UNIKassel
VERSITÄT

Fachbereich
Wirtschaftswissenschaften

New Economic Geography

von

Hans-Friedrich Eckey
Reinhold Kosfeld

Nr. 65/04

Volkswirtschaftliche Diskussionsbeiträge

New Economic Geography

– Critical reflections, regional policy implications and further developments –

HANS-FRIEDRICH ECKEY

REINHOLD KOSFELD

Summary

The standard model of New Economic Geography (NEG) presents a synthesis of polarization and neo-classical theories. Within a monopolistic competition framework it aims to explain processes of concentration and deconcentration of manufacturing in a two-sector economy. In this paper the effects of several assumptions of spatial agglomeration processes are addressed. In particular, we investigate the effects of transport costs for agricultural goods, spatial spillovers, the presence of non-tradable services and limited mobility of the labour force. It becomes clear that the tendency towards deconcentration of manufacturing is more marked

- the higher the transport costs for agricultural goods,
- the stronger the positive spillovers across the regions,
- the more income spent on services,
- the more limited the mobility of the labour force.

JEL: R10, R12

Key words: New Economic Geography, transport costs, non-tradable services, spillovers

Zusammenfassung

Das Grundmodell der NÖG stellt eine Synthese zwischen der Polarisationstheorie und der Neoklassik dar. In methodisch sehr anspruchsvoller Weise werden (De-) Konzentrationstendenzen der Industrieproduktion erklärt. Hierbei werden jedoch eine Reihe von einschränkenden Annahmen getroffen, die in Widerspruch zur Realität stehen. In diesem Beitrag werden einige von ihnen aufgehoben und ihre Auswirkungen auf räumliche Agglomerationsprozesse untersucht. Im Einzelnen handelt es sich um Transportkosten für Agrargüter, räumliche Überschwappeffekte, die Existenz von nicht handelbaren Dienstleistungen und eine eingeschränkte Mobilität der Arbeitskräfte. Dabei zeigt sich, dass eine Tendenz zur Dekonzentration der Produktion umso ausgeprägter ist, je

- höher die Transportkosten für Agrargüter sind,
- mehr positive Spillovers zwischen den Regionen vorhanden sind,
- stärker das Einkommen zum Kauf von Dienstleistungen verwendet wird,
- eingeschränkter die räumliche Mobilität der Arbeitskräfte ist.

JEL: R10, R12

Schlagwörter: Neue Ökonomische Geographie, Transportkosten, nicht handelbare Dienstleistungen, Spillovers

1. Introduction to and explanation of the topics examined

New Economic Geography [1] represents a rediscovery of space in economics. The concept goes back to Krugman [2] and deals with the question of how agglomerations form and under what conditions they are (un)stable. It can be interpreted as a synthesis between polarized growth models and formalized neoclassical models.

The polarization models – whether sectoral [3] or regional [4] – form a counter-thesis to neoclassical location theory, which is based on an inherent tendency of the market economy system towards spatial equilibrium. If reasonable framework conditions are set by politics, economic regions converge. On the other hand, polarization theory presupposes a reinforcing process of increasing concentration and spatial imbalances. Whereas in neo-classical theory every deviation from equilibrium triggers counter-forces, which restore the system to equilibrium, a circular cumulative process arises in polarization theory and this process is based on feedbacks, which distance the system further and further from balance. Let us imagine two regions and call them A and B. Originally they are at the same level of development. Suddenly, region A (region B) is affected by positive (negative) external shock, in the form, for example, of the set-up (closure) of a company. In the neo-classical model this gap will be quickly closed by adjustment of income and movements of the labour force. In the polarization theory, however, forward and backward linkages lead to increasing deviations from spatial equilibrium. In our example, workers move from B to A. Thus, purchasing power is transferred to A and, because of multiplicator effects, contributes to the extension of the services sector. Consequently, advantages of accumulation and urbanization accrue, which make A even more attractive than B and result in increased economic activity in the region and so on. As on a slide, productions shifts from B to A. Whether this happens totally depends on the strength of the negative backward linkages present. Among these latter are increasing land prices in A, an overburdened infrastructure and increasing environmental problems.

As plausible as these thoughts are in polarization theory, they suffer from their formal inadequacy in comparison with neo-classical theory. In neo-classical theory we find

---

1 Hereinafter abbreviated to NEG.

2 Cf. especially P. KRUGMAN (1991).

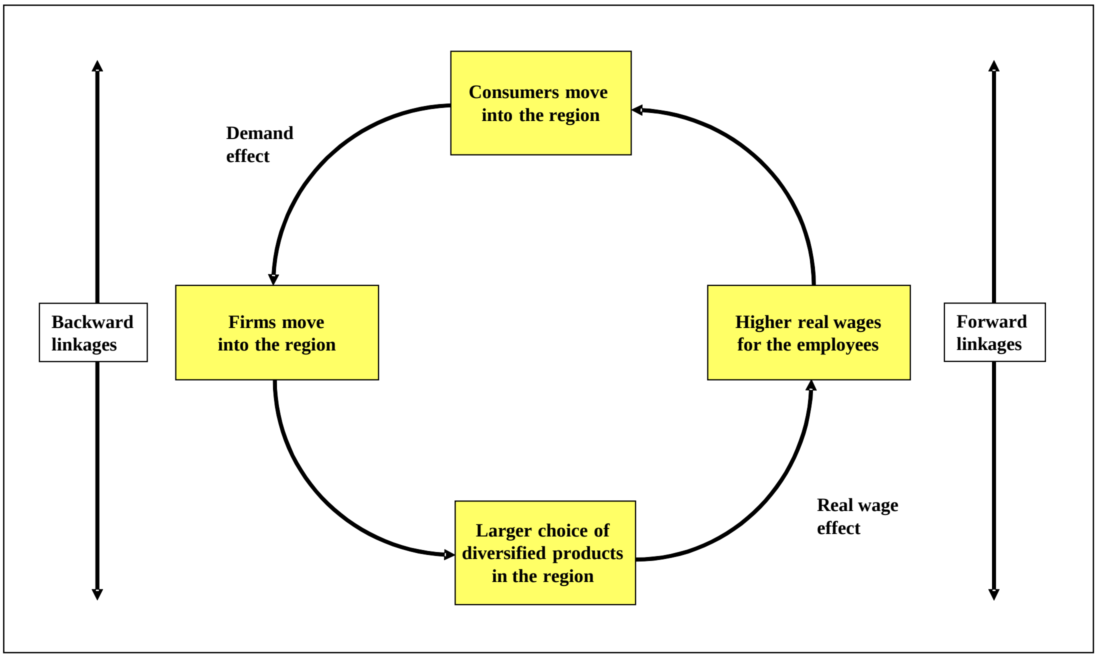
3 Cf. for example F. PERROUX (1950), pp. 90–97.

4 Main proponents of regional polarization theory are A.O. HIRSCHMAN (1958) and G. MYRDAL (1957).

formalized self-contained and empirically testable models, while in polarization we find merely plausibility arguments and fuzzy formulations. This deficiency is removed by NEG. It represents a synthesis of the two theories inasmuch as it adopts the statements of polarization theory using a formalized set of instruments borrowed from neo-classical theory.

The features it has in common with polarization theory are evident in the strong emphasis on forward and backward linkages, as is clear from the following diagram.

Fig. 1-1: Circular Causation through linkage effects



Source: Following M. FUJITA and J-F. THISSE (2001)

When consumers move into a region, they bring enterprises with them because of increased demand. As a result, agglomeration advantages accrue in the region, since enterprises can access intermediate products and consumer goods more cheaply because there are no transport costs. Falling prices mean real income increase, and this in turn leads to further immigration.

The formal structure of the model is neo-classical:

- consumers strive for utility maximization
- workers strive for maximization of their real income
- enterprises strive for profit maximization
- intensive competition reduces company profits to nil.

The core of NEG is the model of monopoly competition evolved by Dixit/Stiglitz.[5] According to this, consumers prefer as broad a range of products as possible. Producers adjust to the wishes of the consumers, but at the same time an endless quantity of products is rendered impossible by the fixed and variable costs of producing goods.

When an industrial product is transported between two regions, there are transport costs, and these are treated within NEG according to the "iceberg" model. If a product unit is intended to arrive in the target region, more than one unit has to be sent in the source region. A part "melts" en route. Transport within a region is free of charge.

The following statements are made with respect to the direction indicated by NEG:

- The very complex model of NEG should be presented in such a form that readers who are not familiar with formal reasoning can gain some insight into it. This objective requires, *inter alia*, the explanation of the stages of computation in the form of examples.
- NEG should be examined critically. This objective is associated with the following questions:
  a) Is the model internally consistent and based on plausible assumptions?
  b) Does it explain the spatial distribution of economic activities better than existing regional models? Does it represent palpable cognitive progress?
  c) Can recommendations for practical environmental planning or regional economic policy be derived from NEG? In short, is NEG of direct socio-political relevance?
- Finally, the aim is to show possibilities for the further development of NEG that will make it more convincingly compatible with social reality.

[5] Cf. A.K. DIXIT and J.E. STIGLITZ (1977), pp. 297–308

2. The core-periphery model of NEG

2.1 Standard model[6] of NEG

In the standard model of NEG there are two regions and two sectors. In one of these branches of the economy agricultural products are produced with constant returns to scale, and in the other industrial goods with increasing returns to scale. The utility U of the consumers follows a Cobb-Douglas function

(2.1-1) $$U = C_M^{\mu} \cdot C_A^{1-\mu}$$

with
C_M : Consumption of industrial goods
C_A : Consumption of agricultural goods
μ : Elasticity of utility of industrial goods
$1-\mu$: Elasticity of utility of agricultural goods

With respect to agricultural goods we assume that, only one agricultural good is produced, whereas ncm industrial goods are produced. Individual industrial goods can, with the help of CES-function, be condensed to the consumption level of industrial goods:

(2.1-2) $$C_M = \left(\sum_{i=1}^{ncm} cm_i^{\rho} \right)^{1/\rho}$$ [7]

with
cm_i: Consumption of the industrial good i
ncm: Number of industrial goods
ρ $= \dfrac{\sigma - 1}{\sigma}$
σ: Substitution elasticity between the individual goods with $\sigma > 1$.

The result is that consumers prefer product variety. With given expenditure on industrial goods, their utility rises as the variety increases. This is because the marginal utility of every industrial good falls as the quantity consumed rises.

♦ Example:

Let us set the expenditure for industrial goods equal to 1 and assume that each good is

---

6 The following presentation is based in particular on M. FUJITA, P. KRUGMAN and A. VENABLES (2001). M. FUIITA and J.-F. THISSE (2001).

7 also representable as Integral in the form $C_m = \left[\int_0^{ncm} cm(i)^{\rho} \, di \right]^{1/\rho}$; for reasons of simplification the discrete case is considered here without alteration of the fundamental results.

demanded in equal quantity, we get the following from (2.1-2):

(2.1-3) $$C_M = \left[\sum_{i=1}^{ncm} \left(1/ncm\right)^{\rho}\right]^{1/\rho} = \frac{1}{ncm}^{\frac{\rho-1}{\rho}} = \frac{1}{ncm}^{\frac{1}{1-\sigma}} = ncm^{\frac{1}{1-\sigma}} .$$

It is then true

(2.1-4) $$\frac{dC_M}{dncm} = \frac{1}{\sigma-1} \cdot ncm^{1+\frac{1}{1-\sigma}} = \frac{1}{\sigma-1} \cdot ncm^{\frac{1-\sigma+1}{1-\sigma}} = \frac{1}{\sigma-1} \cdot ncm^{\frac{2-\sigma}{1-\sigma}} .$$

If we set σ, for example, at three and five [8], we get the following functional relationships between C_M and ncm as well as $\frac{dC_M}{dncm}$ and ncm:

Fig. 2.1-1: Consumption level C_M depending on product variety ncm

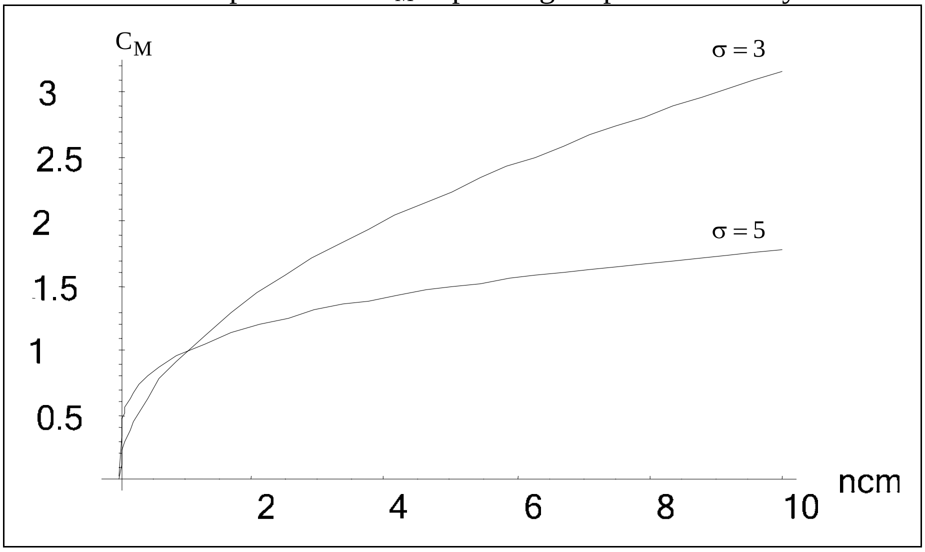
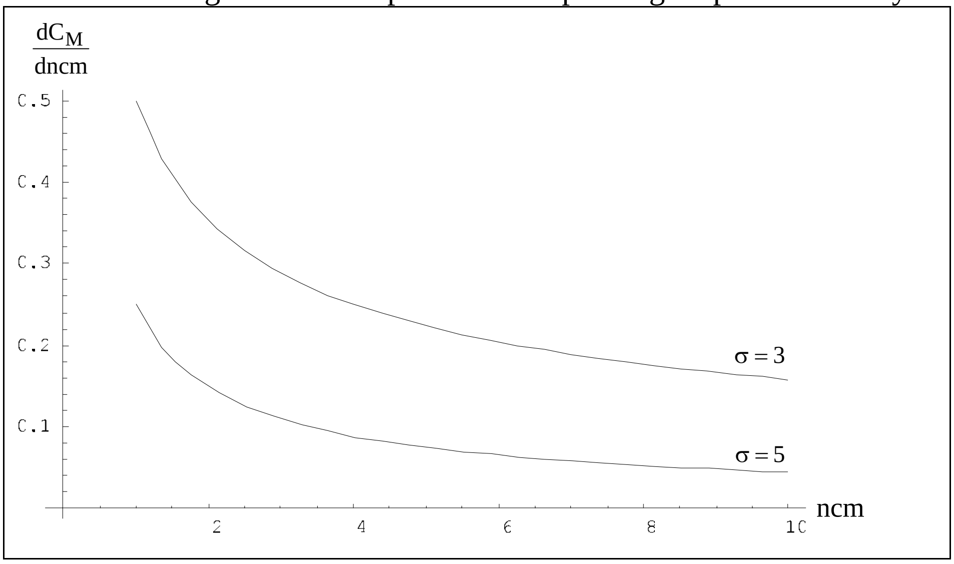


