New Trade Theory (1979)

New Trade Theory (Krugman, 1979):

- Economies of scale as reason for trade
- Explains trade between similar countries

Intuition of model:

There is a trade-off between economies of scale in the production of good types and the number of good types available.

Assumptions of the model:

- 2 identical countries
- 1 factor of production: Labour (L)
- Many (n) firms, each producing a single, unique good type (Reason: Economies of scale in the production of a good type)
- Production under firm-level economies of scale (here: decreasing average costs of production)
- Monopolistic competition (no strategic interaction, each firm has market power)
- Free market entry and exit → zero profits in equilibrium
- Consumers have „love for variety“, meaning they rather consumer small volumes of a lot of good types, than a large volume of a single good type
The Model:

Consumers:

Utility function of representative customer:

\[ U = \sum_{i=1}^{n} v(c_i) \quad \text{mit } v' > 0 ; v'' < 0 \]  
(1)

\( n \) : Number of produced good types  
\( c_i \) : consumption volume of good type \( i \) by consumer

Assumption about function \( v \): decreasing marginal utility in volume consumed of each good type: „Love for variety“

Symmetric preferences:  
Consumers like all different good types just as much

Deriving price elasticity of demand:

Utility maximization under budget constraint:

\[ \max U(c_i) = \sum_{i=1}^{n} v(c_i) \]

\[ u.N.B.: \sum_{i=1}^{n} p_i c_i = I \]

I : Per-Capita Income
\[ L = \sum_{j=1}^{n} v(c_j) - \lambda \left[ \sum_{j=1}^{n} p_j c_j - I \right] \]

First-Order Conditions:

\[ \frac{\partial L}{\partial c_i} = v'(c_i) - \lambda p_i = 0 \]
\[ \rightarrow v'(c_i) = \lambda p_i \]
\[ \rightarrow p_i = v'(c_i) \lambda^{-1} \]  \hspace{1cm} (2')

Price elasticity of demand:

Definition: \[ \varepsilon_i = -\frac{dc_i}{dp_i} \times \frac{p_i}{c_i} \]  \hspace{1cm} (3)

1. Schritt: \[ \frac{dc_i}{dp_i} = \frac{1}{\frac{dp_i}{dc_i}} \]

2. Schritt: Differentiation of (2') by \( c_i \)
\[ \rightarrow \frac{dp_i}{dc_i} = v''(c_i) \times \lambda^{-1} \]  \hspace{1cm} (4)

3. Schritt: Inserting (2') and (4) in (3):
\[ \varepsilon_i = -\frac{v'(c_i)}{v''(c_i) \times c_i} \]  \hspace{1cm} (5)

Price elasticity of each good type depending on amount of volume consumed of this type!

**EXOGENOUS ASSUMPTION:** \[ \frac{d\varepsilon_i}{dc_i} < 0 \]
Intuition: As the number of good types/ firms increases the consumed volume of each good type decreases. Then consumers react much stronger to price changes of each good type, therefore the market power of each firm decreases.

One can therefore say that the price elasticity is a measure for market power of the firms.

**Producers:**

(Assumption: All firms/good types have same cost function)

\[ C(x_i) = w \times l_i = w \times (\alpha + \beta x_i) \]
\[ \rightarrow l_i = \alpha + \beta x_i \]  

(6)

Labour required to produce \( x \) units of good type \( i \).
\( \alpha \): Fixed costs for Production of a good type in a firm (measured in labour units)
\( \beta \): (Constant) Marginal costs in production

Average costs: \[ AC = \frac{\alpha}{x_i} + \beta \]

\( \rightarrow \) Decreasing average costs: “Idea of economies of scale”

\( L \): Number of workers available = Number of consumers

Overall production of one good type: \[ x_i = L \times c_i \]  

(7)
Full Employment equilibrium condition:

\[ L = \sum_{i=1}^{n} l_i = \sum_{i=1}^{n} (\alpha + \beta x_i) \]  

