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## The new Laender as an industry location in unified Germany

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**The New Laender as an industry  
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# The New Laender as an industry location in unified Germany

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### Abstract

This paper discusses whether the dominant position of the Old Laender's economy in the unified Germany hampers the reemergence of industrial production in the New Laender. For that purpose productivity differences are explained by specialization advantages of industrial agglomerations, which are localized by transport costs. The industrial locations are endogenized in a model with trade, migration and also interregional firm location. To point out the relationship of the theoretical argument to the conditions in unified Germany the roles of transport costs, trade in intermediates, congestion effects, start-up costs, and knowledge spillovers are discussed. Although the influence of the agglomerative forces can not be rejected, a persistent deindustrialization of the New-Laender is found difficult to project.

# 1 Introduction <sup>1</sup>

The economic development of former East-Germany in unified Germany is often described as a catch-up process which will result in a convergence of macroeconomic aggregates such as GDP per head with West-Germany. By making use of a growth model, one might determine the speed of convergence depending in particular on the rate of investment. However, since the observed effect of unification was a tremendous decrease of industrial production in conjunction with a boost of imports from the Old Laender, the question arises whether the New Laender will be a location of manufacturing industry after having adjusted to the new conditions prevailing in unified Germany. Until very recently there were no indications for a reemergence of an export oriented manufacturing industry, and the trade deficit of the New Laender has been worsening continuously.<sup>2</sup> Since 1992, West-Germany has been suffering from the recession in Western-Europe and the growth rate of real GDP in the East has begun to exceed the growth rate in the West. But this growth differential does not indicate a broad reindustrialization.<sup>3</sup> It mainly reflects the boom in services and construction industry, sectors that generally produce non-traded goods. Both the trade deficit and the boom in non-traded goods are caused by the massive transfer payments from the West and the break-down of the socialist economy. Although the latest numbers are improving somewhat<sup>4</sup> the question of the reemergence of manufacturing industry should not be assumed to be answered already. Firstly, the numbers improve from a very low level. In 1993 the New Laender's share of Germany's industrial production was estimated at 3-4 per cent compared with a labor-force share of 20 per cent.<sup>5</sup> Secondly, a huge amount of subventions is paid to investors in the New Laender.<sup>6</sup> And, thirdly, in a bunch of regions no such stabilization could be observed.<sup>7</sup>

Corresponding to the poor performance of the New Laender as an industry location, there is a growing discussion on the long term perspectives of New Laender. Mieth(1991) has argued, that the disparities between the two Germanies may hamper the convergence. He raised Myrdal's(1957) argument that through cumulative effects regions can persistently diverge. More recently Brakman/Garretsen(1993) showed that the deindustrialization of East-Germany might be the result of agglomerative forces in West-Germany.<sup>8</sup> Siebert(1993) sees the possibility of hysteresis effects hampering the reindustrialization.

It is the aim of this paper to contribute to the question whether the integration of the two parts of Germany have deprived the New Laender of their industrial locations even in the long run. It is therefore asked, how an affirmative answer can be derived: *How can regional integration lead to a spatially uneven or concentrated*

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<sup>1</sup>The critical remarks and suggestions of my colleagues at CILE and at the Faculty of Economics are gratefully acknowledged, notwithstanding all errors are mine.

<sup>2</sup>cf. DIW(1994a)

<sup>3</sup>cf. DIW(1993) and SVR(1993) §67 ff.

<sup>4</sup>In several branches of manufacturing industry production increases, and the employment reduction has come to a halt. cf. DIW(1994a)

<sup>5</sup>cf. DIW(1993)

<sup>6</sup>cf. SVR(1993) §93

<sup>7</sup>cf. SVR(1993) §87 f.

<sup>8</sup>see also Mieth(1994). A more optimistic view is held by Schmidt/Naujoks(1993).

*pattern of production, theoretically?*

And: *Can such reasoning be employed in the case of German integration?*

Moreover: *By which processes or driving forces does this spatial pattern evolve and what are the countervailing forces?*

Although the discussion is mainly theoretical, some preliminary answers are sought to the question: *Do those forces play a role in the process of German integration?*

After presenting a basic model in section 2, section 3 discusses whether such a framework can be applied to unified Germany. In section 3.1 it will be shown, that a sounder inclusion of region-specific effects might affect the outcome of the model. Since it will become clear, that only by distinguishing firms' and workers' location decisions the actual experience can be tackled, a model with separated location decisions is discussed in section 3.2. This framework allows also the discussion of some arguments concerning the knowledge gap between the laender in section 3.3. The paper concludes with some summarizing remarks.

## 2 Industry location under localization economies

Among the many factors that constitute the suitability of a site as a location for a single firm, there are some which depend on the location decisions of other firms. If the decision of a firm to locate somewhere, as a positive external effect, increases this suitability for others, there is a particular agglomerative force at work, which in regional economics has been discussed under the label localization economies.<sup>9</sup> If more than one location exists, the strength of external linkages in different locations becomes a determinant of interlocational or interregional competition.

The application of such an agglomerative framework to the locational issues of German unification does not only enable the explanation of regional productivity differences with differing strength of positive external economies. It also provides a definition of an industrial complex as a conglomerate of firms which are tied together by external effects.<sup>10</sup> This could be used to give an economic definition of an "industrial kernel", a term which plays an important role in the discussion of deindustrialization in the New Laender and the privatization strategy of the Treuhandanstalt.<sup>11</sup> An "industrial kernel" would be a subset of firms within an industrial complex, the removal or closing down of which would weaken the agglomerative forces to an extent, that the whole complex vanishes.

In regional economics a number of external linkages between firms is discussed, for instance: Economies from specialization, knowledge spillovers, pooling of workers, and the variety of services.<sup>12</sup> As has been demonstrated by Fujita(1989), Rivera-Batiz(1988), and Krugman(1991), the industrial organizations approach to scale economies provides an appropriate analytical tool for the study of industry location in the presence of external economies from specialization and service variety, even

<sup>9</sup>see Dickens/Lloyd(1990) or Armstrong/Taylor(1985)

<sup>10</sup>Schmidt/Naujoks(1993) chose the term "industrial network".

<sup>11</sup>see the discussion in Breuel et al.(1993).

<sup>12</sup>cf. Armstrong/Taylor(1985), p. 76 f.

some features are very stylized. In Krugman's model, producers are pulled together by external effects based on the attraction of consumers by variety. The external effects are localized by transport costs. Fujita's analysis shows a spatial production pattern consisting of industrial complexes in which producers of intermediate goods are tied together through positive external effects from specialization,<sup>13</sup> which are again localized through transport costs. Both models have the advantage that the local number of firms serves directly as an indicator of productivity. But whereas Krugman's approach relies on the attraction of labor through consumption advantages in the model of Fujita productivity advantages attract jobs. This view seems to be more realistic in the case of German unification as can be seen from the "industrial kernel" debate. Moreover facing the huge amount of transfer payments to the New Laender a deindustrialization argument, which is based on pecuniary effects in the consumer goods market seem to be of less importance. Therefore, a model with an intermediate goods framework will be discussed in the next section as a basis for further discussion.<sup>14</sup>

## 2.1 A basic model

Let there be two final goods produced in both regions. The first, on which the analysis focuses, is the final product of the manufacturing industry. It uses labor and a variety of intermediate goods as inputs according to the following production function:

$$M_i = B_i D_i^{1-\delta} L_i^\delta \quad 0 < \delta < 1 \quad B_i > 0 \quad i = 1, 2$$

$L_i$  denotes labor input,  $i$  represents the index of the region,  $B_i$  is a constant, and  $D_i$  is an index of intermediate goods:

$$D_i = \left( \sum_{k=1}^{n_i} x_{ki}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad \sigma > 1 \quad i = 1, 2$$

$\sigma$  denotes the elasticity of substitution between intermediate goods in the production of good  $M$ .  $x_{ki}$  is the good of the  $k$ -th firm of a group of  $n_i$  local intermediate producers. The index  $D_i$  makes the production function dependent on the number of local firms, which is the key mechanism to implement localized returns to scale. By relying on local intermediate producers, it is implicitly assumed that intermediate goods could only be shipped from one region to the other with prohibitively high transport costs. Thereby the analysis is substantially simplified although at the cost of overstressing some features of the model.<sup>15</sup> The term transport cost throughout the paper should be taken to mean spatial transaction costs in general, including information, tariffs and physical transport.

<sup>13</sup>By employing the intermediate goods approach of Ethier(1982) Fujita is mainly concerned with non-traded intermediates.

<sup>14</sup>The model draws important elements from Krugman(1991a and 1992) but differs from it in that it uses the intermediate goods framework of Ethier(1982), allows for a direct labor input in the production of the final good, and does away with the assumption of homogeneous goods in final manufacturing output.

<sup>15</sup>Some effects of explicit introduction of transport cost on intermediate goods are discussed in the appendix.

The intermediate goods are differentiated products of an industry with monopolistic competition modeled as in Dixit/Stiglitz(1977). Since each producer acts as a Bertrand competitor, the mark-up on marginal costs is fully determined by the elasticity of substitution  $\sigma$ . For simplicity it is assumed, that intermediate goods are produced with labor only. The uniform price of a single good is:

$$q_i = \frac{\sigma}{\sigma - 1} w_i \quad i = 1, 2 \quad (1)$$

The price  $p_i$  of final good  $M_i$  is under perfect competition equal to unit costs:

$$\begin{aligned} p_i &= p_{D_i}^{1-\delta} w_i^\delta \xi_i \\ p_{D_i} &= (n_i q_i^{1-\sigma})^{\frac{1}{1-\sigma}} \end{aligned} \quad \xi_i > 0 \quad i = 1, 2 \quad (2)$$

$w_i$  is the wage rate and  $\xi_i$  contains some parameters ( $\delta$  and  $B_i$ ).  $p_{D_i}$  is the price index of intermediate goods in region  $i$  as defined. Ceteris paribus, the price index falls with rising firm-numbers, which reflects the positive external economies.