Fig. 2.1-2: Changes in consumption level depending on product variety



[8] Quotient from relative change of consumption and relative change of prices

It becomes clear that

- consumption level rises continuously with increasing product variety.
- the rise with falling σ becomes greater. The economic justification is relatively simple: the larger σ, the more easily one good can be replaced by another, so that increasing product variety with high σ causes utility level to rise only relatively modestly. ♦

Let the total labour force in the region considered independently by us be standardized to 1. Of this, μ are employed in the production of consumer goods and $1-\mu$ of agricultural goods. To simplify, we assume that in agriculture each unit of the labour force produces one unit of agricultural product. Since there are no other costs involved, the price level of agricultural goods corresponds to the wage rate paid there. If we further consider agricultural product as numéraire, the price for it and the wage rate in the sector equal 1.

Industrial goods are produced in monopoly competition, but at the same time each company produces only a specialized product with increasing economies of scale. For the production of cm_i units of an industrial product ℓ_i units of labour are required in all product variants:

(2.1-5) $$\ell_i = F + \beta \cdot cm_i \ .$$

Of these F units are incurred independently of the volume of production (=fixed labour quantity), whereas per produced unit β work units are required (=variable labour quantity). We get to the cost function by multiplying the labour quantities by the predominant wage rate ω in the region under consideration:

(2.1-6) $$\omega \cdot \ell_i = \omega \cdot (F + \beta \cdot cm_i)$$

with

ω : wage rate of industrial workers

ℓ_i : labour quantity required in the production of good i

$\omega \cdot F$: fixed costs incurred in the production of good i

$\omega \cdot \beta \cdot cm_i$: variable costs incurred in the production of good i

The cost function corresponds to the above-mentioned supposition of increasing economies of scale, since the average costs of production fall with increasing quantity.

Profit maximization in monopoly competition means a mark-up on production costs in the form

(2.1-7) $$p = \frac{\omega \cdot \beta}{\rho} = \frac{\omega \cdot \beta \cdot \sigma}{\sigma - 1} \ .$$

From the suppositions, the result is the same price for all industrial goods variants. The price p rises expectedly with growing variable costs per unit and falls when σ grows, because it is then easier for the consumer to switch to other industrial goods.

Because of higher competition intensity company production just covers costs. Profit G_i is zero:

(2.1-8) $$G_i = p \cdot cm_i - \omega \cdot (F + \beta \cdot cm_i) = 0 \ .$$

Solved for cm_i the result for the equilibrium production volume is [9]

(2.1-9) $$cm_i = \frac{F(\sigma - 1)}{\beta} \ .$$

The higher the fixed costs and the higher elasticity of substitution and the smaller the variable work input per output unit, the greater the equilibrium production level.

Thus, the equilibrium labour quantity is

(2.1-10) $$\ell_i = F + \beta \cdot cm_i = F + \beta \cdot \left[\frac{F \cdot (\sigma - 1)}{\beta} \right] = F \cdot \sigma \ .$$

Since altogether μ units of industrial workers are available, the quantity of product variants or producing companies is

(2.1-11) $$ncm = \frac{\mu}{\ell_i} = \frac{\mu}{F \cdot \sigma} \ .$$

We want to simplify these expressions without loss of generality by putting $\beta = \frac{\sigma - 1}{\sigma}$ and $F = \frac{\mu}{\sigma}$. Then we get

---

9
$$\begin{aligned}
p \cdot cm_i &= \omega \cdot (F + \beta \cdot cm_i) \\
\frac{\omega \cdot \beta \cdot \sigma}{\sigma - 1} \cdot cm_i &= \omega \cdot (F + \beta \cdot cm_i) \\
\beta \cdot \sigma \cdot cm_i &= F(\sigma - 1) + \beta \cdot cm_i \cdot (\sigma - 1) \\
\beta \cdot cm_i \cdot [\sigma - (\sigma - 1)] &= F \cdot (\sigma - 1) \\
cm_i &= \frac{F \cdot (\sigma - 1)}{\beta}
\end{aligned}$$

(2.1-12) $$cm_i = \frac{\mu/\sigma \cdot (\sigma - 1) \cdot \sigma}{(\sigma - 1)} = \mu$$

(2.1-13) $$p = \frac{\omega \cdot (\sigma - 1) \cdot \sigma}{\sigma \cdot (\sigma - 1)} = \omega$$

(2.1-14) $$ncm = \frac{\mu \cdot \sigma}{\mu \cdot \sigma} = 1 \ .$$

The price index P is established as weighted average of the price of the industrial goods ($p = \omega$) [10] and the price of agricultural goods, which we have set at 1:

(2.1-15) $$P = \omega^{\mu} \cdot 1^{1-\mu} = \omega^{\mu} \ .$$

There remains, as long as we consider only one region, the determination of the equilibrium wage rate. This is the wage rate that matches the demand for and supply of industrial goods. We have determined the supply in (2.1-12) and (2.1-14) with μ. The demand can be calculated from the product in manufacturing $\mu \cdot y$, where y represents the total income of the region under consideration:

(2.1-16) $$\begin{aligned} y &= \omega \cdot \mu + 1 \cdot (1 - \mu) \\ \omega \cdot \mu &= \text{income in manufacturing} \\ 1 \cdot (1 - \mu) &= \text{income in agriculture} \end{aligned}$$

Equality of supply and demand for industrial goods can be expressed in the form of the relationship

(2.1-17) $$\begin{aligned} \mu &= \mu \cdot [\omega \cdot \mu + 1 \cdot (1 - \mu)] \\ \text{with } \omega &= 1 \end{aligned} \ .$$

This equilibrium model becomes considerably more expressive when we move to the consideration of two regions, which we shall designate 1 and 2. Altogether, we once again have a labour quantity of one at our disposal, of which μ works in industry and $1 - \mu$ in agriculture. We make the following suppositions for agriculture:

- The agricultural workers are divided evenly in the two regions, so that the quantity of those employed in agriculture amounts to $\frac{1-\mu}{2}$ respectively.

[10] The price index of industrial goods is given in general by $P_M = \left[\sum_{i=1}^{ncm} p_i^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$. The result for $p_i = \omega$ is $P_M = \omega \cdot ncm^{\frac{1}{1-\sigma}}$. With ncm=1 therefore $P_M = \omega$ holds.

- Wages and prices in agriculture, respectively, amount furthermore to one.
- Those employed in agriculture are completely immobile. They cannot move, either to the other region or to the other sector.
- Agricultural products can be transported at no cost to the other region.

For industry we make the following presuppositions:

- Industrial products are, within their economic sector, totally mobile. Wage differentials between the regions trigger migration. People work in the region with the highest real wage.
- Industrial workers altogether amount to μ. Of these $\lambda_1 \cdot \mu$ work in region 1 and $(1-\lambda_1)\cdot \mu$ in region 2.
- In the "export" of goods transport costs are incurred, and we will introduce these into the model in the form of an iceberg. As an iceberg partially melts when traveling, so do industrial goods. To move one unit of an industrial good from one region to another, T units (T>1) have to be shipped. T–1 are the transport costs.

As a result of these suppositions made with respect to industry centripetal and centrifugal forces emerge in the model. For the concentration of industry in a region the following process is possible: if an additional industrial company moves into the region under consideration, the price index falls there, because transport costs for the goods produced by that company are no longer incurred. Accordingly, real wage rises, with the result that industrial workers migrate to this region. Consequently, regional demand rises, with the result that it pays other enterprises to move to the region.[11] As a result, the price index there once again falls[12], more industrial workers move in etc. The centrifugal effect in the model is caused because the agricultural workers who remain in the other region still want to be supplied with industrial goods. Their demand falls off, however, when industrial goods become more expensive because transport costs are incurred with the “imports”.

We now wish to depict these centripetal and centrifugal forces in a model and from it

---

[11] This effect is re-inforced if industrial companies demand intermediate products of other industrial companies.

[12] The increased population in region 1 has, according to the model, no impact on the price index of agricultural goods P_A, which continues to be equal to one. In the model the problem does not arise that the per capita consumption of agricultural goods in region 1 clearly has to fall. These problematic suppositions are removed in chapter 2.3.1 "Transport costs for agricultural goods".

derive the spatial distribution of industrial production to which these forces lead.

The income in both regions follows from

(2.1-18)
$$y_1 = \lambda_1 \cdot \mu \cdot \omega_1 + \frac{1-\mu}{2}$$
$$y_2 = (1-\lambda_1) \cdot \mu \cdot \omega_2 + \frac{1-\mu}{2}.$$

The price index rises in comparison with the one-region-model, because industrial goods are partly imported and transport costs thereby incurred. It is now

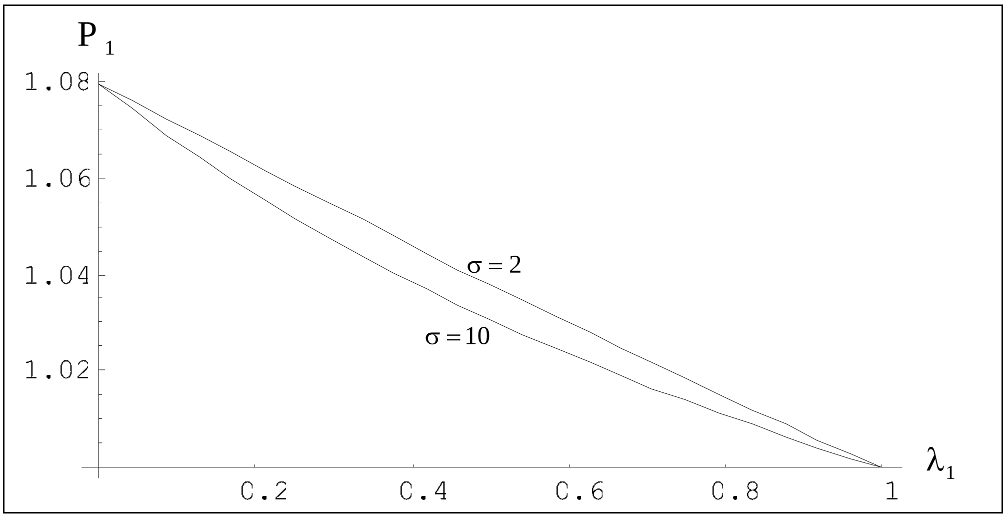
(2.1-19)
$$P_1 = \left[\lambda_1 \cdot \omega_1^{1-\sigma} + (1-\lambda_1) \cdot (\omega_2 \cdot T)^{1-\sigma}\right]^{\frac{\mu}{1-\sigma}}$$
$$P_2 = \left[\lambda_1 \cdot (\omega_1 \cdot T)^{1-\sigma} + (1-\lambda_1) \cdot \omega_2^{1-\sigma}\right]^{\frac{\mu}{1-\sigma}}.$$

Each one of the industrial goods variants produced in region 1, because of (2.1-13) costs ω_1. The variants produced in region 2 incur transport costs, with the result that these cost $\omega_2 \cdot T$ in region 1. λ_1 or $1-\lambda_2$ shows the proportion of industrial production in regions 1 and 2 of. σ indicates clear how simple it is to replace relatively expensive imported goods with relatively inexpensive self-produced goods.

- Example:

Assume $\mu = 0.8$, $\omega_1 = 1$, $\omega_2 = 1$ and $T = 1.1$. This gives the following functional relationship between P_1 and λ_1:

Fig. 2.1-3: Functional relationship between P_1 and λ_1



If $\lambda_1 = 0$, i.e. all industrial goods are produced in region 2, the industrial goods in region 1, because of the transport costs incurred, cost 1.1. Since the price for agricultural goods is 1 and 80% of the income is spent on industrial goods, the price index amounts to $P_1 \; 1.08$. If $\lambda_1 = 1$, all industrial goods are produced in region 1. No transport costs are incurred there, with the result that the price index now becomes 1. In the case of $0 < \lambda_1 < 1$ the result is an interim value between these two extremes. The higher σ, the lower the price index, because increasing σ makes it easier to replace expensive imports with less expensive self-produced goods. ♦

If we replace μ with 1 in (2.1-19), we get the price index for industrial goods, which we will call $P_{1,M}$ or $P_{2,M}$. It allows us to derive the demand for industrial goods in both regions.

