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THE EMPIRICAL RELEVANCE OF THE NEW ECONOMIC GEOGRAPHY: TESTING FOR A SPATIAL WAGE STRUCTURE IN GERMANY

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Abstract

In this paper we want to shed some light on the empirical relevance of the new economic geography. Using one of the central features of the core new economic geography models, namely that wages have the tendency to fall the further one moves away from centres of economic activity, we investigate the existence of a spatial wage structure for post-unification Germany**.** We find support for a spatial wage structure for German city-district wages, and hence indirectly for the relevance of a new economic geography model for Germany. We also find that demand linkages in Germany are strongly localised and that the "old" border still matters to the extent that economic interactions between western and eastern Germany are still limited compared to the situation within these two parts of Germany.

Keywords: New economic geography, spatial wage structure, Germany

JEL Classification: F12, F15, R12

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1. Introduction[1]

Starting with the seminal contribution by Krugman (1991), the new economic geography has been prominent on the research agenda in economics in recent years. The bulk of this research is of a highly theoretical nature (see Fujita, Krugman and Venables, 1999). In this paper we want to shed some light on the empirical relevance of the new economic geography. Using one of the central features of the core new economic geography models, namely that wages have the tendency to fall the further one moves away from centres of economic activity, we investigate the existence of a spatial wage structure for post-unification Germany. Based on the work of Hanson (1998) we do find clear evidence in favour of a spatial wage structure.

The principal aim of the paper is to establish whether or not a spatial wage structure exists for Germany. The German case is interesting against the background of (the lack of) convergence between western and eastern Germany following the fall of the wall. Despite the initial optimism that prevailed following the German re-unification about the convergence prospects between western and eastern Germany, it was quickly pointed out that this optimism was not necessary in line with modern trade and growth theory (Siebert, 1991, 1999). Although some convergence (in terms of gdp per capita) did took place in the period 1991-1995, the clear lack of convergence since then indicates that the new economic geography model with its emphasis on core-periphery outcomes might be of some relevance for post-unification Germany. In fact, the new economic geography model was called upon to show that a so-called *Mezzogiorno* scenario (with western Germany as the core and the former GDR as the periphery) could not be ruled out for the German case (e.g. Brakman and Garretsen, 1993).[2] Others (for instance Sinn, 2000), however, pointed out that the neo-classical model is still relevant for Germany, but that prices, wages and other market forces could not do their proper job due to all kinds of distortions. This argument might be relevant, but then it also holds for the new economic geography approach. In this approach market distortions could prevent core-periphery patterns to become reality. What we try to do in this paper is to find out whether or not the actual spatial wage pattern is consistent with the new economic geography

[1] We like to thank participants of seminars in Groningen (especially Paul de Grauwe), Nijmegen, Berlin and Maastricht as well as participants of the CESifo seminar on November 6th 2000 in Munich for their comments.
[2] A leading textbook on international economics , Krugman and Obstfeld's *International Economics* (1994, Third edition) uses the German re-unification as the example to explain the essentials of the new economic geography.

approach and is not the result of (random) distortions. The present paper is our attempt to test for a spatial wage structure in Germany and is also relevant given the ongoing debate about the proper theory to analyse the convergence process in Germany.

The paper is organised as follows. In the next section we briefly discuss the various approaches to test for (part of) the theory of the new economic geography. Our conclusion is that the idea of a spatial wage structure offers a useful starting point to assess the empirical relevance of the new economic geography approach. Section 3 deals with the data set and our basic specification of the wage equation. The estimation results are discussed in section 4. Section 5 concludes. In the Appendix to this paper we give some additional (and preliminary) estimation results on the spatial wage structure based on a different model specification.

2. How to Assess the Relevance of the New Economic Geography?

2.1. The facts and economic theory

A by now vast amount of empirical research has shown that economic activity is not distributed randomly across space. The agglomeration of economic activity can be observed at various levels of aggregation (countries, regions or cities) and the geographical specialization or concentration of industries is also widespread (see for instance Brülhart and Torstensson, 1996, for the EU). As for instance Brülhart (1998) in his survey of the empirical evidence notes, the same empirical fact about specialisation or agglomeration can almost invariably be explained by different theoretical approaches, i.e. standard trade theory or geography approaches. At the one hand this is good news because it means that these are not facts in search of theory so to say. At the other hand this state of affairs is not very satisfactory because it does not answer the question as to the empirical relevance of individual theories like the new economic geography.