The other final good  $A_i$  is a kind of outside good. It is produced with regional specific factors only, is assumed to be perfectly tradable and serves as the numeraire.<sup>16</sup> These assumptions restrict the influence of the region-specific factor to the demand side as an exogenous demand component. Although these are very harsh assumptions, the purpose of demonstrating how an endogenous regional production evolves is greatly simplified. Section 3.1 shows a different and perhaps more convincing way of introducing regional specificity.

From the cost functions (2) one can derive the demand for labor and intermediate products as inputs in the production of  $M_i$ . Because each unit of the intermediate products is produced with  $b(x_i)$  units of labor, the labor demand of intermediate producers simply equals their output times  $b(x_i)$ . Since regional labor supply to the manufacturing industry  $LS_i$  in the absence of migration is assumed to be inelastic, regional wage rates can be derived from the labor market equilibrium conditions:

$$\begin{aligned} LS_i &\stackrel{!}{=} LD_i \\ LD_i &\equiv \delta \frac{p_i M_i}{w_i} + b(x_i) n_i x_i \end{aligned} \quad i = 1, 2 \quad (3)$$

Where  $LD_i$  denotes labor demand, as defined.

If there is equilibrium in the local markets for intermediate goods, it holds that:

$$n_i x_i \stackrel{!}{=} (1 - \delta) \frac{p_i M_i}{q_i} \quad i = 1, 2 \quad (4)$$

To close the model, final demand has to be specified. Let the utility function of a representative consumer be:

$$U_i = I_i^\mu A_i^{1-\mu} \quad 0 < \mu < 1 \quad i = 1, 2$$

<sup>16</sup>In Krugman(1991a,1992) the specific factor is termed "peasants" and the product the "agricultural" good.



Again,  $I_i$  is an index of each region's manufactured good, and is defined as follows:

$$I_i = \left( M_{1i}^{\frac{\alpha-1}{\alpha}} + M_{2i}^{\frac{\alpha-1}{\alpha}} \right)^{\frac{\alpha}{\alpha-1}} \quad 1 < \alpha < \infty$$

$M_{ji}$  is region  $i$ 's consumption of the final manufactured product of region  $j$ .  $\alpha$  denotes the substitution elasticity of the two regions final products.<sup>17</sup> Although it is assumed that the outside good can be traded without costs, transport costs on the final manufactured goods are explicitly included at this stage, in order to discuss some arguments of Krugman(1991a/1992) and Brakman/Garretsen(1993). Transport costs are simply introduced by the assumption, that to get one unit of good  $M_j$  in region  $i$  one must order  $\tau$  units. Zero transport costs are therefore expressed by  $\tau = 1$ . The unit utility expenditure function follows:

$$e_i = p_{I_i}^\mu \quad \alpha > 1 \quad i, j = 1, 2 \quad i \neq j \quad \tau > 1 \quad (5)$$

$$p_{I_i} = \left( p_i^{1-\alpha} + (\tau p_j)^{1-\alpha} \right)^{\frac{1}{1-\alpha}}$$

Where  $p_{I_i}$  is the price index of manufactured goods in the  $i$ -th region, and  $\tau$  shows the effect of transport costs on the price of the manufactured good from the distant location. Note, that transport costs on manufactured goods have been implicitly assumed to be substantially lower than on intermediate goods.

From the expenditure function, regional demands can be determined which give the equilibrium conditions for each manufactured good:

$$p_i M_i = \mu (s_{ii} Y_i + s_{ij} Y_j) \quad i, j = 1, 2 \quad i \neq j \quad (6)$$

$Y_i$  is the income in the  $i$ -th region,  $s_{ij}$  is the share of region  $j$ 's representative consumer's expenditures on region  $i$ 's manufactured good in its total expenditures on manufactured goods:

$$s_{ii} = \left( \frac{p_i}{p_{I_i}} \right)^{1-\alpha}$$

$$s_{ij} = \left( \frac{p_i \tau}{p_{I_j}} \right)^{1-\alpha} \quad i = 1, 2 \quad i \neq j$$

The demand for the outside good is given by:  $(1 - \mu)(Y_1 + Y_2)$  Because the input coefficient in the production of the outside good can be set to unity by choice of units, the wage rate of the specific factor equals the price of the numeraire. Total regional income can therefore be written as:

$$Y_i = w_i L S_i + n_i \pi_i + A_i \quad i = 1, 2 \quad (7)$$

The output of outside good production ( $A_i$ ) also stands for the supply of the region-specific factor,  $\pi_i$  is the profit in the  $i$ -th firm of a region. It is determined by the mark-up, the firm number and the value of total output of intermediates:

$$\pi_i = \frac{q_i n_i x_i}{n_i} \left( 1 - \frac{(\sigma - 1)}{\sigma} b(x_i) \right) \quad i = 1, 2 \quad (8)$$

<sup>17</sup>To simplify the discussion in final manufactured production perfect competition has been assumed. By assuming monopolistic competition the number of varieties in final products could be endogenized, which here is restricted to the number of regions. This would open the discussion to include agglomeration economies in consumption.

Given the number of firms in each location the model is now determined by equations (1) to (8) except the input coefficient  $b$ .<sup>18</sup>

Since the model is strictly symmetric and there is only one productive factor in manufacturing industry, regional differences in manufacturing industry can only arise through productivity differences. Regional productivity differences depend on the number of firms, which makes the determination of the number of firms in each location a key issue.

### 2.1.1 Industry equilibrium

Because aggregate output of intermediate goods in each location is already determined by (4), one has to find the efficient scale of an individual firm in order to determine the number of firms in each location. In the monopolistic competition framework this is usually done by assuming that free entry drives profits to zero or to a normal level. Hence, in order to find the Chamberlinian solution in the basic model, declining average costs in the production of intermediate goods are assumed, such that the input coefficient  $b$  is defined as:

$$b(x_i) = \frac{1}{x_i} + 1 \quad i = 1, 2 \quad (9)$$

The industry equilibrium can then be characterized as follows from (8):

$$\pi_i \stackrel{!}{=} 0 \Rightarrow x_i = (\sigma - 1) \quad i = 1, 2 \quad (10)$$

The equilibrium scale of output of an individual firm increases with the elasticity of substitution between intermediate goods ( $\sigma$ ). This is because a higher elasticity  $\sigma$  implies a lower mark-up (cf. equation (1)). The industry therefore produces at lower unit-costs, which can only be attained at a higher scale of output of the individual firm.

### 2.1.2 Solution

To know the solution of this model means to know the price, productivity and wage differences of the regions, which both contain a single industrial complex, each consisting of an indeterminate number of producers of the final manufactured good and a determinate number of intermediate goods producers.

Because of the explicit introduction of transport costs, a general analytic solution can not be presented. However, the main features of the basic model can be shown by numeric solution as in Krugman(1991a/1992). For this purpose it is useful to choose some units. Let the total supply of the specific factor in the outside-good production be  $1 - \mu$ , thereby fixing total income at unity ( $Y_1 + Y_2 = 1$ ) and let region one's share of it be  $\phi$ . Let the total labor force be  $\mu$  where the share of region one is denoted by  $\lambda$ . Also the niveau parameters  $\xi_i$  are chosen to be unity. With these

<sup>18</sup> Given  $n$ , the endogenous variables are:  $w_i, p_i, q_i, LD_i, M_i, x_i, e_i, \pi_i, b$

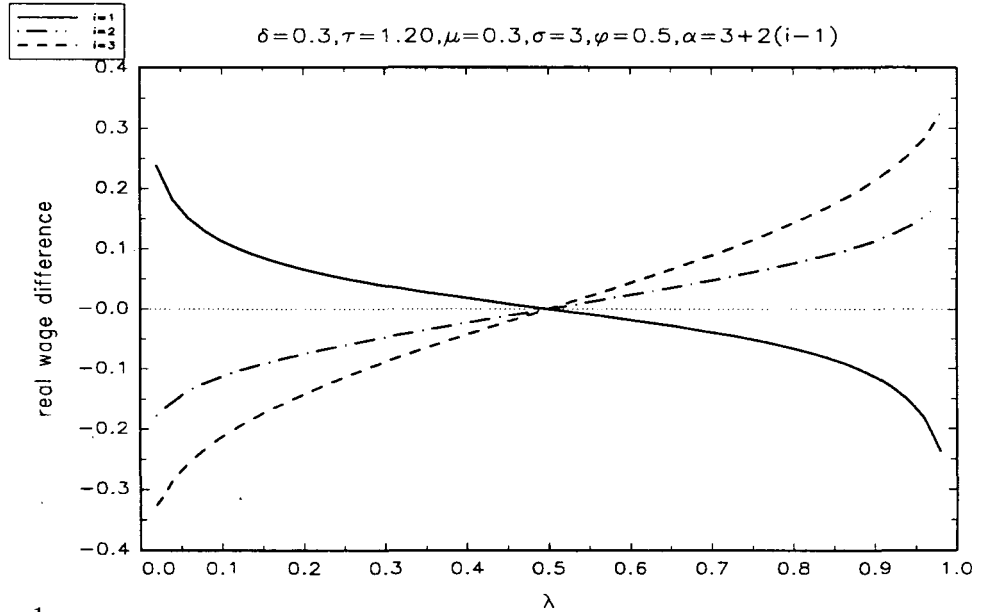


Figure 1

normalizations one can find the regional real wages for every regional allocation of the labor force, characterized by  $\lambda$ , for a given set of parameter values  $\mu, \sigma, \alpha, \phi, \tau$ .