The consumers enjoy utility maximization with the given price index and by keeping to income restrictions. The demand for industrial goods produced in both regions then amounts to [13]

(2.1-20)
$$N_{1,M} = \mu \left[y_1 \cdot \frac{P_{1,M}^{\sigma-1}}{\omega_1^{\sigma}} + T \cdot y_2 \cdot \frac{P_{2,M}^{\sigma-1}}{(\omega_1 \cdot T)^{\sigma}} \right]$$
$$N_{2,M} = \mu \left[T \cdot y_1 \cdot \frac{P_{1,M}^{\sigma-1}}{(\omega_2 \cdot T)^{\sigma}} + y_2 \cdot \frac{P_{2,M}^{\sigma-1}}{\omega_2^{\sigma}} \right]$$

The demand for industrial products manufactured in region 1 is then made up of its own demand $\mu \cdot y_1 \cdot \frac{P_{1,M}^{\sigma-1}}{\omega_1^{\sigma}}$ and the demand of region 2 $\mu \cdot T \cdot y_2 \cdot \frac{P_{2,M}^{\sigma-1}}{(\omega_1 \cdot T)^{\sigma}}$.

Recall (2.1-12) and (2.1-13) and equate the respective supply with μ and the price with the wage rate (2.1-20) then becomes, solved for the wage rate ω, [14]

---

[13] On the derivation cf. Jens SÜDEKUM (2003), pp. 102 .

[14]
$$\mu = \mu \cdot \left[y_1 \cdot \frac{P_{1,M}^{\sigma-1}}{\omega_1^{\sigma}} + T \cdot y_1 \cdot \frac{P_{2,M}^{\sigma-1}}{(\omega_1 \cdot T)^{\sigma}} \right]$$
$$\frac{1}{\omega_1^{\sigma}} \cdot \left(y_1 \cdot P_{1,M}^{\sigma-1} + T^{1-\sigma} \cdot P_{2,M}^{\sigma-1} \right) = 1$$
$$\omega_1^{\sigma} = \left(y_1 \cdot P_{1,M}^{\sigma-1} + T^{1-\sigma} \cdot P_{2,M}^{\sigma-1} \right)$$
$$\omega_1 = \left(y_1 \cdot P_{1,M}^{\sigma-1} + T^{1-\sigma} \cdot P_{2,M}^{\sigma-1} \right)^{1/\sigma}$$

(2.1-21) $$\begin{aligned}\omega_1 &= \left(y_1 \cdot P_{1,M}^{\sigma-1} + y_2 \cdot T^{1-\sigma} \cdot P_{2,M}^{\sigma-1}\right)^{1/\sigma} \\ \omega_2 &= \left(y_1 \cdot T^{1-\sigma} \cdot P_{1,M}^{\sigma-1} + y_2 \cdot P_{2,M}^{\sigma-1}\right)^{1/\sigma}\end{aligned} .$$

The real wages are calculated by means of

(2.1-22) $$\begin{aligned}r\omega_1 &= \frac{\omega_1}{P_1} \\ r\omega_2 &= \frac{\omega_2}{P_2}\end{aligned} .$$

The real wage ratio is thus

(2.1-23) $$r\omega r = \frac{r\omega_1}{r\omega_2} = \frac{\omega_1 / P_1}{\omega_2 / P_2} .$$

If we suppose that industrial workers are completely mobile across regions an equilibrium of the system only does exist if $r\omega r = 1$.

Although the equation system is analytically solvable, [15] us posit, for the sake of clarity, $\lambda_1 = 1$ and $\omega_1 = 1$. We assume therefore that the entire industrial production is concentrated in region 1 and ask ourselves under which manifestations of the remaining parameters there is long-term equilibrium with this total concentration of industrial production.

For $\omega_1 = 1$ and $\lambda_1 = 1$ $P_{1,M}$ or P_1 also equals 1, since in this case there are no transport costs for region 1. For region 2 in this case

(2.1-24) $$\begin{aligned}P_{2,M} &= T \\ P_2 &= T^{\mu}\end{aligned}$$ [16]

(2.1-25) $$\omega_2 = \left(\frac{1-\mu}{2} \cdot T^{\sigma-1} + \frac{1+\mu}{2} \cdot T^{1-\sigma}\right)^{1/\sigma}$$ [17]

---

15 Cf. M. FUJITA, P. KRUGMAN and A. VENABLES, A. (2001), p. 65.

16 Cf. (2.1-19) $P_2 = \left[\lambda_1 \cdot (\omega_1 \cdot T)^{1-\sigma} + (1-\lambda_1) \cdot \omega_2^{1-\sigma}\right]^{\mu/(1-\sigma)}$:

For λ_1=1 and ω_1=1, considered here, the following is true

$$\begin{aligned}P_2 &= \left(T^{1-\sigma} + 0\right)^{\frac{\mu}{1-\sigma}} \\ P_2 &= T^{\mu}\end{aligned} .$$

17 Cf. (2.1-18) $y_1 = \lambda_1 \cdot \mu \cdot \omega_1 + \frac{1-\mu}{2}$.

For λ_1=1 and ω_1=1 the following is true

$$y_1 = \mu + \frac{1-\mu}{2} = \frac{1+\mu}{2} :$$

Cf. (2.1-18) $y_2 = (1-\lambda_1) \cdot \mu \cdot \omega_2 + \frac{1-\mu}{2} = \frac{1-\mu}{2}$.

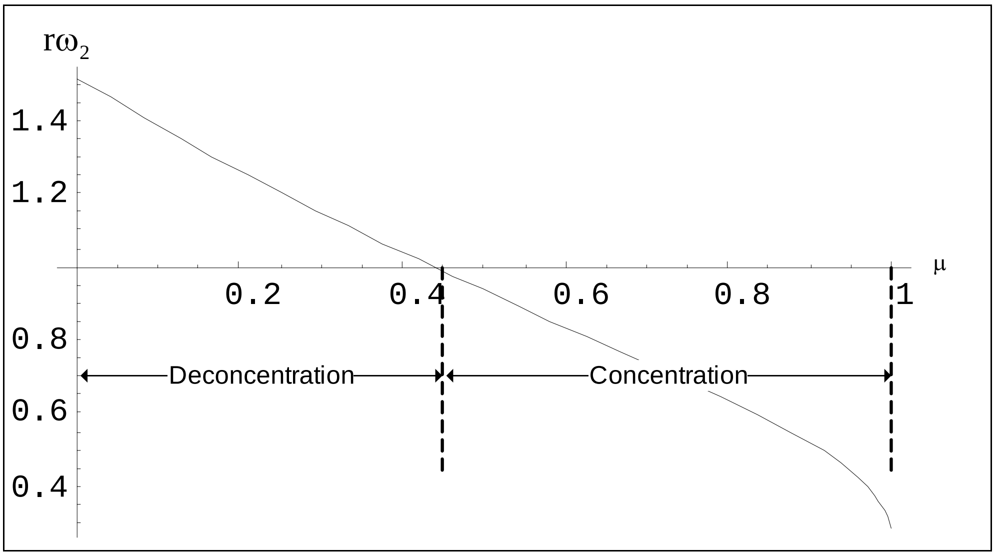
(2.1-26) $$r\omega_2 = \frac{\left(\frac{1-\mu}{2} \cdot T^{\sigma-1} + \frac{1+\mu}{2} \cdot T^{1-\sigma}\right)^{1/\sigma}}{T^{\mu}}$$

holds. If $r\omega_2 < 1$, the total concentration of industrial production in region 1 is a stable situation. In the case of $r\omega_2 > 1$, however, industrial workers would migrate from region 1 and take up work in region 2.

♦ Example:

Let us consider the functional relationship between $r\omega_2$ and the three influential variables μ, σ and T. If we set $T = 2$ and $\sigma = 5$, the result is a functional relationship between $r\omega_2$ (real income in region 2) and μ (proportion of industrial workers), as is clear from Fig. 2.1-4.

Fig. 2.1-4: Functional relationship between $r\omega_2$ and μ with $T = 2$ and $\sigma = 5$



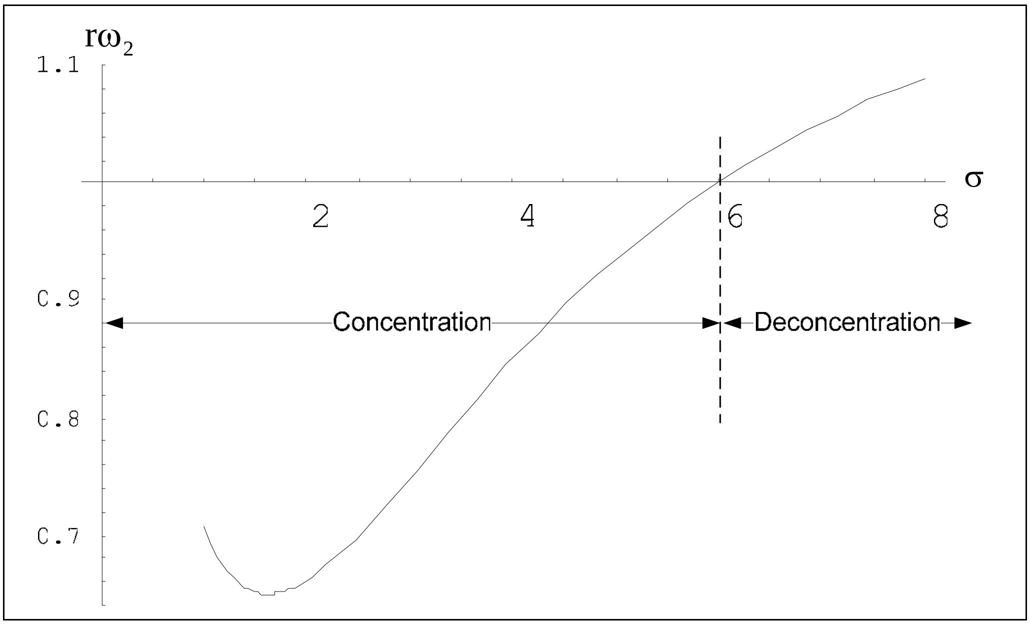
In the interval of $0 < \mu < 0{,}437$ we find $r\omega_2 > 1$, with the result that the concentration of industry in region 1 does not prove to be balanced. Industrial workers migrate from region 1 to region 2. The situation is different, however, with $0{,}437 < \mu < 1$. Here we find $r\omega_2 < 1$, so that concentration of industrial production in region 1 will last. A high proportion of agriculture makes it probable that manufacturing will become increasingly deconcentrated.

Cf. (2.1-21) $\omega_2 = \left(y_1 \cdot T^{1-\sigma} \cdot P_{1,M}^{\sigma-1} + y_2 \cdot P_{2,M}^{\sigma-1}\right)^{1/\sigma}$

$$\omega_2 = \left(\frac{1-\mu}{2} \cdot T^{1-\sigma} + \frac{1-\mu}{2} \cdot T^{\sigma-1}\right)^{1/\sigma} ..$$

Let us now set $\mu = 0{,}5$ and $T = 2$. Then the relationship between $r\omega_2$ and σ shown in Fig. 2.1-5 emerges.

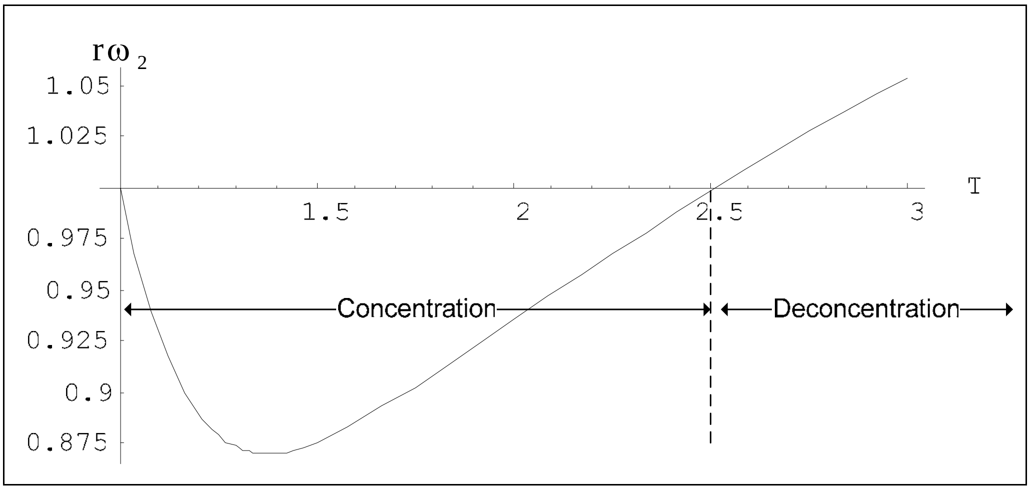
Fig. 2.1-5: Functional relationship between $r\omega_2$ and σ with $\mu = 0{,}5$ and $T = 2$



With small degrees of substitution elasticity there is agglomerated production, because in this case it is difficult to replace one industrial goods variant with another and so the scale effects are particularly strong. On the other hand, there is deconcentrated industrial production with large σ, since here industrial goods can easily be substituted for each other.

Finally, let us consider the functional relationship between $r\omega_2$ and T.