This last point has, of course, not gone unnoticed in the literature and several studies try to test for the relevance of one or more theories of location by investigating how much of the observed specialisation or agglomeration can be ascribed to these theories. An example is the study of the US city-size distribution by Black and Henderson (1999) where it is tested how important scale externalities are in the formation of cities (to stimulate agglomeration) and whether the actual geography and the characteristics of city-neighbours influence (changes in) city-size. The first determinant is at home in modern neo-classical theory whereas the second

set of characteristics describes variables in the modern theories of location, like the new economic geography. It turns out that both sets of determinants are relevant; upward mobility of cities (size-wise) is promoted by, a coastal location, a good climate and a location with a high market-potential. In what can be seen as a follow-up to the development of the well-known Ellison-Glaeser index of industry concentration, Dumais, Ellison and Glaeser (1997) try to show how much of the observed industry concentration in the US is due to externalities. They find evidence that lends support to one of these externalities, namely labour market pooling, and therewith also indirectly find support for theories that rely on pecuniary external economies like the new economic geography. This, however, does not mean that a neo-classical foundation of the observed geographic concentration in the US is irrelevant in principle. Ellison and Glaeser (1999, p. 315) estimate that approx. 20% of this concentration can be explained by geographical advantages (=endowments). It seems that both types of explanations are relevant: neo-classical and modern geography.

These and other "1st versus 2nd nature" (Krugman, 1993) explanations do, however, not offer a direct test of a particular theory, like the new economic geography or the neoclassical model. They typically test for the significance of particular variables, like endowments, economies of scale, scale externalities or specific characteristics of geography for the location of economic activity. Although it can make certain theories look more plausible than others do, this methodology does not discriminate between theories. For one thing, the significance of some of these explanatory variables, for example the importance of transport cost for trade between locations (countries), is consistent with the new economic geography model but also with other approaches like an extended version of the standard neo-classical trade theory (Deardorff, 1995). In general, it seems that many variables, which are important in the neo-classical approach, also turn out to be crucial for modern models of economic geography. The fundamental problem is that these studies still do not try to test directly for the relevance of the underlying mechanisms that sets the modern theoretical approaches of location apart.[3]

To elaborate upon this last important point, take for instance studies in which (in a reduced form regression) some measure of industry concentration is regressed upon a set variables that includes variables from various competing theories. A representative example of this

[3] This need not to be an issue if one is merely trying to explain the variable of interest (here industry concentration) and wants to take all potentially relevant factors into account. For our present purposes it is, however, troublesome because we want to assess the empirical relevance of a particular theory, the new economic geography.

approach is the study by Haaland et al (1999). For a group of 13 European countries and 35 industries the concentration of each industry is regressed upon variables which are meant to capture four different approaches to model international trade. Two variables (labour intensity and human capital intensity of industry production) are used as proxies for the Heckscher-Ohlin model, whereas technological differences between industries represent the Ricardian trade model. Two modern (trade) theories, both the new trade model and the new economic geography model, are proxied by the relative concentration of expenditures (=market size) and a variable measuring economies of scale. A measure of intra-industry input-output linkages is also included and thought to apply to the new economic geography model only. The inclusion of a variable measuring trade costs completes the set of independent variables. It turns out that neo-classical (e.g. human capital intensity) variables as well as "new" variables (e.g. market size) are important determinants of the industry concentration in Europe.[4] The basic problem with the approach followed in these kind of studies is aptly summarised by Brülhart (1998) who argues that such a "regression analysis of industry concentration suggests that all major theoretical approaches are relevant. However they have not been used to assess relative merits of competing models across industries or countries" (Brülhart, 1998, p. 792). From the point of view of the new economic geography one might add that another problem is that allegedly independent variables in some of these studies, notably proxies for market size, are *not* independent because market size is determined by the location of industries in the new economic geography approach. The difference between endogenous and exogenous variables becomes even more difficult than usual.[5]