Figure (1) shows solutions for different values of  $\alpha$ , the elasticity of substitution of regional final manufactured goods in consumption.<sup>19</sup> For a sufficiently high  $\alpha$  the figure shows an increase in the real wage difference ( $\frac{w_1}{e_1} - \frac{w_2}{e_2}$ ) with a rising labor force share of region one ( $\lambda$ ).<sup>20</sup> Because the number of firms rises with the labor supply in a region, this reflects the higher productivity of the larger region due to returns from specialization. The real wage difference for  $\alpha = 5$  or  $7$  as depicted in figure 1 indicates that agglomerative forces dominate the regional pattern of production. For the simple case of zero transport costs  $\tau = 1$ , one can show that in order to obtain the positive relationship between size of a region and its real wage the following condition must hold:

$$\alpha(1 - \delta) + \delta > \sigma$$

One could interpret this condition in the following way: If the differences in the regional final manufactured goods are not substantial from the view of the consumer ( $\alpha$  is high), the agglomerative forces dominate because differentiated inputs become complements. If that condition holds and the share  $\lambda$  approaches unity, the ratio of firm numbers and therefore the productivity difference goes to infinity. If, on the other hand the agglomeration condition does not hold, the direct effect of the

<sup>19</sup>The other parameters are chosen such as to produce figures which highlight the argument. If, for example,  $\mu$  would have a sufficient high value, only curvatures with positive slope were to be shown in figure 1. However, the qualitative effect of  $\alpha$ 's change is independent of the values chosen for other parameters.

<sup>20</sup>Dividing the wages by the regional per unit utility expenditures gives the real wages as wages in utility units.

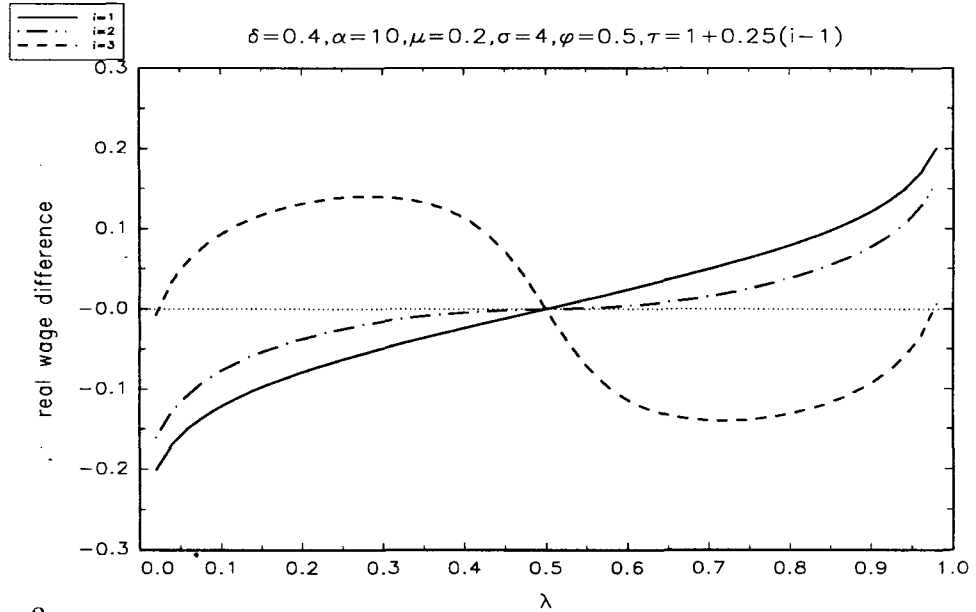


Figure 2

labor supply dominates and the real wage curve shows a mirror image. The interior intersection of the real wage difference curves at  $\lambda = \phi = 0.5$  is simply due to the absence of any regional differences irrespective of the other model parameters.

A rising weight of labor in final manufacturing production ( $\delta$ ) lowers the importance of the intermediate inputs in production and thereby the influence of the agglomerative force. By determining the ratio of average to marginal cost in the production of intermediate goods, the elasticity of substitution in intermediate goods ( $\sigma$ ) functions as a measure of importance of scale economies. With a lower  $\sigma$ , this ratio increases *ceteris paribus*, thereby indicating stronger scale economies. With stronger scale economies, fewer firms exist in the market, and, therefore, the specialization advantages diminish *ceteris paribus*. Since the share of expenditures on final manufactured goods ( $\mu$ ) shows the importance of the manufacturing sector in general, it also determines the power of the agglomerative influence.

The transport costs play an ambiguous role. On the one hand, lower transport costs imply a smaller disadvantage of the less labor abundant region, which will import at lower costs. On the other hand, the influence of the agglomerative force is fortified because the protection from interregional competition diminishes. Figure 2 shows how the lowering of transport costs on final manufactured goods affects the regional real wage differential. With zero transport costs on final manufactured goods  $\tau = 1$ , the real wage difference equals the nominal wage difference. Although the curves for different transport costs become similar in the boundaries ( $\lambda \rightarrow 1$  or  $0$ ) where productivity differences become infinitely large, in the interior range of the labor share transport costs might even reverse the real wage difference. In the case of

figure 2, transport costs of 1.5 limit the reach of regional scale economies to a degree sufficient for such a reversal. Due to the simplification of the model, only the lowering of transport costs on final manufactured goods can be demonstrated. If the transport costs on intermediate goods fell, too, the specialization advantages of the intermediate goods industry would no longer be bounded to the regions, and, *ceteris paribus*, the agglomerative forces would diminish.<sup>21</sup> But, if intermediate goods always showed higher transport costs than the final goods, some agglomerative forces will always exist under the above condition.

The size of the regional outside-good production  $\phi$  as an exogenous part of income raises regional demand, which by itself works in favor of production in the same location. As in Krugman(1992), an increase in this exogenous demand component shifts the curve of the real wage difference up, showing higher real wages at each allocation of labor in manufacturing industry  $\lambda$ .

## 2.2 The spatial pattern of production

Let me briefly sum-up the presented framework: In the simple one factor industry of the basic model only size effects matter. Using strong symmetry assumptions the location with larger supply of labor contains a larger variety of intermediate inputs. The variety of these intermediate goods in a location as an external effect positively affects the productivity of labor in the production of final manufactured output in the location.

This construction formally expresses the idea that a larger location enables a more differentiated division of labor, which gives rise to specialization advantages. These specialization advantages are small, if the inputs are of low importance in production ( $\delta$  is high), or if the inputs do not differ much ( $\sigma$  is high). The degree to which the localization economies can shape the spatial pattern of production depends on the size of interregionally immobile factor supply. If it constitutes a larger part of total factor supply ( $\mu$  is low), localization economies have less influence on the spatial pattern of production. Also, if the final manufactured goods are relatively close substitutes ( $\alpha$  is high) the productivity differences have more influence on the pattern, since regional competition is enforced. If the localization economies are sufficiently strong, an agglomerative force unfolds as a higher marginal productivity of labor which implies a higher wage in the larger location.

The important implication, that the real wage of the region with larger supply of labor can be higher than in the other region, can be assumed to affect the location decision of labor: Regional migration might be introduced as a partial adjustment process of the form:<sup>22</sup>

$$\hat{\lambda} = \nu \left( \frac{w_1}{e_1} - \frac{w_2}{e_2} \right) \quad 0 < \nu < \infty$$

A regional real wage differential accordingly causes labor to migrate into the region

<sup>21</sup>see Appendix.

<sup>22</sup>The hat denotes the relative change in time.

with the higher real wage. The explanation of regional differences in wages and productivity in the last section therefore turns out as the first step in a solution of the model, where location and number of firms of the industrial complex are determined. The second step can be regarded as an integration of the regions, since factor mobility is introduced. If the size of the regions were exactly equal, thereby supporting the interior solution, then the outmigration of a few workers might cause a real wage differential, which attracts others to migrate. A cumulative process might result, which ends if all industry is concentrated in a single location.

The partial adjustment function implies the existence of migration costs. Under migration costs expectations on future wages come to play a role, as has been discussed by Krugman(1991b). Depending on the parameters of the model and the adjustment cost function there might exist a dynamic behaviour that is not well approximated by the partial adjustment function. Under a constellation with overlapping trajectories, it might not be the initial conditions but expectations which determine the final spatial equilibrium, such that expectations are fulfilling themselves. Leaving this interesting point for further debate, let me add a remark on the one factor structure of the industry.

The omission of physical capital as a factor of production in the basic model of course is a drastic simplification. However, the introduction of capital in final manufactured goods production under interregional capital mobility, does not change the outcome. If the rental rates are equalized across the regions they do not carry over to regional differences. Depending on the strength of the localization economies the marginal productivity of labor then could still rise or fall with the size of the regional labor force, as long as intermediate goods were produced with labor only. But if intermediate goods would be produced with capital only,<sup>23</sup> as the opposite extreme, the agglomeration result would be enforced: Under sufficient strength in localization economies marginal productivity of capital would then increase with the size of the stock of capital installed. Assuming that capital is more mobile than labor interregionally, stronger agglomerative effects could then be expected.

### 3 Implications for the New Laender?

Now that the basic principle of localization economies has been shown, one might question the implication for unified Germany.