Fig. 2.1-6: Functional relationship between $r\omega_2$ und T with $\mu = 0{,}5$ and $\sigma = 2$



As might be expected, high transport costs have a deconcentration effect. With $T > 2.52$ concentrated industrial production is no longer a stable state. ♦

Let us now examine in more depth the relationship between the degree of concentration and transport costs. We know already that for $0 < T < 2.52$ complete concentration of industrial production in one of the two regions under consideration represents a stable equilibrium state. The upper end of the interval marks the "sustain point" T_S $(T_S = 2.52)$, since total concentration is sustainable as far as these transport costs.

The derivation of that area of transport costs in which deconcentration, i.e. the even distribution of industrial goods in both regions, represents a stable equilibrium is considerably more complex. Let us first see if an even distribution of manufacturing in both regions represents an equilibrium and ask ourselves under which parameter constellations this equilibrium is (un)stable.

With $\lambda_1 = 0.5$ there is symmetry between both regions. All economic variables are equal in both economic regions. If we put in simplifying terms $\omega_1 = \omega_2 = 1$, then we get

(2.1-27) $$y_1 = y_2 = 0.5 \cdot \mu + \frac{1-\mu}{2}$$ [follows from (2.1-18)]

(2.1-28) $$P_1 = P_2 = \left(0.5 + 0.5 \cdot T^{1-\sigma}\right)^{\mu/(1-\sigma)}$$ [follows from (2.1-19)]

(2.1-29) $$r\omega_1 = r\omega_2 = \frac{1}{\left(0.5 + 0.5 \cdot T^{1-\sigma}\right)^{\mu/(1-\sigma)}}$$

and finally

$$r\omega r = \frac{r\omega_1}{r\omega_2} = 1 .$$

A symmetrical distribution of industrial production represents an equilibrium in all realizations of μ, σ and T. But when is this equilibrium stable? This is clearly the case when $\frac{dr\omega r}{d\lambda_1}$ is negative. And that is because in this case a $\lambda_1 > 0.5$ is accompanied by a fall of $r\omega r$. $\lambda_1 > 0.5$ thus means in this case $r\omega_1 < r\omega_2$. Thus a migration process of workers from region 1 to region 2 begins, which causes λ_1 to fall again and brings it back to the balanced value. It can be proved [18] that

(2.1-30) $$\frac{dr\omega r}{d\lambda_1} = 2 \cdot Z \cdot P^{-1} \cdot \left(\frac{1-\rho}{\rho}\right) \cdot \left[\frac{\mu(1+\rho) - Z\left(\mu^2 + \rho\right)}{1 - \mu \cdot Z(1-\rho) - \rho \cdot Z^2}\right]$$ is with

[18] Cf. M. FUJITA, P. KRUGMAN and A. VENABLES (2001), p. 73.
Because of its complexity the derivation of this relationship is here omitted.

(2.1-31) $$Z = \frac{\left(1 - T^{1-\sigma}\right)}{\left(1 + T^{1+\sigma}\right)} \; .$$

For $\frac{dr\omega r}{d\lambda_1} = 0$ this expression takes on the value

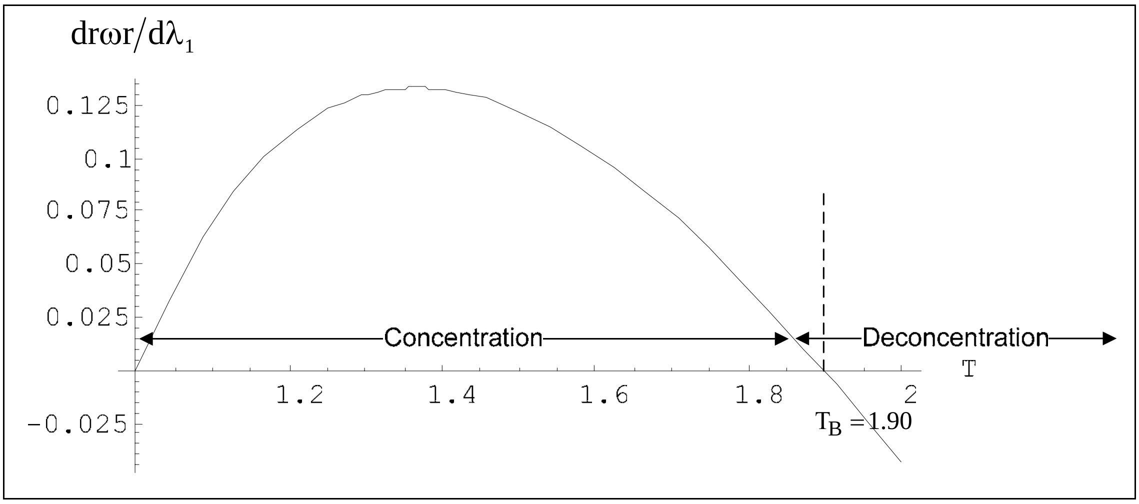
(2.1-32) $$T_B = \left[\frac{(\rho + \mu)(1 + \mu)}{(\rho - \mu)(1 - \mu)}\right]^{\frac{1}{\sigma - 1}} .$$

For $T > T_B$ the symmetrical division of industrial production in both regions is stable; for $T < T_B$ it becomes unstable. Therefore T_B is also described as "breakpoint".

- Example:

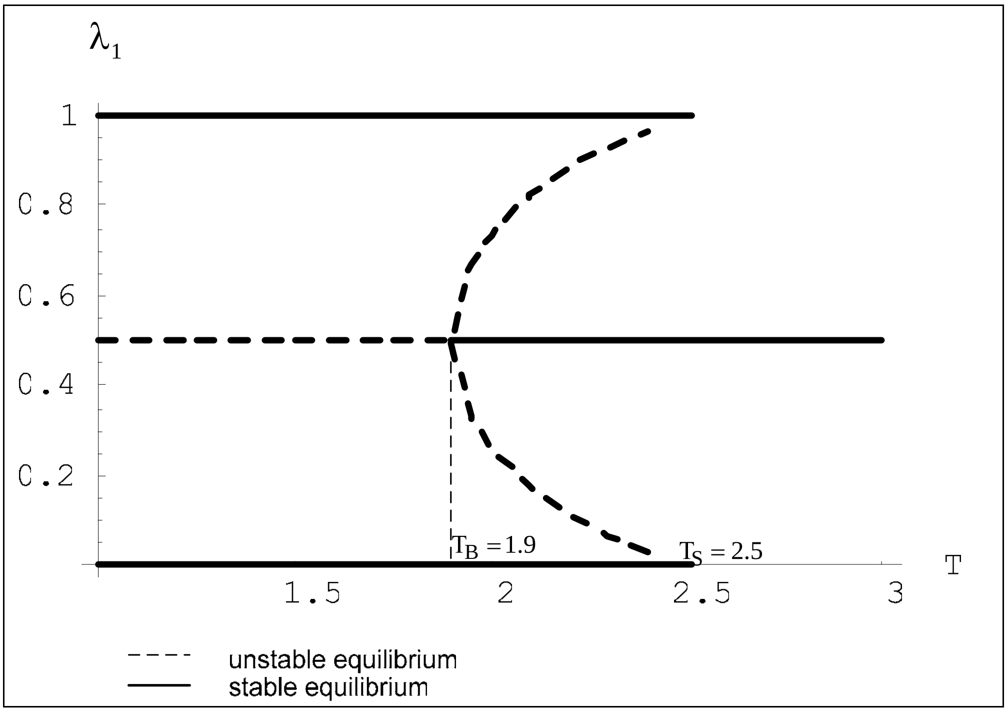
If we once again posit $\mu = 0.5$ and $\sigma = 5$, the stability relationship $\frac{dr\omega r}{d\lambda}$ then looks like Fig. 2.1-7.

Fig. 2.1-7: Functional relationship between $\frac{dr\omega r}{d\lambda}$ and T with $\mu = 0.5$ and $\sigma = 5$



Between $0 < T < T_B = 1.90$ an even distribution of industrial production in both regions is unstable. From $T > T_B$ the deconcentration then becomes a stable equilibrium. This knowledge can be condensed in a so-called bifurcation diagram.

Fig. 2.1-8: Bifurcation diagram with $\mu = 0.5$ and $\sigma = 5$

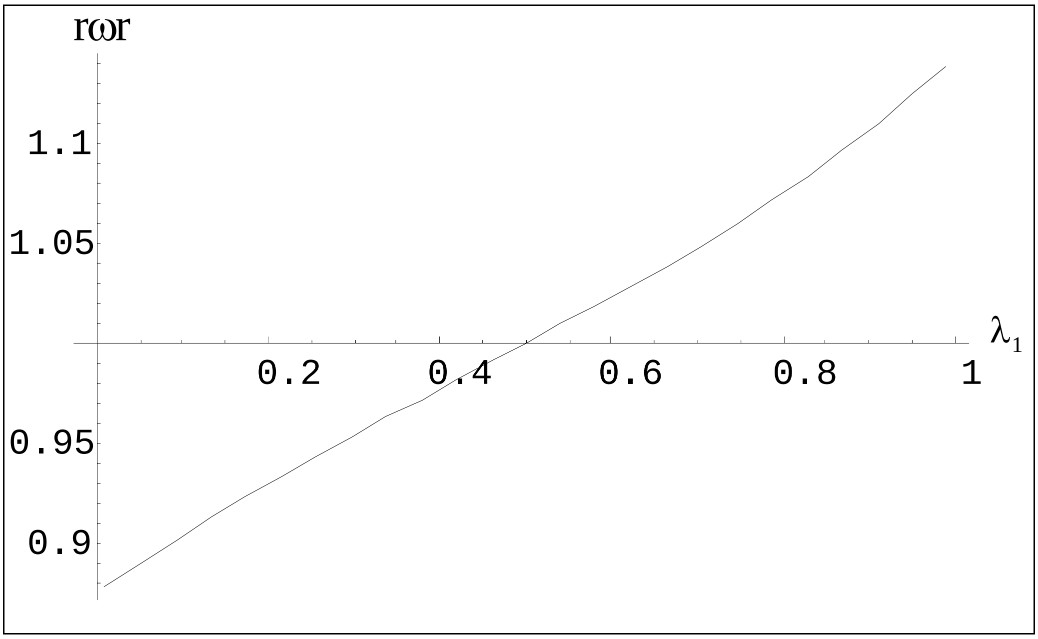


On the basis of the values examined for T_B and T_S the bifurcation diagram can be divided into three partial sequences:

a) Part 1: $0 < T < T_B = 1.9$

In this part the transport costs are so small that industrial production will concentrate in one of the two economic areas. Even distribution of production represents only an unstable equilibrium.

Fig. 2.1-9: Functional relationship between $r\omega r$ and λ_1 with $T = 1.5$

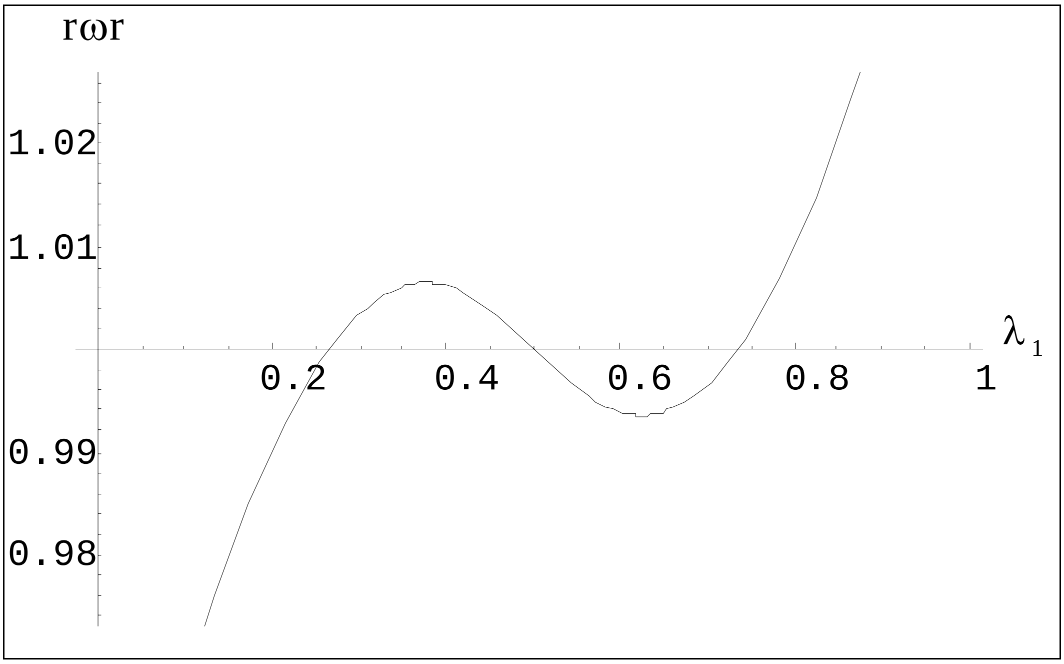


The equilibrium with $\lambda_1 = 0.5$ is unstable, since it is $dr\omega r / d\lambda_1 > 0$, i.e. the ratio of real income changes further in favour of a region when the proportion of industrial production increases in that region.

b) Part 2: $T_B = 1.9 < T < T_S = 2.5$:

Here we expect three stable and two unstable equilibria, and this expectation based on the bifurcation diagram is confirmed, if we look at Fig. 2.1-10.