So, in the former approach it is impossible to discriminate between different theoretical approaches. As Krugman notes, in his survey of the new economic geography, empirical work in the new economic geography has, similar to the new industrial organisation and new growth literature, "failed to offer much direct testing of the specifics of the models" (Krugman, 1998, p. 172). In his view the empirical work by Donald Davis and David Weinstein (1996) on the so-called *home market effect* is an exception. In short, the home market effect notes that producers of differentiated goods, under increasing returns to scale, must choose a location for production; location in the larger region/country is preferred because a larger share of sales can be carried out without incurring transportation costs. Testing for a home market effect in production is obviously important from the perspective of

[4] Other examples include Van den Berg and Sturm (1997) and Kim (1995).
[5] This is also acknowledged by Haaland et al (1999), p. 9.

the new economic geography because the home market effect is a crucial element of the core new economic geography model. As for instance Fujita, Krugman and Venables (1999, p. 57) show in this core model an increase in demand for a region's manufactured goods implies a more-than-proportional increase in manufacturing production (assuming a perfect elastic labour supply).

Davis and Weinstein have used country as well as regional data to establish the empirical validity of the home market effect. Although Davis and Weinstein more directly test the new economic geography approach, there are in our view still two basic problems using the home market effect in testing for the relevance of the new theories. The first problem is that the home market effect is not only at home in the new economic geography but also in the new trade models like Krugman (1979, 1980). Since these new trade models, as opposed to the new economic geography models, treat regional market size and demand as exogenous, and assume no labour mobility across borders, a test for the home market effect is not able to discriminate between the new trade theory and the new economic geography.[6] The second problem with the use of the home market effect (see also Brülhart, 1998, p. 795) is that the home market effect is not very robust. Davis (1998) in particular shows that the home market effect does not arise if, as is usually assumed in the new economic geography models, not only the trade of the differentiated goods but of *all* goods is subject to transportation costs.

To conclude, this brief discussion of the empirical literature on agglomeration suggests that a proper empirical application of the new economic geography approach should include the underlying mechanisms as they are described in the basic new economic geography models.

2.2 Testing for the Relevance of the New Economic Geography: The Spatial Wage Structure

Testing for the home market effect is a first step in testing the new economic geography approaches, it also does point to another, and in our view, more promising method to test for the empirical relevance of the new economic geography. The extent to which an increase in a region's demand for a manufactured good translates into a (more than proportional) increase in that region's production of the good depends on the elasticity of labour supply in the core new economic geography model. If labour supply is not perfectly elastic the increased demand will not only lead to increased production but also to higher nominal wages in that region. Hence, given the (reasonable) assumption that labour supply is not perfectly elastic, is

interesting to see whether regions with a relatively high demand for manufactures also pay relatively higher wages.[7] Or to put more simply, is it the case, as the new economic geography model predicts, that, ceteris paribus, wages fall the further one moves away from centers of economic activity?

The negative relationship between manufacturing wages in a location and the distance of that location from the center(s) of production does set the new economic geography apart from the neo-classical and new trade theory. In the neo-classical trade theory there is no foundation for such a *spatial* wage structure. The existence of economic centers can be rationalised by location-specific endowments but this does not imply a spatial wage structure. Even with (endowment-driven) agglomeration, the main prediction of the neo-classical trade theory is that trade will lead to factor price equalisation. In the new trade models, again see for instance Krugman (1980) and its two-region model, it is true that wages are higher for the country with the larger labour force but in the analysis of the home market effect, wages are equalised between the two regions (Krugman, 1980). Wage equalisation follows from the fact that each country *specialises* in the production of certain varieties of the manufactured good, which results in a concentration of the production certain varieties in one country and the concentration of the remaining varieties in the other country. As opposed to the new economic geography approach, a spatial wage structure is therefore ruled out in new trade models building on Krugman (1980) because there is no *agglomeration* of manufacturing production across space and thus no possibility of a center(s) of manufacturing production.[8]

Using US county-data Gordon Hanson (1998, 1999) investigates if there is empirical evidence that supports the idea of a spatial wage structure. He performs two tests. The first one, in which he estimates a spatial wage equation, is the reduced form of the long-run equilibrium in Helpman's (1998) extension of the Krugman (1991) model. And by doing so he is the first one who uses the equilibrium conditions from the new economic geography model directly in empirical research. The main conclusion is that there is strong evidence in favour of such a wage structure.[9] Although this method is very attractive from a methodological point of view, it has also several drawbacks. First, in order to derive an applicable form of the equilibrium