Leaving aside the stylized structure of the model, one might discuss German unification as a case of regional integration. But since the regional location of industry in former GDR was steered by the central planning authorities, one does not know to what degree the old industrial complexes of the New Laender are tied together by location economies.<sup>24</sup> Therefore, the presented framework can only serve to analyze the conditions for a reemergence of industrial complexes in the New Laender. Accordingly from the consumption externality framework of Krugman(1991), Brakman/Garretsen(1993) derive the conclusion, that the concentration of the manufact-

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<sup>23</sup>This way to model the intermediate goods industry has been used by Romer(1990).

<sup>24</sup>An overview of the evolution of industrial structure in the former GDR has been given by Hasenpflug/Kowalke(1991)

uring industry in West-Germany as the initial condition after unification obstructed a location of industrial production in the New Laender. Obviously, that conclusion can also be derived from the basic framework of section (2.1) as a theoretical point.

The application of the basic model to explain whether industry locates in the East or West, however, conflicts with some basic assumptions. First, it presumes that the transport cost assumption is a reasonable approximation to reality. The important point lies in the definition of a region. A region has been implicitly defined in the basic framework by the spatial covering of labor and goods markets, because it is assumed that inside the region only negligible transport costs prevail. An interpretation of the whole of West and East Germany as single regions, therefore, should be given cautiously. Moreover, as has been shown by Krugman(1992), in a general approach with more than two regions depending on the structure of transport goods not only extreme solutions with a unique location or a maximum number of locations exist, such that an increase in agglomerative forces generally lowers the number of industry locations.<sup>25</sup> The implication is, that more than one location could still exist in the integrated economy.

Another impediment to a discussion of unification using the basic framework is the above assumption that intermediates are non-tradable. As is discussed in the appendix, after the abolition of this assumption, full deindustrialization will not necessarily occur, since by the tradability of intermediate goods, the external economies are not completely restricted to the production of the same region. The localization economies are therefore weaker under trade in intermediates. Since trade in intermediates enables the locations in the New-Laender to gain from the specialization advantages in the Old-Laender, the close location to the Old-Laender in a multiregional framework with locations outside Germany, could also become an advantage with respect to them.

Moreover, at the boundaries, where the size of the regions is very different, specialization of the smaller region in final good production occurs. Although, workers face the same real wage in both locations, this spatial equilibrium can be interpreted as disadvantageous for the peripheral region, since the absence of a local intermediate industry implies disadvantages in growth (see below section 3.3).

However, since unification also led to huge investment in the spatial linkages between both parts of Germany, such as telecommunication, railways, and highways, Brakman/Garretsen discuss the effect of the lowering of transport costs. Using a slightly different framework, they come to the conclusion, that such an investment increases agglomerative forces, and thus aggravates the location disadvantage for the New-Laender. While the lowering of transport costs on final manufactured goods in the basic model also shows this effect (see Figure 2), their result can not be maintained in a more general setting. Because, as is shown in the appendix, if intermediate goods can be traded, the lowering of transport costs makes it more easy for the distant location to use the specialization advantages of the central region.

Leaving the simplifications aside, the question arises whether agglomeration effects can be used to explain the recent unification experience. In Krugman's, as well

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<sup>25</sup>see Krugman(1992), p33 f.

Table 1: Migration and commuting within unified Germany

Year	1990	1991	1992	1993	1994 <sup>b)</sup>
New Laender's potential labor force <sup>a)</sup>	9257	8855	8770	8622	8527
Net west migrating labor <sup>a) c)</sup>	404 <sup>d)</sup>	138	94	48	31
Migration relative to potential labor force <sup>e)</sup>	0.044	0.016	0.011	0.006	0.004
Net commuters <sup>a)</sup>	79	291	367	358	330
Commuting relative to potential labor force <sup>f)</sup>	0.009	0.033	0.042	0.042	0.039

a) numbers in thousands

b) predicted

c) difference between East-West and West-East movements

d) total net outmigration

e) second row divided by first row

f) fourth row divided by first row

Source: Bach et al.(1993)

as in the basic model of the preceding section, the key mechanism to bring about manufacturing industry concentration is interregional migration. If agglomerative forces drew production into the west, therefore, an east-west migration has to take place. Since migration as well as substantial wage differences can be observed between both parts of Germany, such an explanation seems reasonable at first glance. Table 1 shows the share of net west-migration and net commuting in the New Laender's labor potential. Although there has been substantial east-west migration in the aftermath of the break down of border barriers it has nearly ceased today and is in part substituted by large scale commuting. Under the model only two outcomes are possible: Deindustrialization or the elimination of real wage differences. While a substantial labor force is left in the New Laender, the slow-down of migration at first glance should be interpreted as a rejection of the deindustrialization hypothesis. But, since the apparent wage differential between Old- and New-Laender cannot be assumed to be fully offset by transport costs on final manufactured goods, one has to explain, why migration has slowed down despite real wage differences. One explanation of this apparent contradiction could lie in the omission of capital, stating that the real wage differential in the long run, where the capital stock has adjusted, is already eliminated. Another explanation can be found in congestion effects, as is shown in the following section.

### 3.1 A model with congestion effects

Agglomeration effects by nature increase the scarcity of factors, which cannot be increased by any location decision, forcing substitution towards mobile factors. Whereas region-specific factors have already been introduced in the basic framework, the assumption of full tradability of their products have prevented congestion effects. In this section, therefore the introduction of non-traded goods, which are produced with both a region-specific factor and mobile labor is discussed.



It is assumed that besides the manufacturing good each region produces a non-traded good  $S_i$ . It is produced with labor and the region-specific factor, say, land  $A_i$ . Because of the regional specificity this good no longer can serve as the numeraire. Therefore, an additional region is introduced, which is similar to the other two regions, but has a separate factor market. This region should be regarded as another country. Its manufacturing industry produces the numeraire good. Let the non-traded good be produced under perfect competition and have a Cobb-Douglas production function. Its price  $p_{S_i}$  is given by:

$$p_{S_i} = w_i^\gamma r_{A_i}^{1-\gamma} \quad i = 1, 2, 3 \quad (11)$$

$w_i$  is the common wage rate of the traded and non-traded goods production, and  $r_{A_i}$  the land rental rate. The labor market equilibrium condition now becomes:

$$LS_i \stackrel{!}{=} \delta \frac{p_i M_i}{w_i} + b_i n_i x_i + \gamma \frac{p_{S_i} S_i}{w_i} \quad i = 1, 2, 3 \quad (12)$$

Equilibrium in the market of land services implies:

$$A_i = (1 - \gamma) \frac{p_{S_i} S_i}{r_{A_i}} \quad i = 1, 2, 3 \quad (13)$$

Also the definition of income is changed, since the specific factor now earns the rental rate  $r_{A_i}$ :<sup>26</sup>

$$Y_i = w_i LS_i + r_{A_i} A_i \quad i = 1, 2, 3 \quad (14)$$

After changing the production side of the model, also the demand side has to be changed. The utility function now contains the non-traded good instead of the outside-good:

$$U_i = I_i^\mu S_i^{1-\mu} \quad i = 1, 2, 3$$

Where  $I_i$  is the index of manufactured final goods as above.  $(1 - \mu)$  now is the expenditure share on the non-traded good. The expenditure function then contains its price:

$$e_i = p_{I_i}^\mu p_{S_i}^{1-\mu} \quad i = 1, 2, 3 \quad (15)$$

$p_{I_i}$  is the regional index of manufactured final goods. Replacing the equations of labor market equilibrium (3), the income definition (7), and the expenditure function (5), and setting the price of the numeraire,  $p_3$ , to unity, the model is fully determined.

As above the real wage difference as a function of the share of region one's labor force in the total labor force of country one can be computed. In figure 3 computations of the real wage differential are shown for different values of the share of non-traded goods in demand  $1 - \mu$ . It has been assumed that a third of each factor is allocated to the separate region three. Of the remaining two thirds  $\lambda$  shows region one's share of labor and  $\phi$  its share of the region-specific factor.<sup>27</sup> In the computations

<sup>26</sup>Note, that in the industry equilibrium, profits are zero. See above section 2.1.1.