Fig. 2.1-10: Functional relationship between $r\omega r$ and λ_1 with T = 2

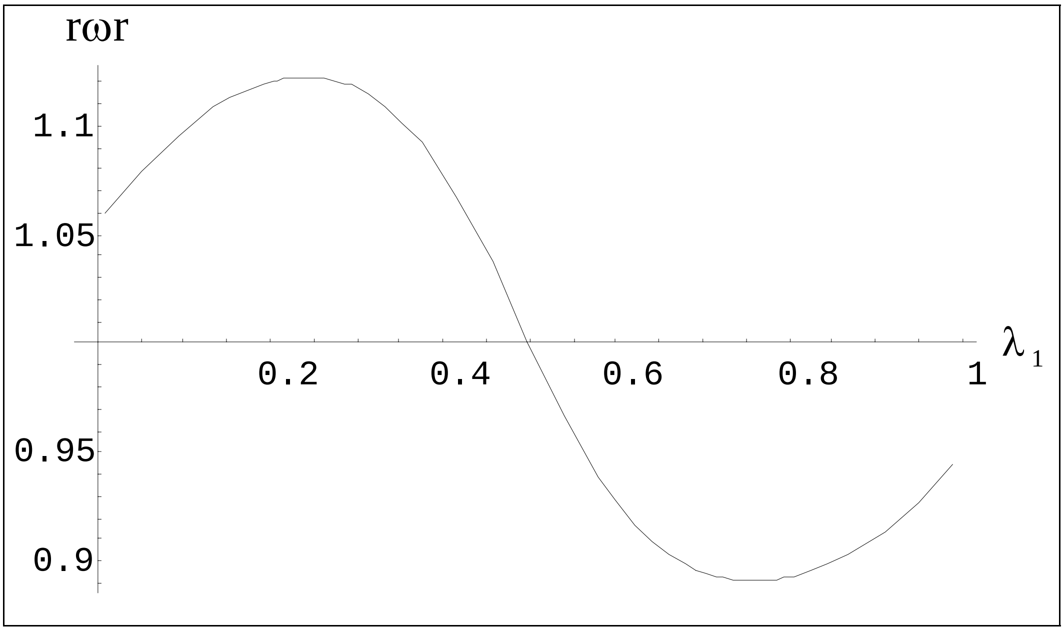


$\lambda_1 = 0.26$ and $\lambda_1 = 0.76$ represent unstable equilibria, since $dr\omega r / d\lambda_1$ in both points is greater than 0; the condition necessary for stability $dr\omega r / d\lambda_1 < 0$, on the other hand, comes into operation with $\lambda_1 = 0.5$.

c) Part 3: $T_S = 2.5 < T < \infty$

Here the transport costs are so high that with $\lambda_1 = 0.5$ the result is a stable equilibrium. $\lambda_1 = 0$ and $\lambda_1 = 1$ are no longer equilibria, because here $r\omega r \neq 1$.

Fig. 2.1-11: Functional relationship between rωr and λ_1 with T = 3



2.2 Critical reflections on the standard model of the NEG

2.2.1 Theoretical foundations of the standard model of NEG

The standard model of NEG shows that, even when two regions have absolutely identical location conditions, agglomeration and deglomeration processes can occur. The derivation takes place in demanding and internally consistent mode. But there is still the question of whether the suppositions made in the model depict human behaviour appropriately and comprehensively.

The suggested behaviour patterns of utility, income and profit maximization are in line with neo-classical arguments. In this sense, appropriate objections cannot be made against the NEG model, but against neo-classics in general. The following objections are more serious:

- The decisions of households and firms are not referred to an inter-temporal decision calculus, characteristic of modern consumption and investment theory. [19]
- Firms set their prices by a mark-up of costs, without paying attention to the reactions of competitors.
- Firms produce respectively only one good. There are no "economies of scope".

[19] See for example M. FRENKEL and H.-R. HEMMER (1999), pp. 65.

- Despite fixed costs firms remain totally mobile. "Sunk costs" are not compatible with the model.
- The production factor "capital" does not occur in the model. Production occurs exclusively by the use of the production factor "labour".
- Agglomeration is slowed down only by transport costs, which have to take on utterly implausible dimensions to explain deglomerations processes. Other decelerating effects, such as rising property prices with concentration size, overload of (traffic) infrastructure and negative environmental impact, do not occur in the model.
- It is implausible that the industrial workers are mobile interregionally, but not intersectorally. Equally obscure is the complete immobility of the labour force in agriculture.
- Whereas transport costs occur in the model for industrial goods, agricultural goods move between the regions at no cost.
- It remains an open question how regional winners can become losers and vice versa. The well-known phenomenon of aspiring mobile and declining regions cannot be explained by this model.

Therefore, one may justifiably ask if the standard model of NEG really deserves the attention and approbation it is currently receiving. It is an extremely complex, but still incomplete instrument that leads to recognition of factors already well known in regional economics. There remains only the proof that the results of the hitherto verbally presented polarization theory can also be derived in a formal model.

2.2.2 Attempt to explain the spatial distribution of economic activities

The standard model of NEG allows only two situations: either industrial production is totally concentrated in one of the two regions or is divided evenly between them. Such a simple result clearly contradicts the experience of the following phenomena which run counter to NEG:

- The area is covered by more than two regions, which are connected with each other in a complicated hierarchical relationship. [20]

- The dichotomy of the NEG (complete concentration or deconcentration of industrial production) does not happen in reality. The regions are more or less strongly industrialized, with the result that differing shades of grey reproduce the experience much more accurately than the black and white representation of the NEG.
- The real world is familiar with upward and downward movement. The dynamization of economic areas is in sharp contrast to the results of the NEG.
- The high significance of transport costs in explaining (de)concentration is not borne out by experience. The proportion of transport costs in the German economy as a whole is less than 3%, and will probably decrease. [21]

The large-scale discrepancy between the claims of the NEG and social reality raises the question of whether spatial economics is benefited by NEG or whether it did not previously reflect actual experience much better. The answer to this question is rather unfavourable for NEG. Since the work of CHRISTALLER [22] and LÖSCH [23] we have had models that generate a system of hierarchically constructed economic areas which agree reasonably well with reality. These models can be dynamized, [24] with the result that the rise and fall of economic areas can also be explained. Substantial progress might be recognized in the fact that the models of NEG better depict the competition between firms through the model of monopoly competition. Nevertheless, the contribution made by NEG to explain the spatial distribution of economic activities is somewhat modest. It offers little that could not be explained by already existing models.

---

[20] In an extension KRUGMAN takes up the case with more than two regions. Cf. M. FUJITA, P. KRUGMAN and A. VENABLES (2001), pp. 80.

[21] Cf. H.-F. ECKEY and W. STOCK (2000), p. 142.

[22] A. CHRISTALLER (1933).

[23] A. LÖSCH (1941).

[24] S. LANGE (1972), pp. 7–48.

2.2.3 Regional political implications

Other spatial growth theories and spatial economic models suggest certain regional political instruments for the development of economic spaces.

- The neoclassical regional growth theory sees no fundamental need for regional policy by central authorities. Instead, it suggests a decentral concept of competing regions, in which economic spaces are in competition for mobile demand, capital and labour. This competition model leads to optimal spatial allocation of production factors and a convergence process between the economic spaces.
- According to the Export Basis Model regional "exports" determine to a large extent the development of economic spaces. It therefore makes sense, within the framework of regional structural policy, to encourage those economic activities that lead to regional exports.
- The sectoral economic growth pole concept, on the other hand, recommends the promotion of those forms of production that produce the maximum number of linkage effects. If a company can be successfully established that demands a lot of intermediate products, the suppliers follow almost automatically, because they want to be near their customers. Branches of industry with distinct forward and backward linkages take on the role of a "locomotive" for the entire region.
- According to the regional growth pole concept the economic activities of an economic area should be concentrated in as few geographical points as possible, because only in that case will there be clear accumulation and urbanization advantages.

A correspondingly direct political implication cannot be derived from NEG. Conclusions of this sort seem to be possible only if one interprets the variables that make up the NEG in a broad sense. Thus LAMMERS/STILLER [25] subsume under decreasing transport costs also advantages through integration, such as the expansion of the EU. One then possibly sees the emergence of spatial concentration processes which may justify a promotion in areas where people move away in terms of equity policy. This happens because, in the self-depopulating areas, immobile labour, which save to accept losses of income terms because of rising transport costs and the associated price levels, remain. It is more than questionable if one really needs NEG to tell us this. It has

[25] K. LAMMERS and S. STILLER (2000).

been known since STOLPER/SAMUELSON [26] that spatial integration can also produce losers. Their argument is considerably more precise, because it names the possibly disadvantaged groups, namely those production factors that are relatively scarce in the economic area under consideration.

2.3 Further developments of the standard model of NEG

2.3.1 Transport costs for agricultural products

The above- and below-mentioned critical points quickly led to attempts to extend the standard model of NEG and so make it more convincingly compatible with reality. The following are four examples of extension that represent further developments of ideas already available in the literature or innovations. Consideration are be paid to the following:

- transport costs for agricultural products
- regional spillover effects
- the existence of non-tradable services
- the limited mobility of the labour force. [27]

Whereas we have so far assumed that agricultural products can be transported without cost between the two regions under consideration, we now wish to cancel this assumption and realistically suggest that the transport of agricultural produce also incurs transport costs. [28] As with industrial goods we suggest an "iceberg" model, where T_A indicates the quantity of agricultural goods that have to be sent from the source region, so that a unit of this product arrives in the target region.

We further assume that agricultural production is evenly divided between both regions. If industrial production is equally high in both areas, the labour force living in the two regions that has to be supplied from the regional agricultural production is also equally

---

[26] On this the arguments A. DIXIT and V. NORMAN (1980). Dixit and Norman examine in detail the possibility that a government redistributes the national income with the help of taxes and subsidies in such a way that all social groups profit from integration.

[27] Additional important extensions are the presence of preliminary inputs in the Krugman-Venables-Model [Cf. P. KRUGMAN and A. VENABLES (1995)] and the consideration of more than two regions [Cf. M. FUJITA, P. KRUGMAN and A. VENABLES (2001), pp. 79.].

Transport costs of agricultural goods, the presence of non-tradable services and limited mobility have already been addressed in other publications, if even in another form. The corresponding literature is cited in the relevant chapters.

[28] A differently constructed model of consideration of transport costs of agricultural goods can be found in M. FUJITA, P. KRUGMAN and A. VENABLES (2001), pp. 97.

high. If there are no transport costs for agricultural goods, our model does not change with $\lambda_1 = 0.5$ (equal distribution of industrial production in both regions).

This, however, is not the case with $\lambda_1 \neq 0.5$. In this case, domestic agricultural production is no longer sufficient to supply the labour force of the region which is responsible for more than half of the industrial production, with the result that agricultural goods have to be imported and corresponding transport costs incurred. The price index for the agricultural goods is no longer one, but is calculated from the following formulae:

(2.3-1)
$$P_{1,A} = \begin{cases} 1 & \text{with } \lambda_1 \leq 0.5 \\ \dfrac{1 + T_A\ [\mu \cdot (2 \cdot \lambda_1 - 1)]}{1 + \mu \cdot (2 \cdot \lambda_1 - 1)} & \text{with } \lambda_1 > 0.5 \end{cases}$$

$$P_{2,A} = \begin{cases} 1 & \text{with } 1 - \lambda_1 < 0.5 \\ \dfrac{1 + T_A\ [\mu \cdot (1 - 2 \cdot \lambda_1)]}{1 + \mu \cdot (1 - 2 \cdot \lambda_1)} & \text{with } (1 - \lambda_1) > 0.5 \end{cases}.$$

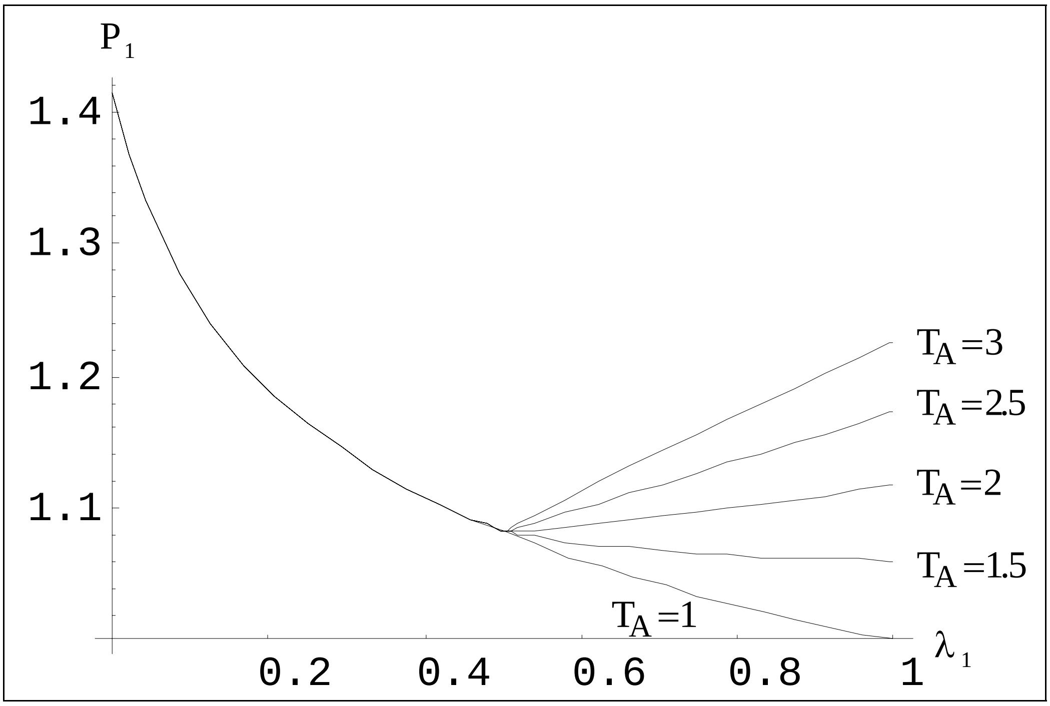
Let us consider in detail the price index for agricultural goods for region 1 (=$P_{1,A}$). It employs $\lambda_1 \cdot \mu$ labour force in industry and $\frac{1-\mu}{2}$ in agriculture. The total labour force thus amounts to $\lambda_1 \cdot \mu + \frac{1-\mu}{2}$. Because up to 50% of the total amount of the labour force in the region can be supplied, a regional self-supply up to a $\lambda_1 = 0.5$ is possible, with the result that agricultural goods do not have to be imported and the price index for agricultural goods remains at 1. But if $\lambda_1 > 0.5$, agricultural goods have to be imported, for which the price is higher than self-production by $T_a - 1$. The regional price indices result from the weighted mean of the price index of industrial goods and the price index for agricultural goods.