(8)

Symmetry: All goods will be produced in the same volume and at the same prices. (Intuition: Symmetric Demand and same production costs!)

\[ x = x_i \quad \text{for all } i = 1, \ldots, n \]

\[ p = p_i \]  

(9)

Variables to be determined:

- \( p/w \) : (Relative) price of good type \( i \)
- \( x \) : Output of \( i \)
- \( n \) : Number of good types/firms

3 steps:

1. Demand for good type \( i \)
2. Profit maximization
3. Zero profit condition of firms (Price = Average costs)

1.) Demand

From (2') \( \rightarrow p_i = v'(c_i)\lambda^{-1} \) and (7) \( x_i = L \times c_i \Rightarrow c_i = \frac{x_i}{L} \)

\( \rightarrow p_i = \lambda^{-1} v' \left( \frac{x_i}{L} \right) \)  

(10)
We get demand by solving for $x$:

$$x_i = v^{i-1} \left( \frac{p_i}{\lambda^i} \right) \times L \tag{11}$$

2.) Profit maximization

Assumption; $n$ large: Firms do not take into account how their production volume decisions affect decisions of other firms and overall prices.

$$\max \pi_i = p_i(x_i)x_i - w(\alpha + \beta x_i) \tag{12}$$

B.E.O.:

$$\frac{d\pi_i}{dx_i} = 0$$

$$p_i'(x_i)x_i + p_i(x_i) - w\beta = 0$$

$$\rightarrow p_i(x_i) \times \left( \frac{p_i'(x_i) \times x_i}{p_i} + 1 \right) = w\beta$$

(Marginal Revenue = Marginal Costs)

$$\rightarrow p_i \left( \frac{dp_i}{dx_i} \times \frac{x_i}{p_i} + 1 \right) = w\beta$$

$$\rightarrow p_i \left( -\frac{1}{\varepsilon_i} + 1 \right) = w\beta$$

$$\rightarrow p_i = \frac{\varepsilon_i}{\varepsilon_i - 1} \times w\beta$$

(Preis = Mark-Up „times“ marginal costs) \tag{13}
\[ \frac{p_i}{w} = \frac{\varepsilon_i}{\varepsilon_i - 1} \times \beta \]  

(14)

**PP-Kurve**: Profit maximization by firms

Slope of PP-Curve:

The higher the consumption volume \( c \) of good type \( i \), the lower the price elasticity for this good type. Market power of the firm is then large and therefore the price for the good type is high. („Competition effect“)

Die PP-Kurve depends positively on \( c \) and therefore has positive slope.

- Price depends on marginal costs and price elasticity of demand
- PP-Curve determines the price for given Consumption-/Output-Volume of a good type

Needed for fully specified equilibrium: Deriving Output/Consumption-Volume for each good type

3.) Zero profit condition

\[ \pi_i = 0 \]

\[ \to p_i x_i - w(\alpha + \beta x_i) = 0 \]

\[ \to p_i x_i = w(\alpha + \beta x_i) \]

\[ \to \frac{p_i}{w} = \frac{\alpha}{x_i} + \beta \]

„/ x“, „/ w“
(7) Inserting yields:
\[
\frac{p_i}{w} = \beta + \frac{\alpha}{L \times c_i}
\]  \hspace{1cm} (16)

**ZZ-Kurve**: Zero profit condition of Firms

Slope of ZZ-Curve: The higher per capita consumption \( c \) of good type \( i \), the higher the produced Output \( x \) of this good type. Due to decreasing average costs this leads to lower average costs and therefore lower prices (as \( P=AC \)). Firms can now charge lower prices and still break even.

(“scale effect in production“)

The ZZ-Curve therefore depends negatively on \( c \) and has negative slope.