<sup>27</sup>For the ease of numerical calculation the regional supply of the specific factor is set equal to:

$$A_1 = (1 - \gamma)(1 - \mu) \frac{2}{3} \phi \quad A_2 = (1 - \gamma)(1 - \mu) \frac{2}{3} (1 - \phi) \quad A_3 = (1 - \gamma)(1 - \mu) \frac{1}{3}$$

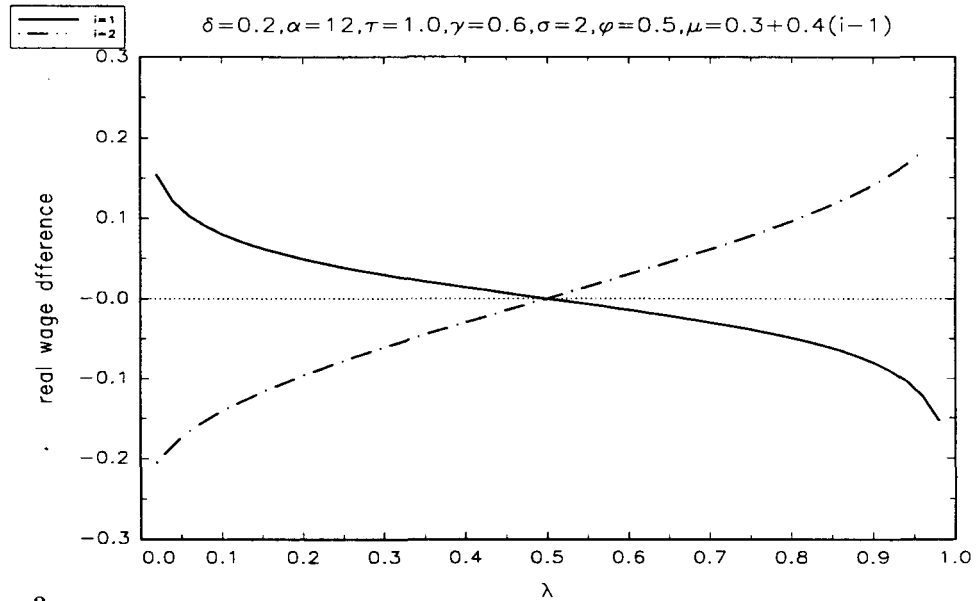


Figure 3

the share of region one in the two regions supply of land  $\phi$  is fixed to be 0.5. The figure demonstrates the intuitively obvious result, that with a higher weight of the non-traded good ( $1 - \mu$ ) the real wage gap between the larger and the smaller region may vanish or even be reversed. Since the income of a region increases with its size, demand for the non-traded good raises its price, thereby increasing the cost of living. The effect of a change in the elasticity of labor in the production of the non-traded good ( $\gamma$ ) can be seen in figure 4. This weight determines to what degree the scarcity of specific factors can be overcome by an increase in the mobile factor supply. With a lower weight, therefore, the congestion effects are enforced.

With respect to unification, an explanation of the slow-down of migration can therefore be given by means of congestion effects due to non-traded goods: Although strong agglomeration economies are working towards industry concentration, congestion effects could reverse the real wage difference. The slow-down of migration can then be interpreted as an approximation to an interior equilibrium, where a wage differential still exists. The large numbers of east-west commuters (see table 1) suggest, that congestion effect as on the housing market might have caused migration to slow down.

It should be stressed, that this is a long run result. Since housing supply typically responds slowly to market forces it may well restrict migration in the short run, even if in the long run the wage and price differences outweigh the congestion effects. In terms of the framework this effect could be described by a lowering of the weight of regional specific factors (increasing  $\gamma$ ) over time.

There are other reasons which could explain the slow-down of migration, in parti-

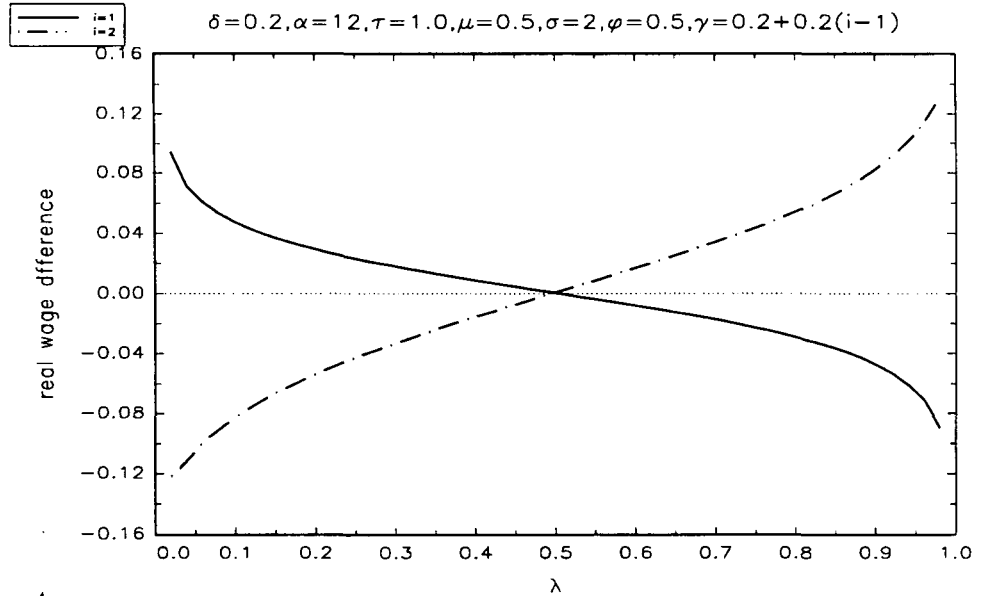


Figure 4

cular the labor market conditions (see below). However, the model has the strong implication, that since workers are left in the New Laender, firms will settle there, so that at least a minor industrial complex will emerge. This implication is of course more an assumption than a result, since it stems from the naive industry equilibrium, where firm numbers are instantaneously determined in the labor market. Thereby, the central issue of concern is evaded, namely what obstructs firms to emerge or settle in the New Laender despite the fact, that there is labor supply. To discuss this issue, first of all the location decisions of firms and labor have to be separated. The next section shows how such separation can be embedded in the basic model of section 2.

### 3.2 A framework with start-up costs

The establishment of a new firm can be regarded as an effort to generate quasi-rents. The costs of this effort, denoted as start-up costs, have to be financed by the entrepreneur. If, for any reasons, not enough rents can be obtained to cover these entry costs, no founding of firms will take place, irrespective of worker's location decision. Following Grossman/Helpman(1991) the start-up costs can be given by  $w_i a_i$ , where  $a_i$  is the input coefficient of labor needed to design a new product. It represents the available stock of (free) technical knowledge because an increase of this stock implies a lower input coefficient  $a_i$ .

Whereas the firm numbers are now known as initial conditions from history, the

change in the numbers has to be determined in order to find the industry equilibrium. Innovation, here i.e. the founding of firms, takes place as long as the startup costs, which might be financed by selling of shares, are at least covered by the stream of gross profits or quasirents. With free entry into the market for intermediate goods, net profits are driven to zero, and the present value of gross profits is just equal to the start-up costs, when innovation takes place. If the present value is below start-up costs, no innovation takes place. Formally, this can be stated as a free-entry condition:<sup>28</sup>

$$\dot{n}_i (v_i - w_i a_i) \stackrel{!}{=} 0 \quad a_i > 0 \quad i = 1, 2 \quad . \quad (16)$$

Where  $v_i$  denotes the share value of a firm in region  $i$  and is defined as the discounted infinite flow of profits:<sup>29</sup>

$$v_i \equiv \int_t^\infty e^{-r_i(\tau-t)} \pi_i(\tau) d\tau \quad i = 1, 2$$

$r_i$  denotes the interest rate in region  $i$ . Therefore, if the value of a firm is not less than the financial need for starting a firm, innovation takes place, and by free entry the firm value just equals start-up costs. By differentiation one can describe the motion of firm value in time as:

$$\dot{v}_i = v_i \left( r_i - \frac{\pi_i}{v_i} \right) \quad i = 1, 2$$

It states that a positive differential between the return to holding a share and the rate of profit it earns will only exist, when the firm value increases, therefore no further arbitrage opportunities prevail. Using a standard intertemporal utility maximization problem of the representative consumer, the interest rates  $r_i$  can be set equal to the utility discount rate  $\rho$ .<sup>30</sup> For simplicity, transport costs on final manufactured goods are set to zero ( $\tau = 1$ ). Then the price indices of final goods in both regions coincide, and the expenditure share of the final manufactured goods of region  $i$  in total expenditures on manufactured goods (see page 5) becomes:

$$s_i = s_{ii} = s_{ij} = \left( \frac{p_i}{p_I} \right)^{1-\alpha} \quad i = 1, 2 \quad (17)$$

Where  $p_I$  now denotes the country wide price index of final manufactured goods. Differently from the basic model (cf. equation (9)) the direct labor input coefficient

<sup>28</sup>In the following, the time indices are omitted if not necessary. A dot denotes the time derivative.

<sup>29</sup> $e$ , here, denotes Euler's number.

<sup>30</sup>The household has the optimization problem to maximize the discounted stream of utility over time subject to the constraint that the present value of expenditures cannot exceed the sum of the present value of earnings and the stock of wealth. An optimal consumption plan meets the Euler condition, which could be written in the following form:

$$\frac{\dot{E}_i(t)}{E_i(t)} = r_i - \rho \quad i = 1, 2$$

It states that expenditures should grow with a rate equal to the difference between interest and utility discount rate. Since total expenditure is fixed to unity the regional expenditure shares are related by:  $\dot{E}_1 + \dot{E}_2 = 0$  Therefore, the equality of interest rates and utility discount rate follows either by deducing that shares cannot change monotonically unbounded or from the additional assumption of full interregional capital mobility, where  $r_1 = r_2$ .

is set equal to unity ( $b(x_i) = 1$ ), thereby technological returns to scale are excluded. Profit per firm follows as:

$$\pi_i = \frac{(1 - \delta)s_i\mu}{\sigma n_i} \quad i = 1, 2$$

It can be seen that profits are directly affected by the number of firms: each additional firm reduces the market share of the others. Due to the external productivity effects, however, the share  $s_i$  is positively affected by the number of firms, making the net effect positive over some range of firm numbers. In this range firm locations are complementary.

With the profit equation the change of firm value is found:

$$\dot{v}_i = \rho v_i - \frac{(1 - \delta)}{\sigma n_i} s_i \mu \quad i = 1, 2 \quad (18)$$

The motion of firm numbers over time is determined by the labor market equilibrium condition, which acts as a resource restriction: If innovation occurs, all workers, who are not employed in the manufacturing industry at the going wage rate, will find a job in the innovation industry.

$$\dot{n}_i = \frac{L S_i}{a_i} - \frac{(\sigma + \delta - 1)}{\sigma v_i} s_i \mu \quad i = 1, 2 \quad (19)$$

Equations (18) and (19) form a differential equation system of fourth order. Provided the system is stable, it converges to a steady state in which no further innovation occurs.<sup>31</sup> The reason for an emergence of a static industry equilibrium lies in the reduction of the market share of each firm, which comes to dominate the positive external linkage.