(2.3-2)
$$P_r = P_{r,M}^{\mu} \cdot P_{r,A}^{1-\mu}, \quad r = 1.2$$

- Example:

Once again we set $\mu = 0.5$ and $\sigma = 5$. In addition, we suppose $T = 2$ and $T_A = 3$ and consider the functional relationship between P_1 and λ_1.

Fig. 2.3-1: Functional relationship between the regional price index P_1 and the proportion of industrial employment λ_1 with $T_A = 3$



If there are no transport costs with agricultural goods, i.e. $T_A = 1$, we get the relationship already known from fig. 2.1-3 between P_1 and λ_1 with $\frac{dP_1}{d\lambda_1} < 0$ for $0 \le \lambda_1 \le 1$. The more industrial goods produced in region 1, the fewer that have to be imported and the smaller the transport costs. The situation with existing transport costs for agricultural goods $(T_A > 1)$, however, is different, because with $\lambda_1 > 0.5$ agricultural goods have to be imported, which means transport costs that then drive up the price index. ♦

Because of the deconcentrated effect of $T_A > 1$ we expect a stronger tendency of the model towards even distribution of production. If we put $\lambda_1 = 1$ and calculate T_S, then, if we once again set $\omega_1 = 1$,

(2.3-3) $$r\omega_1 = \frac{1}{[1 + 0.5 \cdot \mu \cdot (T_A - 1)]^{1-\mu}}$$

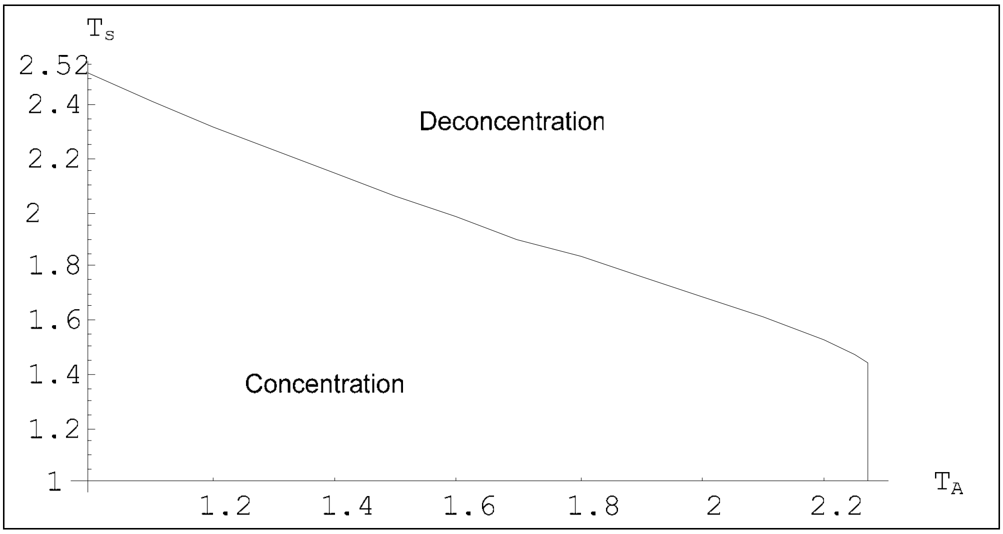
(2.3-4) $$r\omega_2 = T^{-\mu} \cdot \left[\frac{1}{2} \cdot T^{\sigma-1} \cdot (1-\mu) + \frac{1}{2} \cdot T^{1-\sigma} \cdot (1+\mu)\right]^{1/\sigma}$$

By inserting different values of T_A in $r\omega r = \frac{r\omega_1}{r\omega_2} = 1$, we can calculate how large T_S is.

♦ Example:

We recall that with $T_A = 0$ $T_S = 2.52$ was the case; up to T=2.52 $\lambda_1 = 1$ and $\lambda_1 = 0$ is thus a stable equilibrium. Simulation calculations give the functional relationship of T_S and T_A. It becomes clear that as T_A rises, T_S becomes smaller. If T_A=2 for example, then T_S amounts only to 1.69. A T>1.69 now means an equal industrial production in both economic areas. The tendency towards deconcentration becomes considerably stronger. From T_A>2.28 production is evenly divided in any case between the two regions, independently of how large T is.

Fig. 2.3-2: Concentration and deconcentration area with differing transport costs for agricultural and industrial goods



♦

2.3.2 Spillover effects

In economics spillover effects are understood as external effects, which may be of a spatial nature. [29] Between the production levels of region 1 and 2 there is a relationship that may be positive $\left(\frac{dy_1}{dy_2} > 0\right)$ or negative $\left(\frac{dy_1}{dy_2} < 0\right)$. Whereas pecuniary external effects are considered in the market and price mechanism, this is not true of non-pecuniary external effects, which are also described as technological externalities. In the Krugman Model reciprocal effects between the two regions manifest themselves, which

[29] Cf. T. DÖRING (2004).

are pecuniary and so do not impair market efficiency. But consideration is not given to technological external effects which are not considered by the economic subjects in their decision-making and consequently impair market efficiency. With the positive spillovers, radiating effects of large infrastructure developments, such as trade-fairs, airports, universities etc., [30] as well as supraregional networks that serve as exchange of information and diffusion of knowledge, [31] are of particular importance, whereas negative spillovers may involve congestion or trans-regional environmental damage.

Spatial spillovers lead to definition equations for the production level in both regions, as is clear from (2.3-5). This relationship takes the place (2.1-18),

(2.3-5)
$$y_1 = \left(\lambda_1 \cdot \mu \cdot \omega_1 + \frac{1+\mu}{2}\right) + \vartheta \cdot y_2$$
$$y_2 = \left[(1-\lambda_1) \cdot \mu \cdot \omega_2 + \frac{1+\mu}{2}\right] + \vartheta \cdot y_1$$

with ϑ as spillover factor. If we once again set $\lambda_1 = 1$ and $\omega_1 = 1$ to determine T_S, then, if (2.3-5) is reduced according to y_1 and y_2, we get:

(2.3-6)
$$y_1 = \frac{1+\vartheta+\mu-\vartheta\cdot\mu}{2-2\cdot\vartheta^2} = \frac{1+\mu+(1-\mu)\cdot\vartheta}{2\cdot\left(1-\vartheta^2\right)}$$
$$y_1 = \frac{1+\vartheta-\mu+\vartheta\cdot\mu}{2-2\cdot\vartheta^2} = \frac{1-\mu+(1+\mu)\cdot\vartheta}{2\cdot\left(1-\vartheta^2\right)} .$$

- Example:

With $\vartheta=0$ and $\mu=0.5$ $y_1=0.75$ is true. [32] If we vary ϑ, we get relationship between y_1 and ϑ that emerges from Fig. 2.3-4. As expected $y_1 > 0.75$ (< 0.75) , if positive (negative) spillovers manifest themselves. With increasing ϑ y_1 becomes larger.

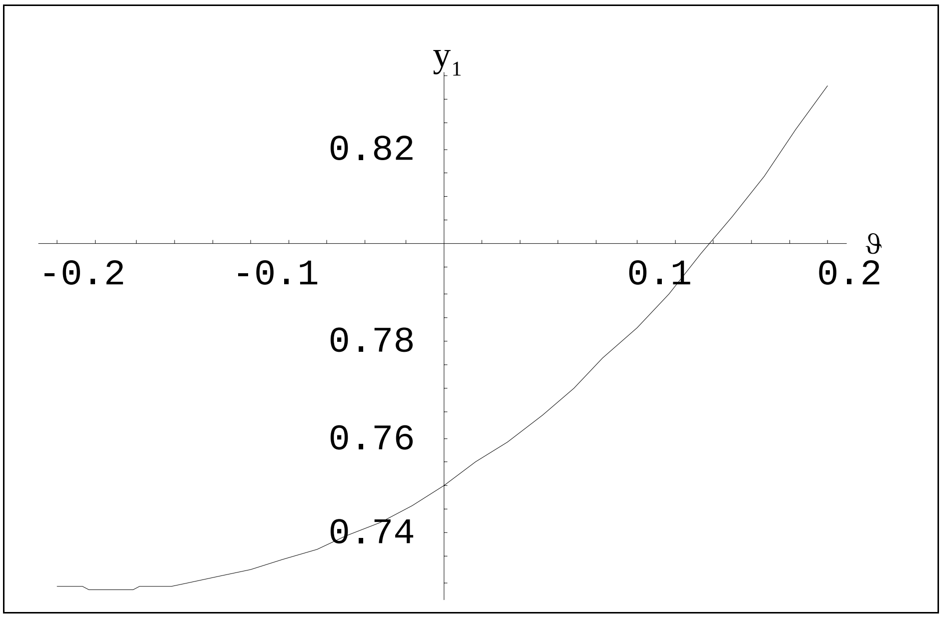
---

[30] Cf. E.A. BRUGGER (1984).

[31] Cf. on this L. SCHÄTZL (2001).

[32] Of this 0.5 comes from industrial and 0.25 from agricultural production.

Fig. 2.3-3: Functional relationship between the income of region 1 y_1 and the spillover factor ϑ



The real income ratio $r\omega r$ becomes

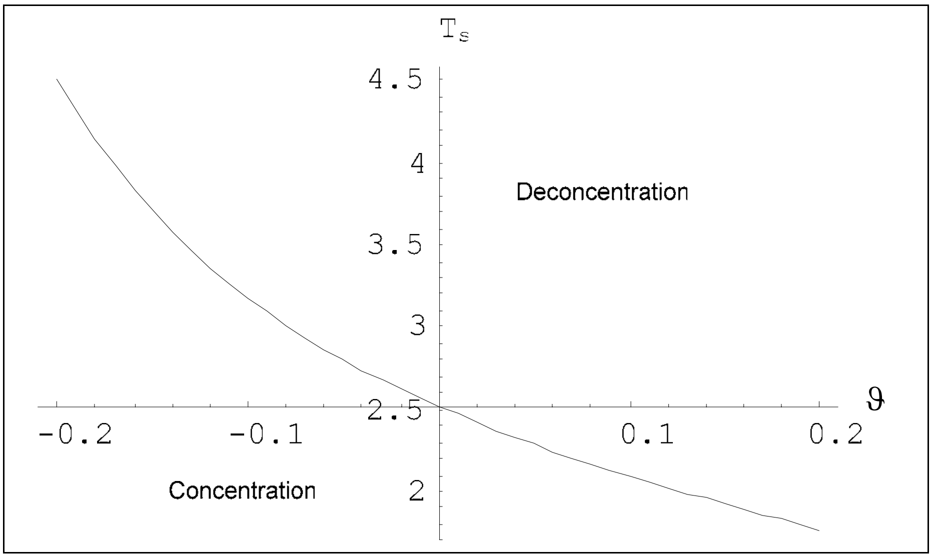
(2.3-7) $$r\omega r = T^{\mu} \cdot \left\{ \frac{T^{\sigma-1} \cdot \left[2 \cdot (1-\mu) + \left(1+\mu^2\right) \cdot \vartheta\right] + T^{1-\sigma} \cdot \left[2 \cdot (1+\mu) + \left(1-\mu^2\right) \cdot \vartheta\right]}{4 + \vartheta^2\left(\mu^2 - 1\right)} \right\}^{-\frac{1}{\sigma}}.$$

♦

♦ Example:

Once again we put $\sigma = 5$ and $\mu = 0.5$ Then, there is a functional relationship between T_S and ϑ, as is clear from Fig. 2.3-4.

Fig. 2.3-4: Concentration and deconcentration areas with occurrence of spatial spillovers



If no spillover effects appear, that is if $\vartheta = 0$, T_S is known to take on the value 2.52. In the case of negative spillovers T_S is expected to rise. The negative effects transferred from region 1 to region 2 make this region still less attractive, with the result that an even distribution of production comes into play only, if T_S takes on higher values. Thus, T_S is for $\vartheta = -0.1$ already 3.36. The reverse is true of positive spillovers. Region 1 takes region 2, as it were, with it and supports this economic area. Thus, with $\vartheta = 0.1$, only transport costs T>2.08 appear, so that the spatial concentration of industrial production no longer represents a spatial equilibrium. ♦

2.3.3 Non-tradable goods and services

In the standard model of NEG there is only an industrial and an agricultural sector. There are no services. We wish to introduce an appropriate extension in the model [33] and suggest that non-tradable services D exists, for which, borrowing from export basis theory, there is a demand because of the income generated in the other sectors. In this connection we are thinking of both private (trade, banks, insurance companies, gastronomy, legal and personal services and so on) and public services (nurseries, schools, public administration, hospitals and so on). These household and manufacturing oriented services make up a considerable proportion of total employment. [34]

If we designate the consumption of services as C_D, we now have for the utility function of the consumer, instead of (2.1-1),

(2.3-8) $$U = C_M^{\mu} \cdot C_A^{1-\mu-\gamma} \cdot C_D^{\gamma}.$$

[33] Consideration of non-tradable services in NEG goes back to E. HELPMAN (1998), who however remains in the two sector model and replaces agriculture with services.
All three sectors have been taken into consideration by J. SÜDEKUM (2003), pp. 122, though he starts from the economically utterly implausible hypothesis that the service sector, independently of the spatial distribution of agriculture and industry, is evenly distributed over both economic sectors.
Since therefore both approaches can be regarded as inadequate, an extension of the NEG will be undertaken here. It will involve only a supplement in respect of the services that cannot be exchanged between the regions (non-tradable), since tradable services are treated in the model as industrial goods.

