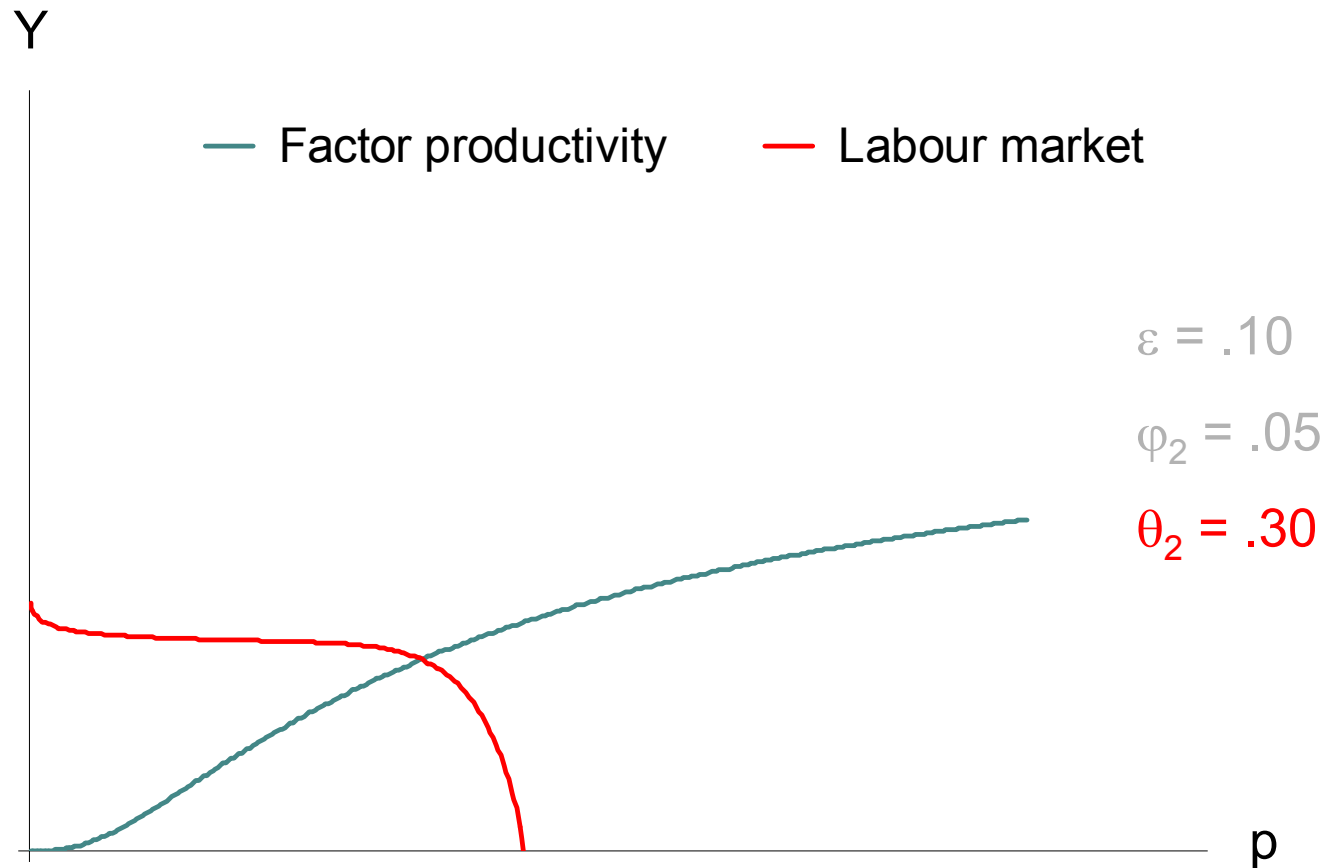
Sensitivity to DR elasticity θ_2



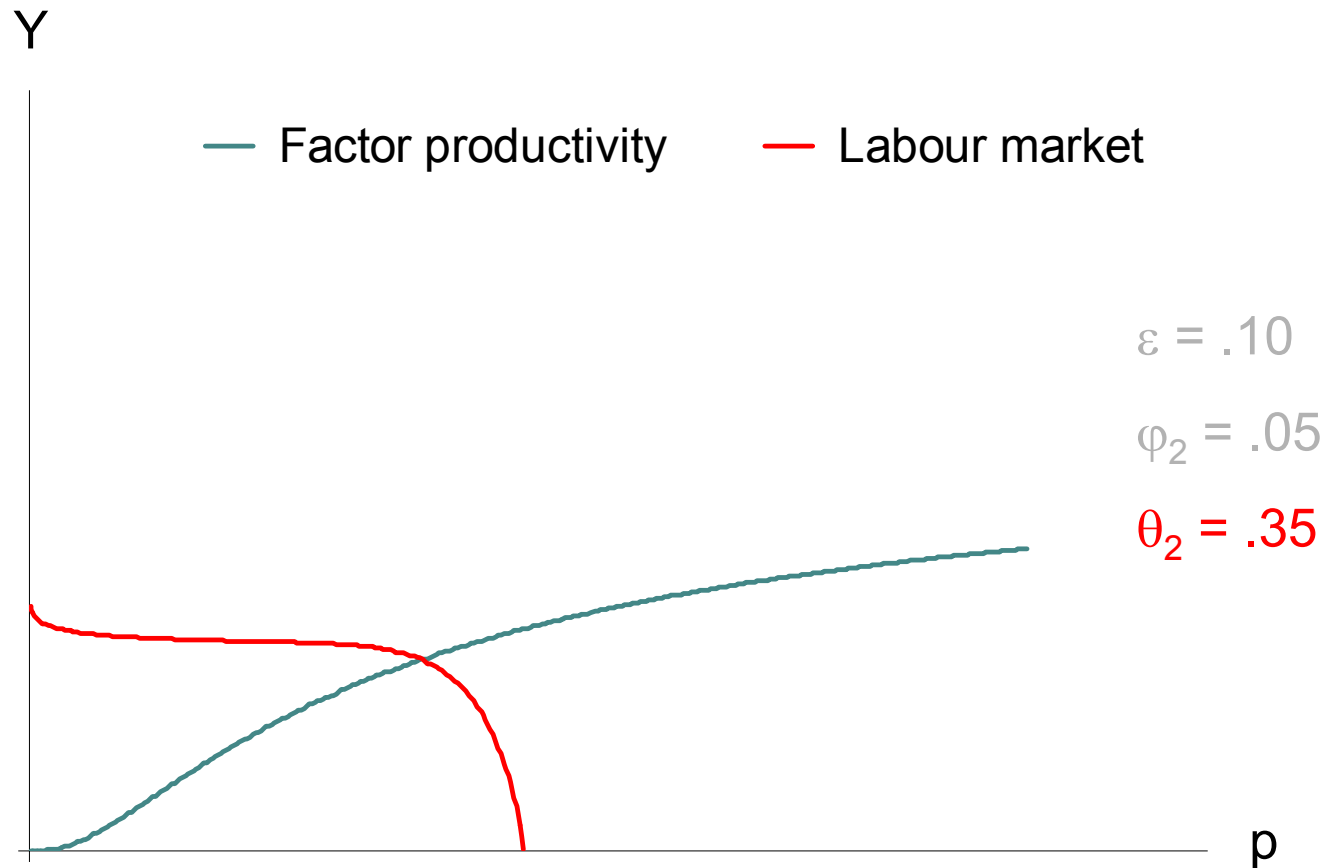
Sensitivity to DR elasticity θ_2