The long-run outcome is a close analogy to the above average-cost-pricing equilibrium. Whereas above the fixed-costs in the intermediate good firms were arbitrarily assumed to be unity times the wage rate (see equation (9)), now the fixed costs consist of the serving of firm-shares. In the long-run equilibrium this amounts to  $v_i \rho$ . Because it is assumed that the direct labor input coefficient is unity, the average cost pricing condition can now be written as:

$$q_i = \frac{v_i \rho}{x_i} + w_i \Leftrightarrow w_i \frac{\sigma}{\sigma - 1} = \left( \frac{v_i \rho}{w_i x_i} + 1 \right) w_i \quad i = 1, 2$$

With the free entry condition (16) one gets the equilibrium scale of output of intermediate good firms:

$$x_i = (\sigma - 1) a_i \rho$$

This is quite similar to the above result (see equation 10). Therefore, if higher knowledge is reflected in lower start-up costs ( $a_i$  is low) there is a larger number of firms each producing at a lower equilibrium scale of output. The localization economies are thus increased at lower  $a_i$ . By reducing the steady-state level of profit,

<sup>31</sup>It may suffice to mention that its long run solution ( $\dot{n}_i = \dot{v}_i = 0 \quad i = 1, 2$ ) can be shown to be a saddle point locally. By assuming rational expectations all unstable paths can be excluded in the perfect foresight framework. The imposed factor mobility, however, conflicts with the perfect foresight assumption.

a lower interest rate also increases the number of firms and thereby the localization economies. If  $a_i\rho$  equals unity in both regions, all of the above presented solutions (section 2 and 3.1) can also be interpreted as the long-run solution of this framework with equal knowledge capital in both regions. If capital mobility is assumed, only some additional assumptions concerning the allocation of profits to the regions are necessary to determine regional demands.

From this way to model the industry equilibrium it turns out, that if the local labor markets translate productivity differences in wage signals, in the long-run firm location is again determined by workers location. And if for some reason start-up costs prevent innovation with firm location determined by history, they are persistently separated.

After having extended the basic framework by presenting a model with distinguished location decisions of firms and workers in the short run, let me turn back to the central question: Why there is no reemergence of manufacturing industry in the New Laender? The framework with start-up costs suggests that in order to answer this question, one has to seek for reasons why start-up costs are above the critical level.

One answer could be found in the waiting behaviour of firms. The obtained industry equilibrium has been derived by the assumption of perfect foresight. But because unification is characterized by substantial uncertainties, the industry equilibrium conditions might not be relevant. Instead of the usual profitability condition, where the net capital value is greater or equal to zero, investment under uncertainty increases the critical level of capital value. Therefore, if waiting reduces uncertainty, it might be optimal.<sup>32</sup> But if waiting carries the risk of losing the option to invest in an industry, investment decisions could be further interrelated, and also investment spurts become possible. And, since many uncertainties are substantially decreased, this answer is not very convincing. Moreover, the subventions paid to investors reduce the critical level of capital value.

A more convincing answer could stress the central role of the labor market equilibrium condition in the previous analysis: if the productivity signals are not transmitted through the labor market, the spatial distribution of industry cannot reflect the local labor supply. With regard to the huge unemployment problem in the New Laender, such an explanation seems to be reasonable at first glance. But as the high wages in the New Laender are the outcome of bargaining, a high-wage explanation should trace back to the objectives of the bargaining partners. Since the Old Laender's trade unions played an important role in the New Laender's wage determination, in that they have tried to diminish the real wage differential to prevent migration,<sup>33</sup> the question arises whether an agglomeration framework could explain their behaviour. Since, in the long run, immigration increases the productivity of labor, the Old Laender's unions would appreciate migration in the model. In the short run, however, if firm numbers are given, migration would lower real wages in the west, which could also be reduced by congestion effects. If the explanation lies hierin, another problem arises. Namely, if wages were equalized, the incentive for migration does not necessarily disappear.<sup>34</sup> Suppose the unions were to successfully fix the wage

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<sup>32</sup>see Dixit(1992)

<sup>33</sup>On the rationale for the union behaviour in the aftermath of Unification cf. Franz(1991).

<sup>34</sup>cf. Franz(1991), also see Meckl(1992).

rate uniformly over the regions, which in both regions lies above full-employment level, then productivity differences will be reflected in differences in employment rates. But differences in employment rates then produce a differential in expected real wages, which will further induce migration. Furthermore, at equalized wages, firms will experience higher profit rates in the region with more firms, since higher productivity of labor is not offset by a wage differential. Equalization of wages, - in particular under capital mobility - will therefore produce further concentration of unemployment in the lower-productivity region. An explanation why unions would still try to diminish the wage gap, therefore, has to take in account the social institutions which provide the subsidization of unemployed as well as pursue normatively motivated targets. However, it can be concluded, that preventing migration via high wages and subventions, does not solve the problem how a deindustrialization can be prevented, but increases the importance of founding and locating firms, instead. Therefore, one might conclude that deindustrialization can be prevented if additionally subventions to investors in the New-Laender are paid. The success of this strategy also depends on an external effect explaining industry concentration which has not yet been accounted for, namely the knowledge spillovers.

### 3.3 The role of knowledge spillovers

In drawing the analogy to the earlier sections, the stock of knowledge has not only been assumed to be constant in the last section, but also to be equal in both regions. Therefore complete interregional knowledge spillovers have been assumed. If, say, region one has a greater stock of knowledge available, its efficient firm size decreases relatively, allowing for a greater specialization in the intermediate-good firms. Figure 5 shows computations of the long-run outcome for different input coefficients  $a_1$  and  $a_2$  in the regions.<sup>35</sup> Obviously, if the larger region also has a greater stock of knowledge, the agglomerative effect is enforced.

The parameters for the computation in figure 5 are chosen such that the possibility of a catastrophe in the mathematical sense arises.<sup>36</sup> Krugman(1992) demonstrates this possibility by varying the exogenous income from outside-good production  $\phi$ . Here, due to a small decrease in the stock of knowledge in region 2, the interior equilibrium may become unstable and agglomerative forces become dominant. If the outmigration of labor due to selection effects causes as a negative externality a reduction in the stock of knowledge, an upward shift of the real wage differential follows, leading to further (cumulative) locational disadvantages. By expecting the higher qualified of the New Laender's workers to be more mobile, this cumulative process has been regarded to be possibly important in the case of unified Germany.<sup>37</sup>

<sup>35</sup>The computation has been done without allowing for capital mobility. If in the opposite under capital mobility as an extreme case all profits flow in one region, the qualitative figure is not affected.

<sup>36</sup>A change in the input coefficient might induce, what has been called the fold-catastrophe, cf. Ursprung(1982), S.128 ff

<sup>37</sup>see Mieth(1991) , Burda/Wyplosz(1991) p. 21f., Koller/Jung-Hammon(1993) p. 23. This argument has also been used by the German unions to defend rapid wage adjustment in the New

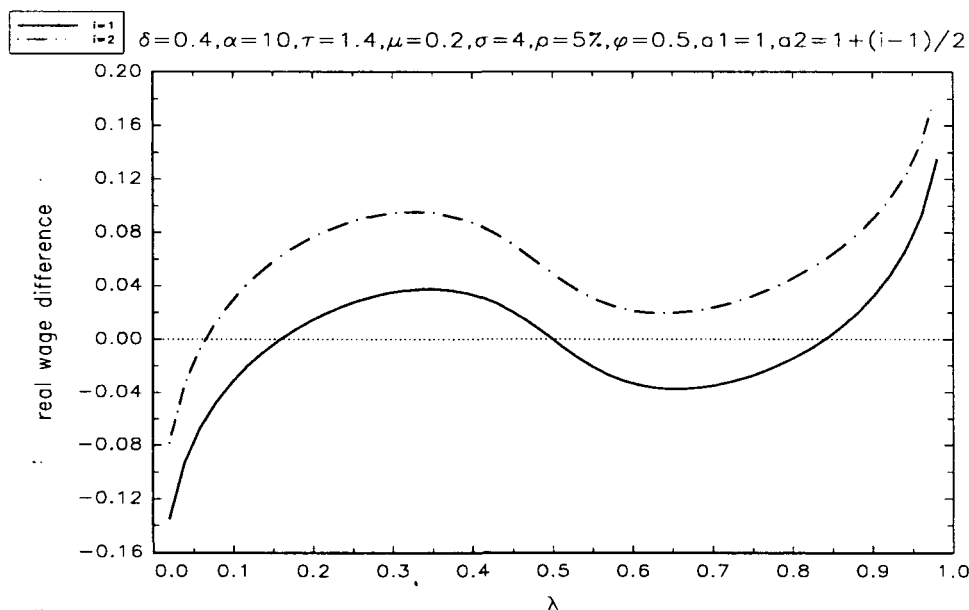


Figure 5

Although it has been difficult to support empirically the view that higher qualified East Germans have been more apt to move,<sup>38</sup> they have a higher share in realized migration.<sup>39</sup> Note, that selection effects from migration can also occur, if net migration is zero.