[6] See Fujita, Krugman and Venables, 1999, p. 59 for what is essentially a similar observation.
[7] In fact this description characterizes the short-run equilibrium of the new economic geography model
[8] This point also holds for the Davis and Weinstein studies of the home market effect, they deal with specialization of production.
[9] Using a different approach a similar conclusion is reached for Mexican regional wages in Hanson (1997)

wage equation, Hanson has to assume that real wages are equalised. This means that he implicitly assumes that the actual spatial wage distribution is also a long-run equilibrium, which more often than not will not be the case. Second, one has to find estimates for the parameters in the Dixit-Stiglitz monopolistic competition model, of which Fujita, Krugman and Venables (1999, p. 45) say; "that (it) is grossly unrealistic, …, (and) leads to special but very suggestive set of results". In a qualitative sense the model is indeed very suggestive, but hardly provides an adequate description of the real world.

These and other difficulties have led Hanson to a second specification of the spatial wage equation, which is an approximation of the nominal wage equation in the Krugman (1991) model. This equation is similar to the well-known concept of market potential function from the "old" economic geography, however, one should bear in mind that we are discussing a spatial *wage* equation and not a spatial demand equation or some other trade variable. This is what is new in the Hanson approach. Hanson's starting point is "that the level of economic activity in a location is conditioned by that location's access to market for its goods. While this view may seem narrow- it ignores climate, natural resource supplies, and other factors which surely influence city location-I attempt to show that market access provides a useful way to characterise the forces that contribute to the *geographic concentration of economic activity* " (Hanson, 1998, p.1, emphasis added).

The reference to the market potential function is not coincidental, Krugman (1995, p. 99) already observed that the equilibrium condition for the nominal wage equation in the new economic geography model, in a qualitative sense, closely resembles a market potential function as introduced by Harris (1954). In the core new economic geography model, the nominal wage equation can be looked upon as a spatial labour demand function to the extent that wages (and hence labour demand) in a region are higher, the nearer this region is to areas with a high demand for this region's products. Hanson (1998), therefore, considers the market-potential function as a "reduced form" of the nominal wage equation from the core new economic geography model. So he uses the market-potential function as the empirical specification to estimate the spatial wage structure for the US (see also section 4 below). This is also the method we use in this paper, because we can avoid the difficult task to estimate parameters in a grossly unrealistic Dixit-Stiglitz model. Furthermore, it is very likely that the actual spatial wage distribution in Germany is not a long-run equilibrium only 10 years after

the unification and therefore the equilibrium condition of the wage equation is not relevant for our purpose (see however the Appendix)[10].

3. The German Case and the Data Set

Our purpose is to test for a spatial wage structure in Germany. Compared to for instance the USA, the German case creates several challenges. First of all, unlike the USA Germany is typically to be considered as an open economy. To test for a spatial wage structure, one has to take economic activity from abroad into account. Second, the labour market in Germany is considered to be rigid. If one detects a spatial wage structure, despite this institutional set up, then that would mean a clear case in favour of the agglomeration dynamics, which are described by the models of the new economic geography. Third, also typical of the German case are, of course, the differences between the western and eastern economy. Nominal wages are lower in the east than in the west, due to a lower labour productivity (see Sinn (2000), p. 19). Moreover, East German firms face severe difficulties entering interregional, West German, markets. Despite the relatively high unit labour costs in east Germany, producer prices are estimated to be 20% lower than West German producer prices for equivalent products (see Müller, 1999). Market segmentation between East and West Germany is thus something to take into account as well. We will return to the issue of segmentation below.

Before we turn to the estimation results, we first briefly discuss our data set. Germany is administratively divided into about 440 districts (Kreise)[11]. Of these districts a total of 118 districts are so called *city-districts* (kreisfreie Stadt), in which the district corresponds with a city. We use district statistics provided by the regional statistical offices in Germany. The data set contains local variables like the value added of all sectors (GDP), the wage bill, number of hours of labour in firms, with 20 or more employees, in the mining and manufacturing sector. In the empirical analysis we restrict our sample to the more homogeneous group of city-districts. We have data for 114 city-districts, of which 26 are East German, and this group of districts represents 47% of total German GDP and about 40% total German urban population.[12] In the new economic geography approach transport costs are a crucial variable.