[34] In 2002 the proportion of the service sector in the German economy was 68.8% [cf. Statistisches Bundesamt (Hrsg.) (2003), p. 112). A division between non-tradable and tradable services in the system of this branch of the economy is not automatically possible and is subject to a certain arbitrariness. The majority of those employed undoubtedly work in the non-tradable sector, such as the predominant areas of trade, gastronomy, transport, property and housing as well as public and private service providers.

If we again set total labour force of the economy at to one, then μ $(1-\mu-\gamma, \gamma)$ work in manufacturing (agriculture, service sector). Thereby employment depends in the service sector on employment in both other sectors:

(2.3-9)
$$\begin{aligned}&[\mu+(1-\mu-\gamma)]\cdot(1+z)=1\\&(1-\gamma)\,(1+z)=1\\&\text{with } z=\frac{\gamma}{1-\gamma}\end{aligned}\quad .$$

z represents the number of those employed in the service sector which can be derived directly from employment in agriculture and industry. If, for example, 0.8 workers are employed in agriculture and industry $(1-\gamma=0.8)$, the service sector increases existing employment by 25% $(z=0.25)$. This means a mark-up $z=1$. According to equation (2.3-9) z at $1-\gamma=0.5$ has to take the value 1. With $1-\gamma=0.5$ the result is also $\gamma=0.5$.

The significance of non-tradable services can be determined according to the level of employment and income in agriculture by the mark-up z.

If, for our derivation, we once again set $\lambda_1=1$ and $\omega_1=1$, the resulting relationships for the regional incomes emerge

(2.3-10)
$$\begin{aligned}y_1&=\left(\mu+\frac{1-\mu-\gamma}{2}\right)(1+z)=\frac{1-\gamma+\mu}{2\cdot(1-\gamma)}\\y_2&=\left(\frac{1-\mu-\gamma}{2}\right)(1+z)=\frac{1-\gamma-\mu}{2\cdot(1-\gamma)}\end{aligned}\quad .$$

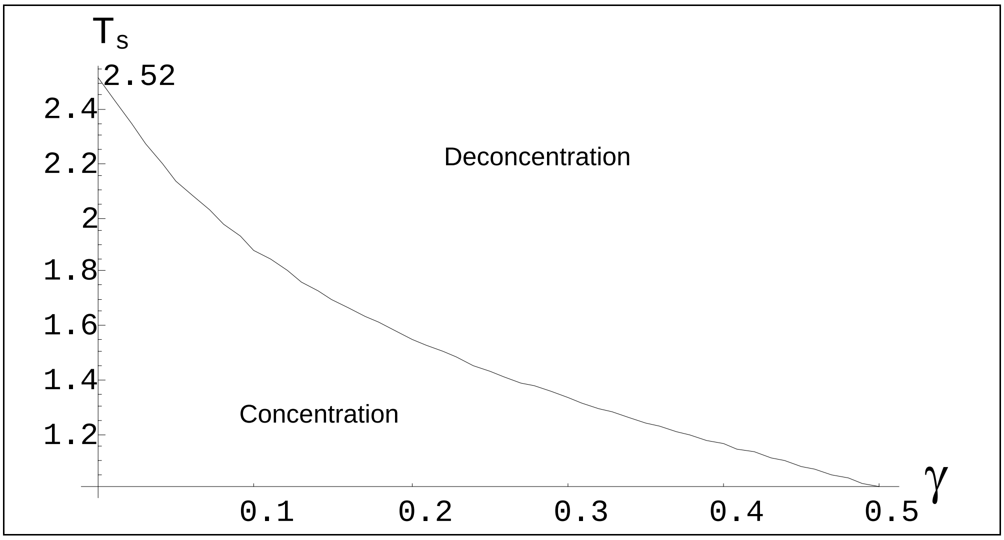
The ratio of real income becomes

(2.3-11)
$$r\omega r=T^{\mu}\cdot\left[\frac{T^{\sigma-1}\cdot(1-\mu-\gamma)+T^{1-\sigma}\cdot(1-\mu+\gamma)}{2\cdot(1-\gamma)}\right]\ .$$

♦ Example:

With once again σ=5 we assume that the proportion of agriculture remains at 0.5. Thus, $0.5=\mu+\gamma$ resp. $\mu=0.5-\gamma$ for there is a functional relationship between T_S and γ, as is clear from Fig. 2.3-5.

Fig. 2.3-5: Concentration and deconcentration area in the presence of non-tradable services



If $\gamma = 0$, there are no non-tradable services. The model remains unchanged with a T_S of 2.52. If on the other hand $\gamma = 0.5$, industry is eliminated from the model. There are only agriculture and services, which in turn depend on the purchasing power created in agriculture. An even distribution of production becomes manifest in both regions with $T_S = 1$, because no (industrial) goods have to be transported, making transport costs irrelevant. The presence of non-tradable services then has a deconcentrating effect. ♦

2.3.4 Limited mobility of production factors

So far we have suggested that the labour force in industry is totally mobile, i.e. reacts to even the smallest real wage differentials between the regions by migrating. This supposition should be adjusted to reality and thus removed. [35] We suggest that readiness of industrial workers to migrate between regions depends on the real wage differentials $r\omega_1 - r\omega_2$ and a preference factor c, which expresses the tie to the home region.

Let

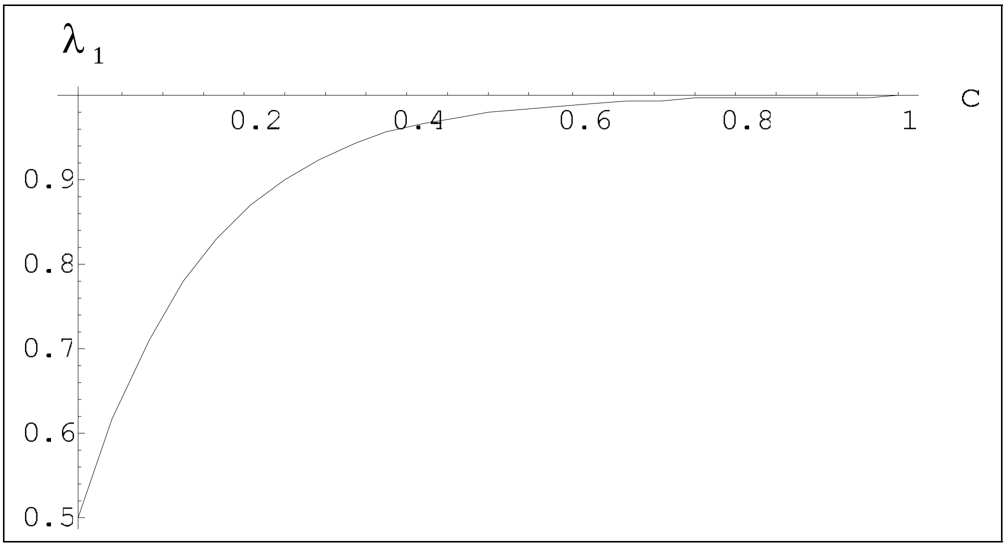
$$\lambda_1 = 1 - \frac{e^{(r\omega_1 - r\omega_2)\cdot(-c\cdot 100)}}{2} \qquad (2.3\text{-}12)$$

e = Euler's number

[35] A model with limited mobility, albeit in another form, can be found in R.D. LUDEMA and I. WOOTON (1997).

be a dampening, which expresses the willingness to migrate. $c = 0$ means total immobility of the industrial workers, $c = 1$ total mobility.

Fig. 2.3-6: Functional relationship between the proportion of industrial workers in region 1, λ_1, and the mobility degree of the employed



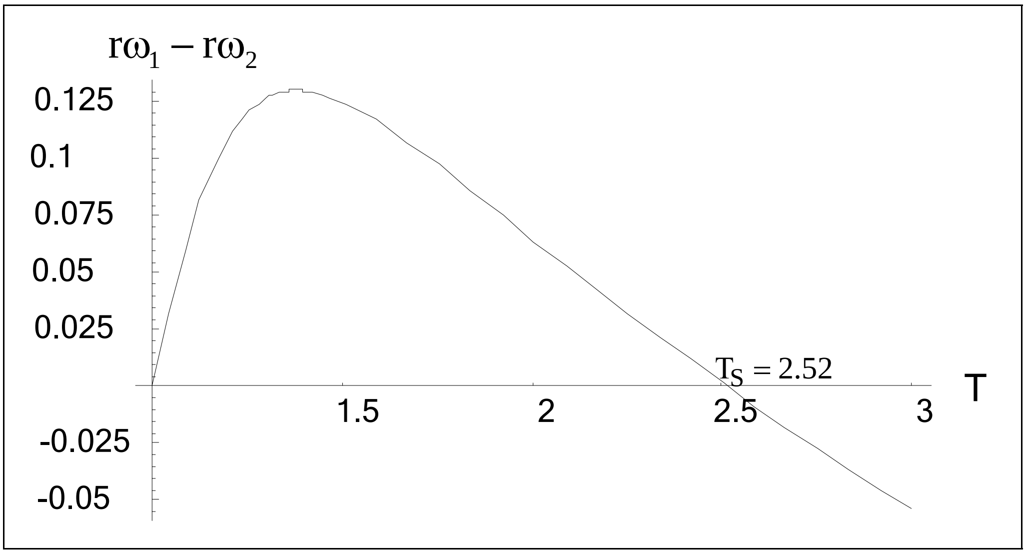
We have here put $T = 2, \mu = 0.5 \text{ and } \sigma = 5$, which leads to a real wage differential of $r\omega_1 - r\omega_2 = 1 - 0.935 = 0.065$. With $c = 0$, i.e. total immobility, the even distribution of industrial production does not change despite this real wage differential, because all workers prefer to work in their home region which is more important than the wage differential. With $c = 1$, on the other hand, all industrial worker migrate from region 2 to region 1.

Supposition of limited mobility produces a bifurcation model, which can explain all forms of the distribution of industrial workers in both regions, whereas in the standard NEG model it is known that λ_1 can only be 0.5 or 1.

- Example:

With $\mu = 0.5 \text{ and } \sigma = 5$ there is a functional relationship between the real wage difference $r\omega_1 - r\omega_2$ and T, as is clear from Fig. 2.3-7.

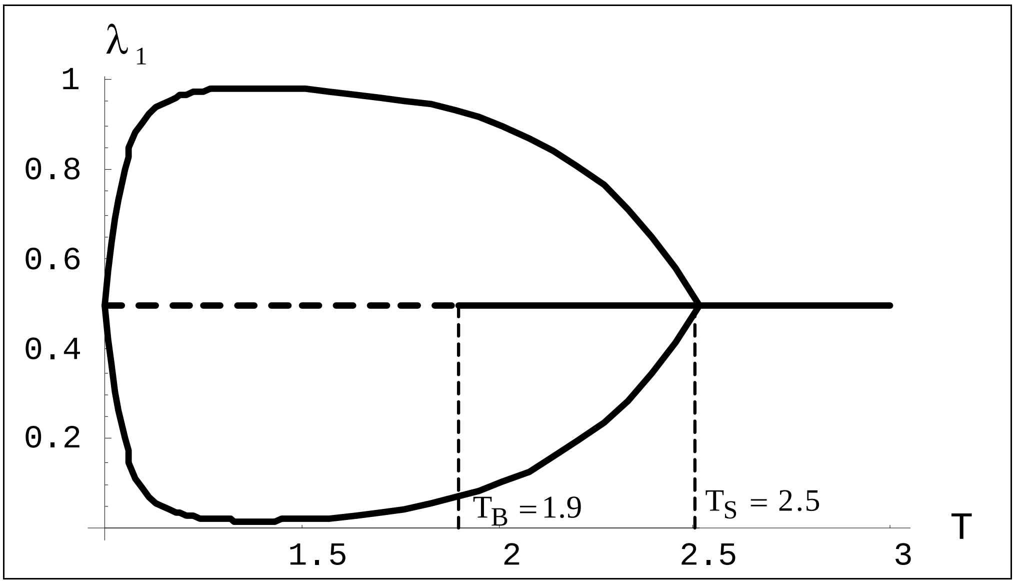
Fig. 2.3-7: Functional Relationship between the Real Income Differential $r\omega_1 - r\omega_2$ and the Maximum of Transport Costs



The real wage differential reaches its maximum with 0.130 at $T = 1.38$.

If we set $c = 0{,}25$, we can derive the new bifurcation diagram.

Fig. 2.3-8: Bifurcation diagram with $\mu = 0.5$, $\sigma = 5$ und $c = 0.25$



When $T = 1.38$ and maximum $r\omega_1 - r\omega_2 = 0.13$, 98% of the industrial workers work in one and 2% in the other region. When $T = 2$, the division is 90 at 10%. The limited mobility of the labour force can now explain every concentration of industrial production $(0 \le \lambda_1 \le 1)$, whereas the model with total mobility provides an explanation only for λ_1=0, λ_1=0.5 and λ_1=1.