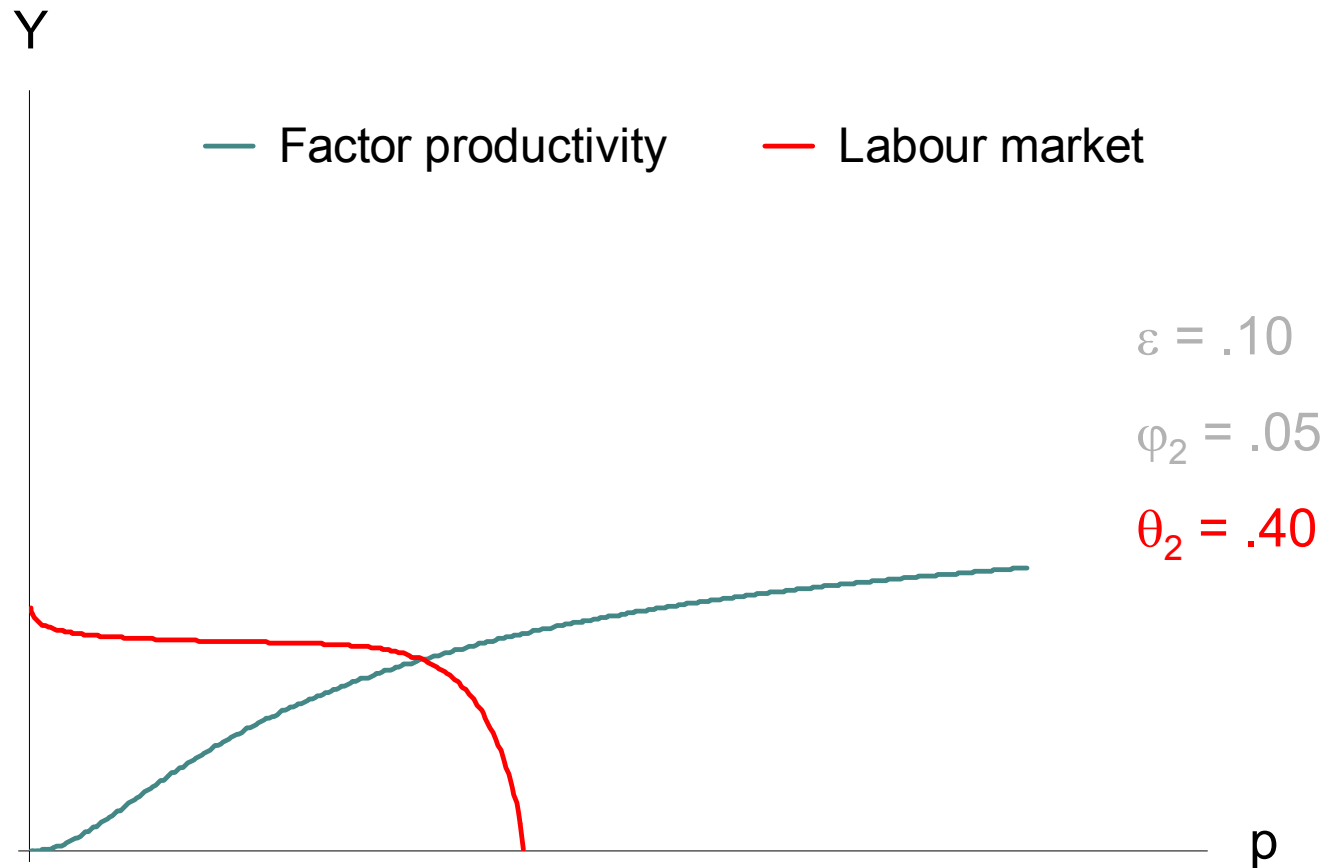
Sensitivity to DR elasticity θ_2



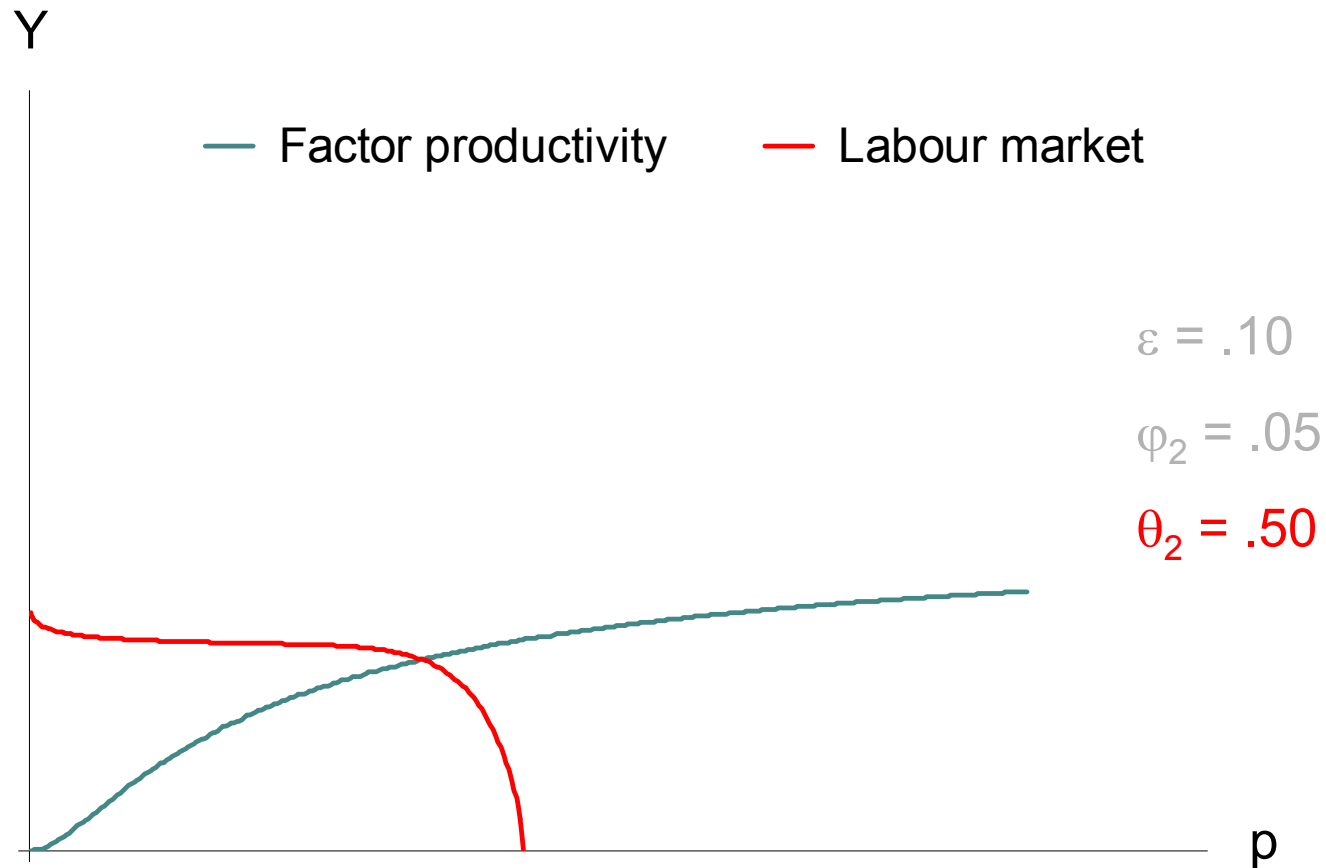