[10] In the Appendix we present, however, some preliminary estimation results of the long-run equilibrium wage equation in Germany, which provide estimates of the structural 'German' parameters in the basis new economic geography model.

[11] In terms of the NUTS-classification the districts are the regions of NUTS level 3.

[12] A country-district contains several towns and villages and the average population density in country districts is 8.4% of the average population density in city-districts. For some other studies that estimate market potential function with *urban* areas as the geographical unit, see Hanson (1998, p.X). We did also ran our regressions for

We do not use the geodesic distance between city-districts because this measure does not distinguish between highways and secondary roads; here distance is measured by the average number of minutes of travel by car. The data are obtained with the Route Planner 2000 (Europe, And Publishers, Rotterdam). Since we have one observation per city district for the average hourly wage and for GDP (1994/1995) we estimate this wage equation in levels.

The basic spatial wage equation to be estimated is:

$$\log\left(w_j\right) = \alpha_1.\log\left[\sum_{k=1}^{J} Y_k.e^{-\alpha_2.d_{jk}}\right] + \alpha_3 \qquad (1)$$

where w_j is the nominal hourly wage in city-district j, Y_j is the value added of all sectors in city-district j, d_{jk} is the distance between city-districts j and k with distance measured in minutes of travel by car.

4. Estimation Results

4.1 Spatial Wage Equations

The estimation of equation (1) serves two purposes. First and foremost, we want to find out if at the city-district level spatial nominal wages in Germany depend positively on the proximity of large and nearby markets for its products. So, we want to find out if a spatial wage structure indeed exists. Secondly, we want to establish whether and how the results are changed when some important characteristics of the German economy are taken into account. The first column of Table 1 gives the estimation results for equation (1). The main conclusion is that for Germany as a whole (here, 114 city-districts) we find strong confirmation of the relevance of a spatial wage structure. The coefficients α_1 and α_2 are both significantly different from zero and notably distance clearly matters. Wages in city-district j depend positively on the economic activity and the resulting demand from other city-districts (α_1 is positive*)* but the impact of this demand on wages in city-district j is localised (α_2 is positive*).* Or, in other words, the results confirm the idea that wages will be higher when a city-district is close to or part of an economic center (i.e. a clustering of districts with relatively high *Y).*

One rather obvious criticism of applying equation (1) to post-unification Germany is that the nominal wages in the mining and manufacturing sector in East Germany were about 35% lower than in West Germany in 1995 (*Statistisches Bundesamt Deutschland*). In order to

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the larger sample (city- and country-districts) but this not change the main results, so we'll stick to the sample of

account for this east/west wage differential, a dummy for East German city-districts is added to equation (1), which therefore becomes:

$$\log\left(w_j\right) = \alpha_1.\log\left[\sum_{k=1}^{J} Y_k.e^{-\alpha_2.d_{jk}}\right] + \alpha_3.\text{dummy}_{EAST} + \text{constant} \qquad (2)$$

The second column of Table 1 shows that the main conclusions about the spatial wage structure remain unchanged. Coefficient α_3 is equal to -.23, which indicates that 23 percentage points of the east/west wage gap of 35% in 1995 is explained by exogenous factors and one third of the east/west wage gap could be looked upon as the result of the geographical distribution of economic activity in Germany.

Another feature of the German economy that may have a bearing on the results is that equation (1) assumes that Germany is a closed economy. Germany's main trading partners are the other member states of the European Union (EU). Adding the market access to these 14 EU-countries yields equation (3):

$$\log\left(w_j\right) = \alpha_1.\log\left[\sum_{k=1}^{J} Y_k.e^{-\alpha_2.d_{jk}} + \sum_{EU=1}^{14} Y_{EU}.e^{-\alpha_2.d_{jEU}}\right] + \alpha_3.\text{dummy}_{EAST} + \text{constant} \qquad (3)$$

where d_{jEU} is the distance (measured in minutes of travel by car) between the German city-district *j* and the capital of the EU Member State *EU*, Y_{EU} is defined as the GDP of Member State *EU* multiplied[13] by the ratio GDP of all German city-districts to German GDP.