**Graph:**

![Graph of ZZ-Curve](image-url)
From Graph: Per capita consumption $c$ of good type $i$

Then output per good type $i$ also defined: $x_i = L \times c_i$

**Deriving equilibrium number of produced good types**

From full-employment condition (8):

$$L = \sum_{i=1}^{n} l_i = n \times (\alpha + \beta cL)$$

(because of symmetry! All $n$ good types produced and consumed in same amount in equilibrium with same production function → same amount of labour employed for each good type)

Solving for $n$:

$$n = \frac{L}{\alpha + \beta cL}$$  \hspace{1cm} (17)

**Introducing trade**

Assumption: Two identical countries

- Same preferences, technology
  - $w = w^*$; $p = p^*$
- If $L = L^*$ : $n = n^*$

How does trade work in this model?
Market enlargement / Increase in country size: Number of consumers demanding product of a firm increases in Home from L to L+L*, in Foreign from L* to L+L*.

What happens to the PP-Curve, ZZ-Curve if L increases to L+L*?

PP-Curve: Unchanged, as independant of L

$$ZZ\text{-Curve: } \frac{p}{w} = \beta + \frac{\alpha}{L \times c}$$

L increases $\rightarrow$ ZZ-Curve shifts/spins to the left

Trade leads to: decrease in c; decrease in p/w
2 Effects:

1.) \( n_{\text{Konsum}} = n_{\text{Produktion}} + n^* \)  
\[ n_{\text{Produktion}} \text{ and } n^* \text{ constant; } p/w \text{ constant} \]

2.) by assumption: \( \frac{d \epsilon_i}{dc_i} < 0 \)

As per capita consumption of each good type decreases, the price elasticity increases.

Intuition:
Trade leads to increased competitione (more good types in each market: \( n_{\text{Konsum}} \) increases)
→ per capita consumption of each good type decreases
→ market power of each firm decreases (as \( \epsilon \) increases): Smaller Mark-Up
→ Some firms cannot pay for their fixed costs anymore (\( p < AC \)) and exit the market (\( n_{\text{Produktion}} \) decreases): ! Note determined which good types/firms leave the market!!!
→ Because of this exit and the broader customer base production volume of each good type actually increases in the end → \( x \) increases
→ Therefore average costs decrease: Price \( p/w \) decreases.

**Summary Effects of trade:**

Direct Effect: More good types consumable in each country
Indirect Effect: Cheaper prices due to additional economies of scale

Pattern of trade?
Indetermined, which country will produce which good type!
But: Each good type will only be produced by a single firm and therefore only in a single country.

**Trade volume**

We know: As all goody types are produced and consumed in same amounts in equilibrium we only need the number of good types produced in each country to analyse the trade volume.

Number of produced good types in Home in autarky:

\[ n = \frac{L}{\alpha + \beta cL} \]

Number of produced good types in Home with trade:

\[ n = \frac{L}{\alpha + \beta c(L + L^*)} \]

Number of produced good types in Foreign with trade:

\[ n^* = \frac{L^*}{\alpha + \beta c(L + L^*)} \]

Total number of good types produced with trade:

\[ n + n^* = \frac{L + L^*}{\alpha + \beta c(L + L^*)} \]
Share of imports in expenditure in Home:

\[
\frac{n^*}{n + n^*} = \frac{L^*}{\frac{L + L^*}{\alpha + \beta c(L + L^*)}} = \frac{L^*}{L + L^*}
\]

Share of imports in expenditure in Foreign:

\[
\frac{n}{n + n^*} = \frac{L}{\frac{L + L^*}{\alpha + \beta c(L + L^*)}} = \frac{L}{L + L^*}
\]

Value of imports of Home (M) and Foreign (M*):

\[
M = w \times L \times \frac{L^*}{L + L^*}
\]

\[
M^* = w^* \times L^* \times \frac{L}{L + L^*}
\]

Balanced trade must hold in equilibrium: M=M*

One can easily then see that trade volume is maximized if both countries have the same size (L=L*)

Welfare implications of trade:

Absolutely positive: Consumers get larger variety of goods and can consume them at lower prices (bzw. More purchasing power)