Sensitivity to DR elasticity θ_2



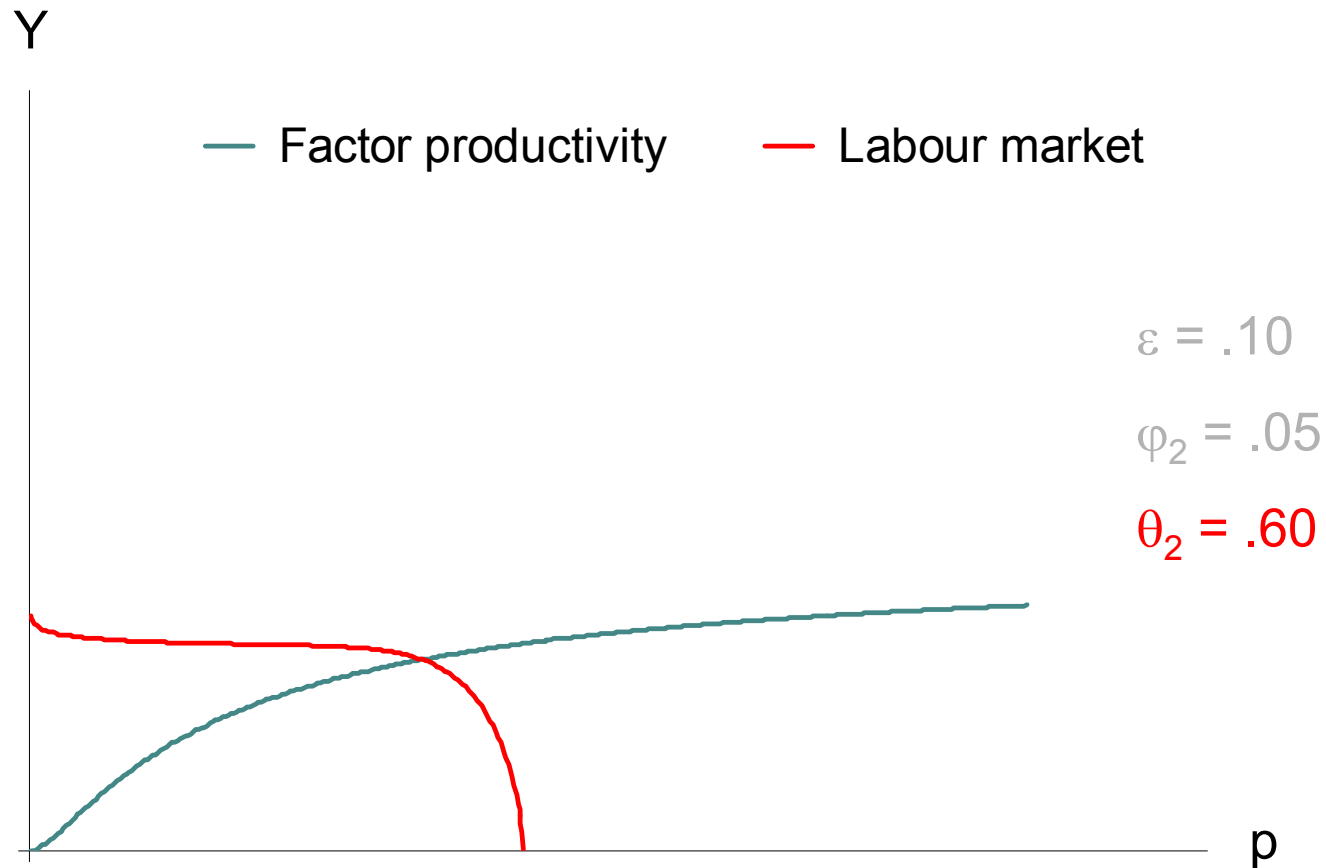
Sensitivity to DR elasticity θ_2



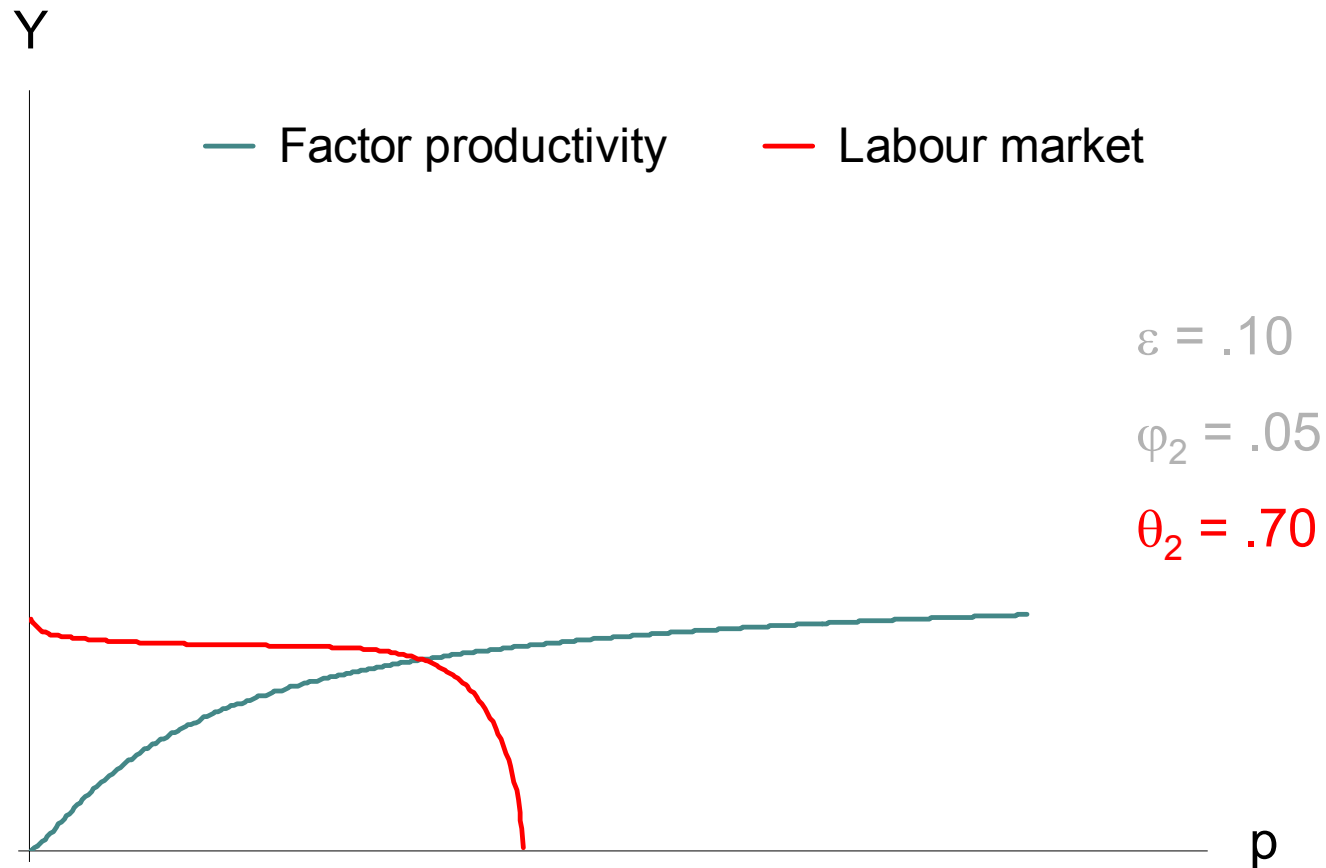