The role of knowledge becomes even more important if one considers its impact on economic growth. As has been emphasized in the New Growth Theory, the stock of available knowledge might itself increase with the experience in designing varieties. A region which has already developed a relatively complex industry structure with highly specialized intermediate inputs might be also relatively efficient in creating new varieties of inputs. If the regional knowledge spillovers thereby act as dynamic returns to scale, persistent regional changes in growth rates may result, as is shown in this section.<sup>40</sup> To achieve this result, one has to assume that the stock of knowledge rises at least proportionately with the number of input varieties. Then the input coefficient in designing new products can be written as  $\frac{a}{n_i}$ . The (dynamic) industry equilibrium is now defined by:

$$\hat{n}_i (v_i n_i - w_i a) \stackrel{!}{=} 0 \quad a > 0 \quad i = 1, 2 \quad (20)$$

The hat denotes relative changes in time. To analyze the behaviour of this system is a rather laborious task, because the expenditure shares  $s_i$  as defined in equation (17)

Laender. cf. Franz(1991).

<sup>38</sup>DIW(1992)

<sup>39</sup>DIW(1994b)

<sup>40</sup>Brakman/Garretsen(1993) have already mentioned this implication of the New Growth Theory in the context of industry location in unified Germany.



themselves depend on the prices for manufactured goods. A very similar system has been analyzed by Feenstra(1990) where  $\delta$  is set equal to zero, i.e. no labor input in final manufacturing production has been allowed for and an analogous system with differentiated final goods by Grossman/Helpman(1991)<sup>41</sup>. Therefore, I can be brief, following their technique.

Denoting the regional rate of innovation with  $g_i$ , the equations of motion become:<sup>42</sup>

$$\hat{n}_i = g_i = \frac{LS_i}{a} - \frac{(\sigma + \delta - 1)}{\sigma w_i a} s_i \mu \quad (21)$$

$$\hat{w}_i = g_i + \rho - \left( \frac{1 - \delta}{\sigma} \right) \frac{s_i \mu}{a w_i} \quad (22)$$

Suppose now a steady state exists at  $\hat{w}_i = 0$  and is stable under perfect foresight. If the spending shares were constant, as it would be in autarky, one could obtain the following steady state innovation rates:

$$\bar{g}_i = \frac{(1 - \delta)LS_i}{a\sigma} - \frac{\sigma + \delta - 1}{\sigma} \rho \quad i = 1, 2 \quad (23)$$

With fixed expenditure shares, the region with larger labor supply to manufacturing industry will experience higher innovation rates in the long run. Using this expression and after some manipulation<sup>43</sup> one can find the change in the innovation rate to be:

$$\dot{g}_i = \left( \frac{LS_i}{a} - g_i \right) (g_i - \bar{g}_i - \hat{s}_i)$$

The relative change of the expenditure share is:

$$\hat{s}_i = (1 - \alpha)(1 - s_i) \left( \left( \frac{\sigma}{\sigma + \delta - 1} - \frac{1 - \delta}{\sigma - 1} \right) (g_i - g_j) - \frac{\sigma}{\sigma + \delta - 1} (\bar{g}_i - \bar{g}_j) \right)$$

If region  $i$  is larger, its share  $s_i$  goes to unity<sup>44</sup> and its long run growth rate is given by (23). By substitution the growth rate of the smaller region  $j$  can be found to be:

$$g_j = \frac{\left( \frac{\alpha}{\alpha - 1} \right) \left( \frac{\sigma}{\sigma + \delta - 1} \right) - \left( \frac{1 - \delta}{\sigma - 1} \right) \frac{\bar{g}_j}{\bar{g}_i}}{\left( \frac{\alpha}{\alpha - 1} \right) \left( \frac{\sigma}{\sigma + \delta - 1} \right) - \left( \frac{1 - \delta}{\sigma - 1} \right)} \bar{g}_j$$

This is lower than the constant share innovation rate  $\bar{g}_j$ . The long run growth rates therefore differ somewhat more than with constant shares. In general, the larger region experiences higher growth rates and the industry of the smaller region

<sup>41</sup> see Chapter 9, especially p. 246-250

<sup>42</sup> As in Grossman/Helpman(1991) it is more convenient to formulate the model in terms of the innovation rate  $g_i$  and the wage rate  $w_i$  which is equal to the total regional share value  $n_i v_i$ .

<sup>43</sup> Using (23) and (22) one can describe the the growth rate of wages as:

$$\hat{w}_i = \frac{\sigma}{\sigma + \delta - 1} (g_i - \bar{g}_i) \quad i = 1, 2$$

<sup>44</sup> Here lies the crucial point of the argument, it can be carried out analogously to Grossman/Helpman(1991), cf. p.250

becomes negligible, despite a perhaps substantial industrial labor force. With factor mobility, of course, the labor force also becomes concentrated.

With respect to the New and Old Laender of Germany the longer experience in competitive international markets can act as a higher stock of knowledge and thereby as a location advantage, enhancing productivity in favor of the Old Laender as reflected in Figure 5, if there are no complete knowledge spillovers. Under dynamic localization economies, i.e. if knowledge at least grows at a rate equal to the innovation rate, the knowledge gap then could become ever increasing.

Although, it seems difficult to argue, that knowledge spillovers are completely localized in the absence of barriers from language and with a similar educational system being rebuilt in the New-Laender, the degree at which knowledge diffuses within Germany will determine the gap in innovation rates. In that context, in particular the large scale operation of Western firms in the New Laender is expected to diminish the knowledge disadvantage.<sup>45</sup> But, the role of multi-regional operation of firms can be seen differently. In the extreme case where the design of new inputs and their production can be fully separated spatially, the firms would operate inter-regionally by designing in the region with higher knowledge and producing wherever they get sufficient profit rates. Assuming complete labor markets, in the presented model the spatial distribution of industry would reflect the spatial allocation of the labor force. The shifting effect of figure 5 then would not occur. Yet, critics of the growth centre approach point out that the "trickling down" effect of growth of such branch plant location decisions is rather small.<sup>46</sup> Therefore, the importance of knowledge diffusion suggests that investment in the spatial linkages between both parts of Germany is an important device for an improvement of the quality of the New-Laender as an industry location.

As in the evaluation of the basic framework, implications are difficult to draw, because of the two-ness in the regional structure. In a multiregional framework as the European Union the close location to the Old Laender's stock of knowledge might become a location advantage: If the assumption of non-tradable intermediates is removed (see appendix), the New Laender could gain from the specialization advantages of the Old Laender. On the other hand, if the innovation framework is enlarged to take account of trade in intermediates, the possibility of specialization on the final manufactured goods production arises. This implies a further growth disadvantage for the specialized region, which then only acts as a prolonged workbench, producing without developing a local intermediate industry.

Also, the New-Laender must not be taken as a single region, implying that under a high degree of local knowledge spillovers and a lower degree of spillovers in larger areas, innovation could well take place at a few local growth poles. Accordingly some regional policy proposals focus on the localization of knowledge.<sup>47</sup> Moreover, if growth takes place at local poles, it is inefficient to spread the subsidization of investment equally over the sub-regions.<sup>48</sup>

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<sup>45</sup>cf. Schmidt/Naujoks(1993), p 17.

<sup>46</sup>cf. Coffey/Polèse(1985) p.87 f., and cf. Mieth(1994), p.15 f.

<sup>47</sup>The SRI-International concept for Jena/Thuringia provides a good example. see Weissshuhn(1993) and Mütze(1993)

<sup>48</sup>cf. Stöhr(1981). Mieth(1994) criticises the differentiation of subventions with respect to the disadvantage of regions within the New-Laender.

## 4 Conclusion

Localization economies as a reason for spatial concentration of production provide a theoretical basis for the hypothesis of deindustrialization due to integration. The explanation for localization economies given here is the more differentiated supply of intermediate goods in the larger location, which gives rise to productivity advantages. If the advantages are strong enough, they lead to an increasing marginal productivity of labor. The region with larger supply of labor will then attract the inflow of workers by offering a positive real wage differential, thereby cumulatively increasing the productivity advantage.

The application of this argument as an explanation of the spatial structure of industry in unified Germany conflicts with some weaknesses in the formal argument. Firstly, it is deduced from a two-dimensional framework, and secondly, it does not allow for trade in intermediates. The removal of each assumption tends to weaken the extreme outcome of the basic framework. In particular the inclusion of trade in intermediates alters the striking implication that a reduction in transport costs within Germany increases the danger of deindustrialization for the New-Laender. Moreover, the complete deindustrialization can no longer be deduced under trade in intermediates. Thirdly, the presence of non-traded goods allows for a greater variety of spatial equilibria, in which strong wage differences can persist, without full concentration of industry.

The observation that migration has substantially slowed down after unification without a strong emergence of manufacturing industry doubts the strong linkage between migration decisions of workers and location decisions of firms. If this linkage is assumed to exist only as a long-run phenomenon, a forced interregional equalization of wages has been found possible to cause a deindustrialization. Yet, the combination of preventing migration with high wages and encouraging investment and firm foundation with subventions theoretically offers a way out of the danger of deindustrialization. But focusing on knowledge as an additional region-specific factor under the absence of complete knowledge spillovers, not only migration and its selection effects but also the accumulation of technical knowledge would be a process by which the spatial concentration of industry might evolve. In this respect the interregional operation of firms within Germany must not be seen as limiting the knowledge gap. Again, by increasing knowledge diffusion a reduction in transport costs within Germany should raise the quality of the New Laender as an industry location. Also if knowledge spillovers are accounted for, the omission of trade in intermediates and the two-dimensionality of the argument render it difficult to draw implications for the New-Laender.