3. Summary of the results

The standard model of NEG represents a synthesis of polarization theory and neo-classics. (De)concentration tendencies of industrial production are explained in a methodologically rigorous fashion. But a series of limiting suppositions are also encountered, which are diametrically opposed to reality. In this paper several of these have been highlighted and their consequences on spatial agglomeration processes examined, in particular transport costs for agricultural goods, spatial spillover effects, the presence of non-tradable services and limited mobility of the labour force. It becomes clear that a tendency towards deconcentration of production is more marked

- the higher the transport costs for agricultural goods,
- the stronger the positive spillovers between the regions,
- the more income spent on services,
- the more limited the regional mobility of workers.

The modified NEG is much more compatible with reality than the original version. In particular, two conclusions can be drawn:

- In a world of falling transport costs the result of the original model of NEG is an inevitable tendency towards an increasingly strong concentration of industrial production. Contrary to this, in the modified NEG it is an open question what kind of tendencies prevails. In addition to diminishing transport costs, which have a concentrating effect, positive spatial spillovers and non-tradable services are two factors that have a deconcentrating effect because of their growing significance.
- The modified NEG allows us to explain every concentration of industrial production that happens in reality by means of the limited mobility of the labour force, whereas the original NEG is able to give reasons for only total (de)concentration.

References:

BRUGGER, E.A. (1984), Die Bedeutung des Spillovers für regionale Entwicklung und Regionalpolitik, in: Infrastruktur, Spillovers und Regionalpolitik. Methode und praktische Anwendung der Inzidenzanalyse in der Schweiz, hrsg. v. René L. FREY/Ernst A. BRUGGER, Diesenhofen, 31–36.

CHRISTALLER, A. (1933), Die zentralen Orte in Süddeutschland, Jena.

DIXIT, A./NORMAN, V. (1980), Theory of International Trade, Cambridge.

DIXIT, A.K./STIGLITZ, J.E. (1977), Monopolistic Competition and Optimum Product Diversity, in: American Economic Review (1977), Jg. 67, 297–308.

DÖRING, T. (2004), Räumliche Wissens-Spillovers und regionales Wirtschaftswachstum –Stand der Forschung und wirtschaftspolitische Implikationen–, in: Schmollers Jahrbuch 124 (2004), 95–137.

FRENKEL, M./HEMMER, H.-R. (1999), Grundlagen der Wachstumstheorie, München.

FUJITA, M.; KRUGMAN, P.; VENABLES, A. (2001), The spatial Economy, Cambridge/Mass. und London/England.

FUJITA, M./THISSE, J.-F. (2001), Economics of Agglomeration, Cambridge/Mass.

HELPMAN, E. (1988), The Size of Regions, in: D. Pines, E. Sadka, I. Zilda (eds.): Topics in Public Economics, Cambridge University Press.

HIRSCHMAN, A.O. (1958), The Strategy of Economic Development, New Haven/Conn.

KRUGMAN, A./VENABLES, A. (1995), Globalization and the Inequality of Nations, in: Quarterly Journal of Economics 60 (1995), 857–880.

KRUGMAN, P. (1991), Geography and Trade, Cambridge/Mass.

KRUGMAN, P./VENABLES, A. (1995), Globalization and the Inequality of Nations, in: Quarterly Journal of Economics 60 (1995), 857–880

LAMMERS, K./STILLER, S. (2000), Regionalpolitische Implikation der Neuen Ökonomischen Geographie, Band 85 der HWWA Discussion Papers, Hamburg.

LANGE, S. (1972), Die Verteilung von Geschäftszentren in Verdichtungsräumen – ein Beitrag zur Dynamisierung der Theorie der Zentralen Orte, in: Zentralörtliche Funktionen in Verdichtungsräumen, Bd. 72 der Forschungs- und Sitzungsberichte der Akademie für Raumforschung und Landesplanung, Hannover 1972, 7–48.

LÖSCH, A. (1941), Die räumliche Ordnung der Wirtschaft, Jena.

LUDEMA, R.D./WOOTON, I. (1997), Regional Integration, Trade and Migration: Are Demand Linkages Relevant in Europe?, CEPR Discussion Paper, No. 1656.

MYRDAL, G. (1957), Economic Theory and Undeveloped Regions, London.

PERROUX, F. (1950), Economics spaces: Theory and Application, in: Quarterly Journal of Economics (1950), Jg. 4, 90–97.

ROOS, M. (2002), Ökonomische Agglomerationstheorien, Köln.

SCHÄTZL, L. (2001), Wirtschaftsgeographie (1. Theorie), 8. überarb. Aufl., Paderborn u.a.

Statistisches Bundesamt (Hrsg.) (2003), Statistisches Jahrbuch 2003 für die Bundesrepublik Deutschland, Wiesbaden.

SÜDEKUM, J. (2003), Agglomeration and Regional Unemployment Disparities, Frankfurt a.M.

Bisher erschienene Beiträge

19/01 **Michaelis**, Jochen
Monetary Policy: Prosper-thy-neighbour and Beggar-thyself?
erschienen in: *Kredit und Kapital*, 37. Jg. (2004), Heft 1, S. 1-30.

20/01 **Eckey**, Hans-Friedrich
Der wirtschaftliche Entwicklungsstand in den Regionen des Vereinigten Deutschlands

21/01 **Pflüger,** Michael P.
Trade, Capital Mobility and the German Labour Market
erschienen in: *Weltwirtschaftliches Archiv*, Vol. 137 (2001), S. 473 – 500.

22/01 **Pflüger,** Michael P.
Trade, Technology and Labour Markets. Empirical Controversies in the Light of the Jones Model
erscheint in: *Journal of Economic Integration*

23/01 **Lingens,** Jörg
The Impact of a Unionised Labour Market in a Schumpeterian Growth Model
erschienen in: *Labour Economics*, Vol. 10 (2003), S. 91 – 104.

24/01 **Kosfeld**, Reinhold
Influence Diagnostics for Principal Factor Analysis
erschienen in: *Allgemeines Statistisches Archiv*, Vol. 86 (2002), S. 427-446.

25/01 **Beckenbach**, Frank
Moderne Systemkonzepte in den Wirtschaftswissenschaften
erschienen in: T. Sommerlatte (Hrsg.), *Angewandte Systemforschung*, Gabler Verlag, Wiesbaden 2002, S. 80-100.

26/01 **Postlep**, Rolf-Dieter, Lorenz **Blume** und Oliver **Fromm**
Regionalpolitik im föderativen Staatsaufbau

27/01 **Blume**, Lorenz, Maria **Daskalakis** und Oliver **Fromm**
Determinants of Entrepreneurial Innovations as Starting Points for Regional Economic Policy

28/02 **Metz**, Christina E.
Currency Crises – The Role of Large Traders
revidiert und wiedereingereicht bei: *Journal of Monetary Economics*

29/02 **Jerger**, Jürgen und Jochen **Michaelis**
Wage Hikes as Supply and Demand Shock
erschienen in: *Metroeconomica*, Vol. 54 (2003), S. 434-457.

30/02 **Großmann**, Harald
Sozialstandards in der Welthandelsordnung

31/02 **Heinemann**, Frank und Christina E. **Metz**
Optimal Risk Taking and Information Policy to Avoid Currency and Liquidity Crises
revidiert und wiedereingereicht bei: *European Economic Review*

32/02 **Michaelis**, Jochen
Optimal Monetary Policy in the Presence of Pricing-to-Market
revidiert und wiedereingereicht bei: *Journal of Macroeconomics*

33/02 **Eckey**, Hans-Friedrich
Die Entwicklung des Straßenverkehrs in Deutschland bis zum Jahr 2020 und ihre Auswirkung auf die Belegung des Straßennetzes in Nordhessen

34/02 **Lingens**, Jörg
Growth and Employment Effects of Unions in a Simple Endogenous Growth Model

35/02 **Michaelis**, Jochen und Michael P. **Pflüger**
Euroland: besser als befürchtet aber schlechter als erhofft?
erschienen in: *Vierteljahrshefte zur Wirtschaftsforschung*, Vol. 71 (2002), S. 296-311.

36/02 **Nutzinger**, Hans. G.
Effizienz, Gerechtigkeit und Nachhaltigkeit
erschienen in: Nutzinger, Hans G. (Hrsg.), *Regulierung, Wettbewerb und Marktwirtschaft - Festschrift für Carl Christian von Weizsäcker zum 65. Geburtstag*, Vandenhoeck & Ruprecht, Göttingen 2003.

37/02 **Birk**, Angela und Jochen **Michaelis**
Employment- and Growth Effects of Tax Reforms in a Growth-Matching Model

38/02 **Dreger**, Christian und Reinhold **Kosfeld**
Consumption and Income - Paneleconometric Evidence for West Germany
erschienen in: *Applied Economics Quarterly* - *Konjunkturpolitik*, Vol. 49 (2003), S. 75-88.

39/02 **Kosfeld**, Reinhold, Hans-Friedrich **Eckey** und Christian **Dreger**
Regional Convergence in Unified Germany: A Spatial Econometric Perspective
erscheint in: Dreger, C. und H.P. Galler (eds.), *Advances in macroeconometric modeling*, Papers and Proceedings of the 4th IWH Workshop in Macroeconometrics, Nomos, Baden-Baden.

40/02 **Feld**, Lars und Stefan **Voigt**
Economic Growth and Judicial Independence: Cross Country Evidence Using a New Set of Indicators
erschienen in: *European Journal of Political Economy*, Vol. 19 (2003), S. 497-527.

41/02 **Eckey**, Hans-Friedrich und Günter **Schumacher**
Divergenz und Konvergenz zwischen den Regionen Deutschlands

42/03 **Kosfeld**, Reinhold und Jorgen **Lauridsen**
Dynamic Spatial Modelling of Regional Convergence Processes
erschienen in: *Empirical Economics*, Vol 29 (2004), S. 705-722.

43/03 **Beckenbach**, Frank
Das Handlungskonzept der Evolutorischen Mikroökonomik

44/03 **Metz**, Christina E. und Jochen **Michaelis**
The Role of Information Disparity in the Mexican Peso Crisis 1994/95: Empirical Evidence

45/03 **Lingens**, Jörg
Unionisation, Growth and Endogenous Skill-Formation

46/03 **Hayo**, Bernd und Stefan **Voigt**
Explaining *de facto* judicial independence

47/03 **Beckenbach**, Frank und Maria **Daskalakis**
Invention and Innovation as Creative Problem Solving Activities - A Contribution to Evolutionary Microeconomics

48/03 **Weise**, Peter
Selbstorganisation - ein fruchtbares Konzept für die evolutorische Ökonomik?
erschienen in: W. Kerber (Hrsg.) (2004), Studien zur Evolutorischen Ökonomik IX, Berlin.

49/03 **Fromm**, Oliver; Maria **Daskalakis** und Oliver **Farhauer**
Das Reformprojekt Kostenmanagement im Sozialamt der Stadt Kassel - Die Investive Sozialhilfe der Stadt Kassel

50/03 **Eckey**, Hans-Friedrich, Reinhold **Kosfeld** und Matthias **Türck**
Intra- und internationale Spillover-Effekte zwischen den EU-Regionen

51/03 **Blume,** Lorenz
Factors of Successful Local Economic Policies: An Empirical Research of East German Cities

52/04 **Kosfeld**, Reinhold und Christian **Dreger**
Thresholds for Employment and Unemployment. A Spatial Analysis of German Regional Labour Markets 1992-2000
revidiert und wiedereingereicht bei: *Papers in Regional Science*

53/04 **Daskalakis**, Maria und Oliver **Fromm**
Entwicklungspotentiale der Region Nordhessen. Eine empirische Bestandsaufnahme.

54/04 **Grossmann**, Harald und Jochen **Michaelis**
Trade Sanctions and the Incidence of Child Labour

55/04 **Eckey**, Hans-Friedrich und Reinhold **Kosfeld**
Regionaler Wirkungsgrad und räumliche Ausstrahlungseffekte der Investitionsförderung
erscheint in: *Jahrbuch für Regionalwissenschaft*

56/04 **Nill**, Jan
Evolutorisch-ökonomische Perspektiven einer Theorie ökologischer Innovationspolitik

57/04 **Kosfeld**, Reinhold und Jorgen **Lauridsen**
Factor Analysis Regression

58/04 **Michaelis**, Jochen und Angela **Birk**
Employment- and Growth Effects of Tax Reforms

59/04 **Nutzinger**, Hans G.
Die Wirtschaft in der Bibel
erscheint in: U. Ebert (Hrsg.), *Wirtschaftsethische Perspektiven VII*, Duncker & Humblot, Berlin, 2005 oder 2006

60/04 **Henrich**, Károly
Globale Einkommensdisparitäten und -polaritäten

61/04 **Michaelis**, Jochen und Alexander **Spermann**
Evaluation von Minijobs sowie Arbeitslosengeld II: Methodische Grundprobleme und Lösungsansätze
erscheint in: *Zeitschrift für Evaluation*

62/04 **Michaelis**, Jochen und Heike **Minich**
Inflationsdifferenzen im Euro-Raum – Eine Bestandsaufnahme
erscheint in: *Aussenwirtschaft*

63/04 **Lerch**, Achim
Eine ökonomische Begründung der Nachhaltigkeit

64/04 **Eckey**, Hans-Friedrich, Reinhold **Kosfeld** und Matthias **Türck**
Regionale Produktionsfunktionen mit Spillover-Effekten für Deutschland

65/04 **Eckey**, Hans-Friedrich und Reinhold **Kosfeld**
New Economic Geography

Impressum
Volkswirtschaftliche Diskussionsbeiträge
Herausgeber:
Fachbereich Wirtschaftswissenschaften
Universität Kassel
Nora-Platiel-Str. 4
34127 Kassel
Internet: http://www.wirtschaft.uni-kassel.de
ISSN 1615-2751