Sensitivity to DR elasticity θ_2



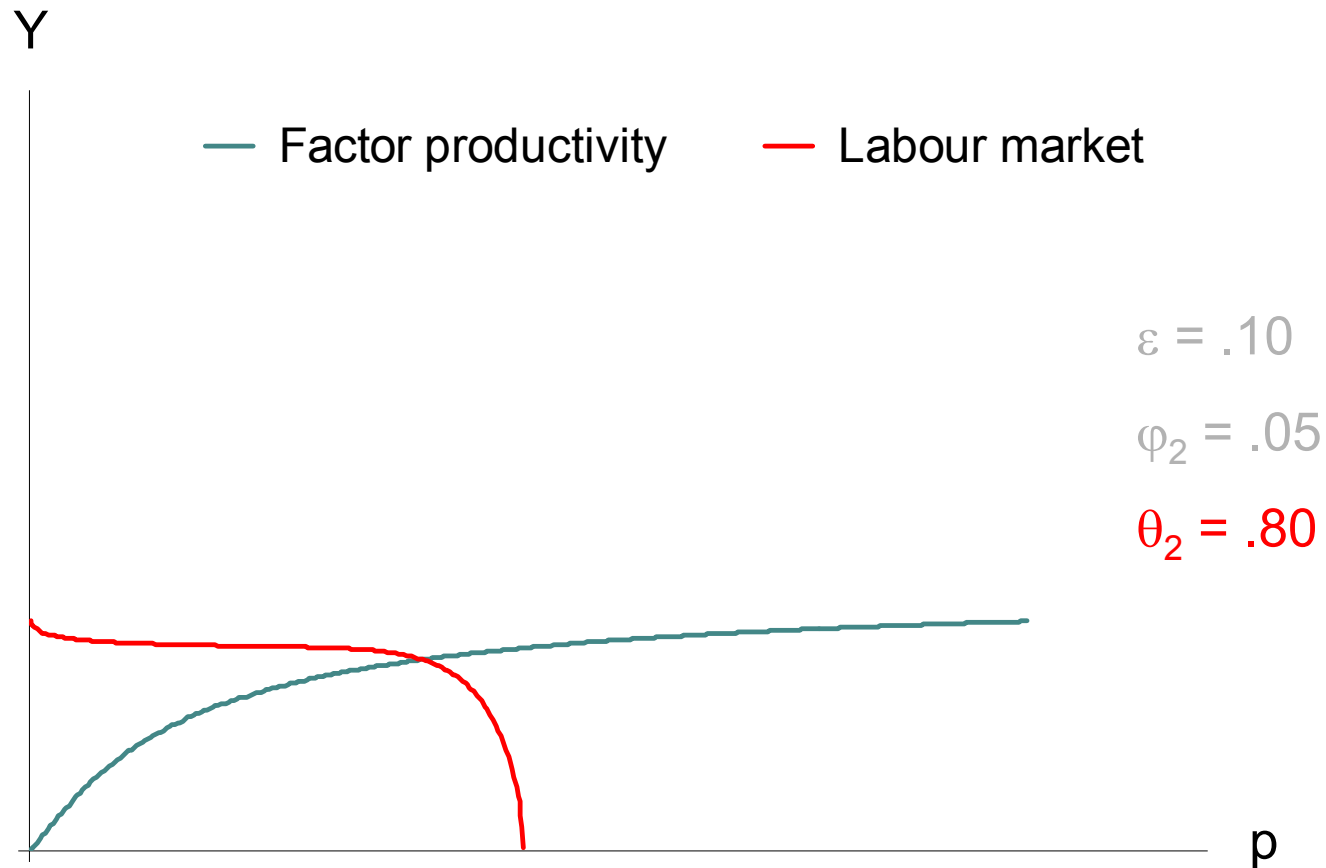
Sensitivity to DR elasticity θ_2



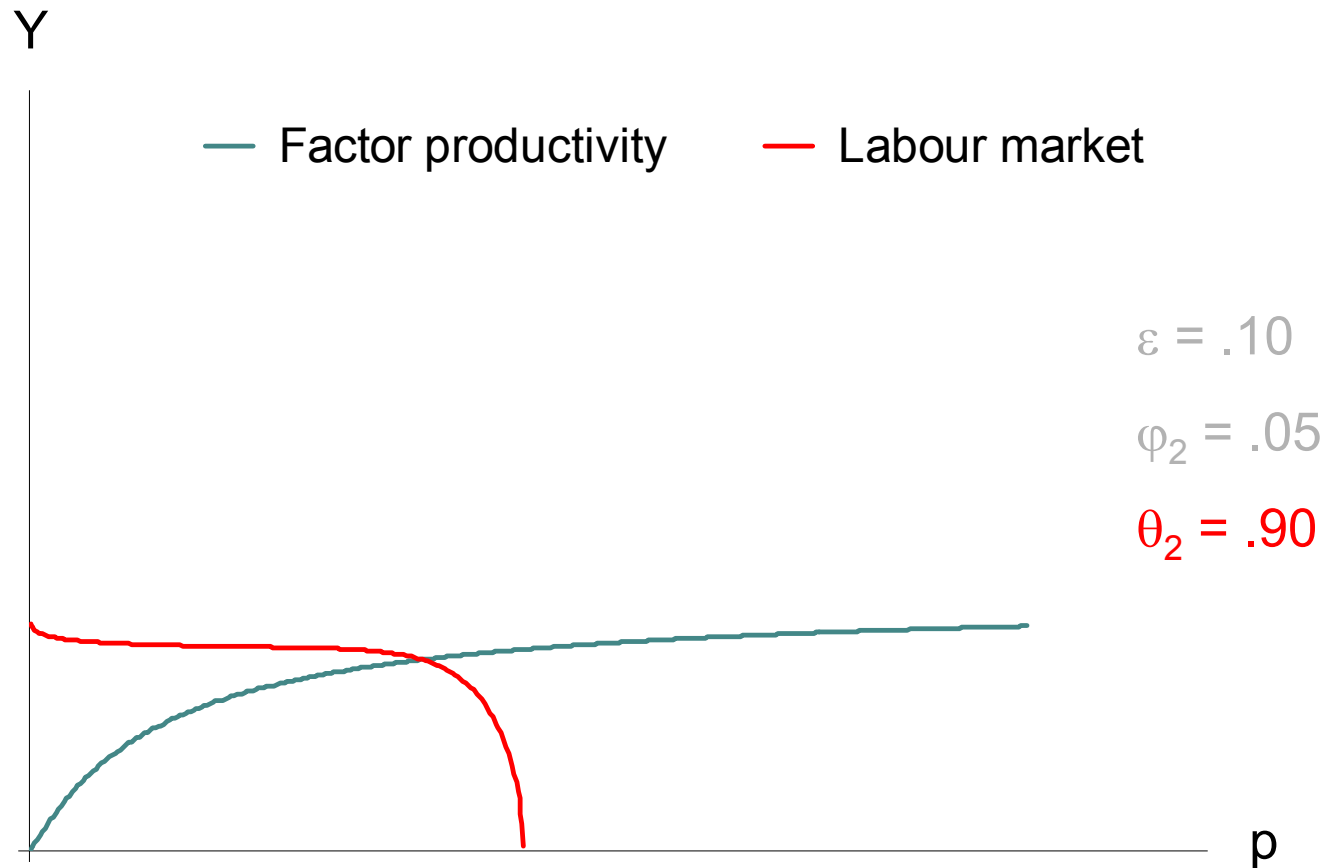