The complexity of forces which might shape the spatial pattern of production requires the empirical verification of their influence as well as their quantification. The theoretical discussion suggests to ask questions like: To what degree can regional labor productivities be explained by the size of the regional labor force in the Old Laender after having controlled for different sectors? And: Can the degree of regional concentration within sectors in the Old-Laender be used as an explanation for the performance of that sectors in the New-Laender?

## Appendix: The role of transport costs on intermediates

If intermediate goods can be imported, albeit with transport costs  $\vartheta$ , the basic model must be slightly reformulated. The price index for intermediate inputs in the production of region  $i$  as stated in equation (2) must now be written as:

$$p_{D_i} = \left( n_i q_i^{1-\sigma} + n_j (q_j \vartheta)^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \quad i, j = 1, 2 \quad \vartheta > 1 \quad (24)$$

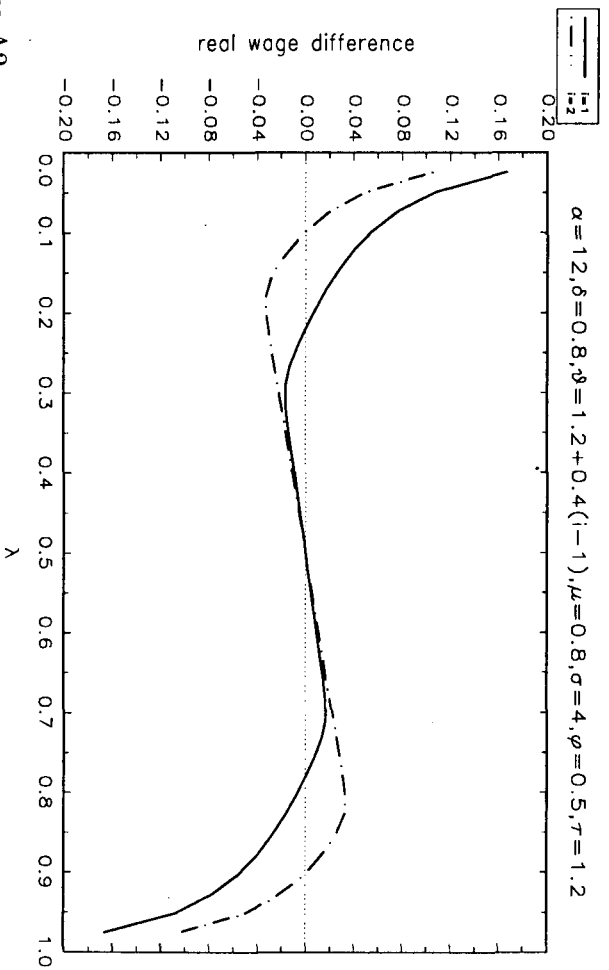
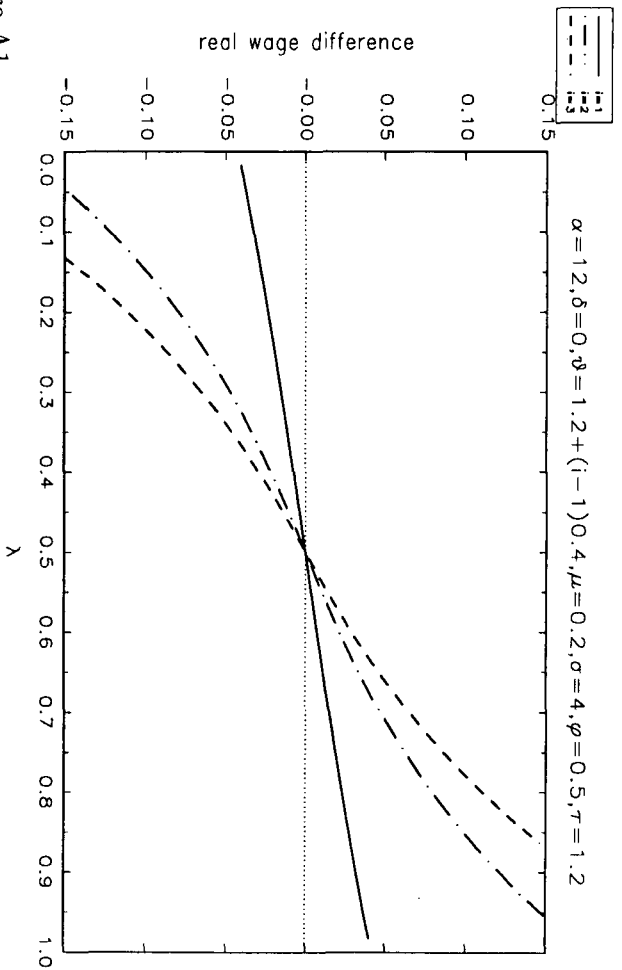
The equilibrium conditions on the markets for intermediate goods as stated in equation (4) above, now are:

$$n_i x_i \stackrel{!}{=} \frac{1-\delta}{q_i} (r_{ii} p_i M_i + r_{ij} p_j M_j) \quad i = 1, 2 \quad (25)$$

Where  $r_{ij}$  is the share of region  $j$ 's purchases of intermediate goods of region  $i$  in its total expenditures of intermediate goods. It can be determined from the cost functions:

$$\begin{aligned} r_{ii} &= n_i \left( \frac{q_i}{p_{D_i}} \right)^{1-\sigma} \\ r_{ij} &= n_i \left( \frac{q_i \vartheta}{p_{D_j}} \right)^{1-\sigma} \end{aligned} \quad i = 1, 2 \quad i \neq j$$

The explicit introduction of transport costs on intermediate goods  $\vartheta$  allows for intraindustry trade in intermediates, which enables also the distant location to use the specialization advantages. Therefore, the lowering of these transport costs extends the influence of regional scale economies to other regions and therefore works in the opposite direction than the lowering of transport costs on final goods. Figure A1 shows the effect in a slightly simplified model with  $\delta = 0$ . The assumption that there is no labor input in the final production of manufactured goods carries over from the basic model, the property that the number of local firms is proportional to the local labor supply. If direct labor input in the production of final manufactured goods is allowed for, full regional concentration of industry is no longer the outcome with strong agglomerative forces as is shown in Figure A2. This is because for a small regional labor force, a specialization in final manufactured goods production can occur. With a reallocation of labor towards the larger region, the number of local firms shrink and intermediate goods become increasingly imported. This raises the price-index of intermediates and local intermediate goods become increasingly substituted by labor until the whole local labor supply is employed in final goods production and all intermediate goods are imported. Any further outmigration then increases the wage rate, by causing a reduction in production of the final good. The full deindustrialization of a region, therefore, must not follow under even strong agglomerative forces. Figure A2 demonstrates also that an increase in transport costs on intermediates makes specialization on final goods production less likely. A similar effect results from a variation in the elasticity of substitution between the regional final goods ( $\alpha$ ). With a higher elasticity  $\alpha$  the response of final demand to changes in price is stronger. The decrease in labor, therefore, leads to a larger contraction of final goods production which lowers the importance of the substitution effect. In the



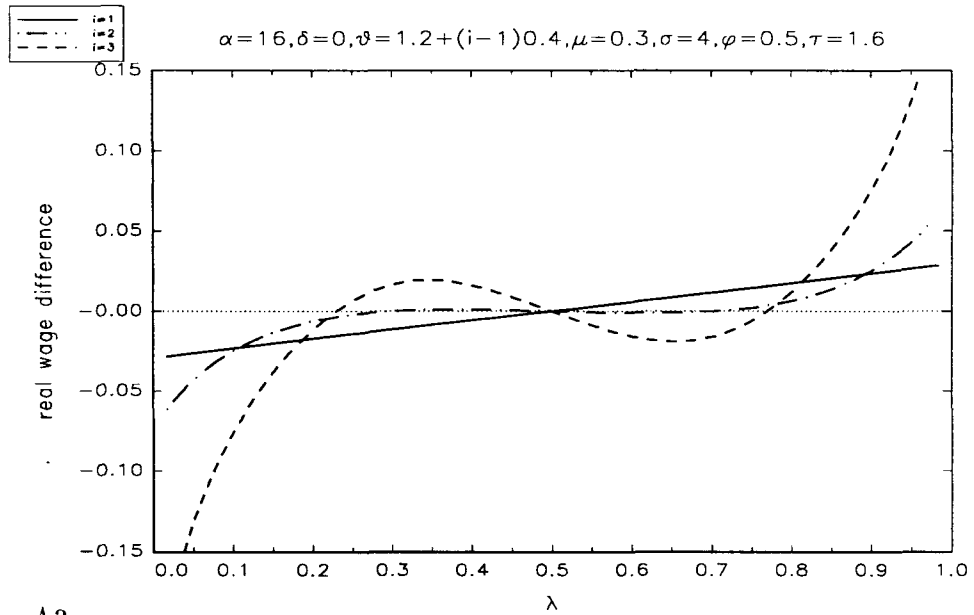


Figure A3

extreme case with full substitutability ( $\alpha = \infty$ ) no such specialization equilibrium is reached.

If the assumption of the basic model that transport costs on intermediate goods ( $\vartheta$ ) are higher than on final goods ( $\tau$ ) is removed, reversals of real wage differences also become possible. Figure A3 shows a stable interior solution at relatively higher transport costs on intermediates  $\vartheta = 2$  and  $\tau = 1.6$ , and the opposite outcome if the transport costs structure is reversed. If one thinks of local producer services, for instance, one could imagine how the introduction of new communication electronics might dramatically lower transport costs on intermediates and thereby effect a reversal of location advantages. Generally, the effect of regional integration becomes more difficult to predict under non-prohibitive transport costs on intermediates.

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