Sensitivity to DR elasticity θ_2



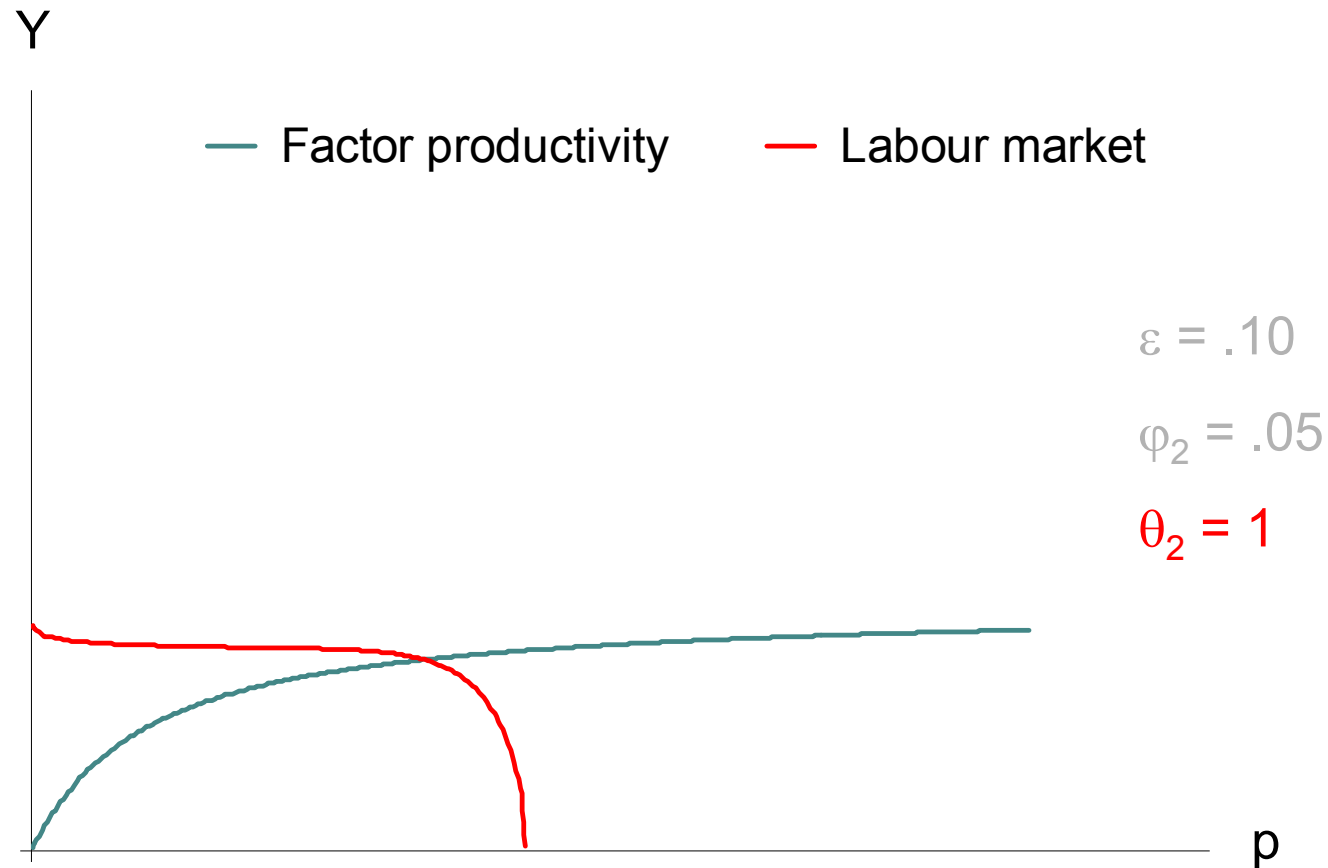
Sensitivity to DR elasticity θ_2



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Sensitivity to DR elasticity θ_2



A case for the wage curve

Implementation of a **wage curve** linking real wage and unemployment variations:

- Ample statistical evidence and seemingly robust elasticity estimate (Blanchflower & Oswald, 1995)
- Ready behavioural interpretation
bargaining power of employees negatively correlated to the level of unemployment
- Compact form and straightforward programming