As can be seen from the third column of Table 1 the recognition of the openness of the German economy does not give rise to different results. There is hardly any change in the coefficients estimated. This result does not imply that the wages of city-districts that are relatively close to (some of) these EU-countries would *not* benefit from the inclusion of the EU-countries. However, we estimated a specification of equation (3) (not reported here), in which we allowed for two separate distance parameters: one for the pairs "city-district *i*, city-district *j"* and one for the pairs "city district *i*, capital of Member State *EU"*. The latter remained statistically insignificant. So the spatial wage structure does not seem to be affected by economic activity abroad. To sum up, the results in Table 1 clearly illustrate the presence of a spatial wage structure in Germany.

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114 city-districts in the remainder of the paper.

[13] To account for the fact that not all of the economic activity in Germany is considered in the empirical analysis.

Table 1 Estimation Results of Hourly Wage in German Districts (1995)

(Nonlinear Least Squares)

	Basic wage-equation	Wage-equation with dummy for East German districts	Open-economy wage-equation
	(1)	(2)	(3)
α_1	.207	.174	.174
	(9.7)	(7.9)	(7.9)
α_2	.135	.170	.171
	(4.5)	(3.6)	(3.6)
α_3	---	-.234	-.234
		(-4.1)	(-4.1)
Constant	2.224	2.598	2.599
	(11.5)	(12.8)	(12.8)
Adj. R^2	0.458	0.526	0.526
Obs.	114	114	114

The t-statistics are in parentheses.

4.2 Border Effects

Given the potential relevance of border effects for post-unification Germany, we now turn to the question whether distance is less relevant *within* East or West Germany than *between* East and West Germany. Or in other words, is the former border between the former Federal Republic of Germany and German Democratic Republic, still discernible to the extent that it has an impact on the spatial wage structure? To this end we changed equation (2) in the following manner:

$$\log\left(w_j\right) = \beta_1.\log\left[\sum_{k=1}^{J} Y_k.e^{\left\{-\beta_2-\beta_3.\varphi_{jk}\right\}.d_{jk}}\right] + \beta_4.\text{dummy}_{EAST} + \text{constant} \qquad (2')$$

where φ_{jk}=0, if j=East (West) German city-district and k =East (West) German city-district

φ_{jk}=1, if j=east (west) German city district and k=West (East) German city-district.

We should expect, following studies like Engel and Rogers (1996) or McCallum (1995), that if border effects occur between East and West Germany then β_3 is positive, thereby enlarging the distance parameter. However, as can be seen from the empirical results in column (1) of Table 2 the distance parameters β_3 is negative and, moreover, β_2 and β_3 cancel out if $\boldsymbol{j}_{jk}$=1.[14] What do these results with respect to the two distance parameters imply in our view?
First of all, β_3 has the wrong sign. So in this sense no border effect is observed.
Secondly, for $\boldsymbol{j}_{jk}$=0 the distance parameter β_2 is lower compared to what we found in the estimations shown in Table1 (0.131 compared to 0.170). A reason for the relatively high value for the distance parameter in Table 1 might indeed simply be that we have pooled two groups of city-districts, east and west German districts, whose markets are still segmented 5 years after the re-unification. If this is the case the pooled estimate for the distance parameter will be biased upwards. The estimation results for $\boldsymbol{j}_{jk}$=0 confirm this. When we thus confine our estimations to only either West or East German city-districts (i.e. with $\boldsymbol{j}_{jk}$=0), distance clearly still matters but its impact is less for city-district wages (a coefficient of 0.13 compared to 0.17 for the full sample). So in this respect demand linkages are geographically stronger within either part of Germany than between these two parts of Germany. As such our results are consistent with the so-called home bias effect in trade, which says that (here, interregional) goods markets appear to be far more segmented than is commonly supposed. So our research confirms the theoretical notion of Obstfeld and Rogoff (2000) that transportation costs are a possible explanation for this phenomenon.

Thirdly, the fact that β_2 and β_3 cancel out when $\boldsymbol{j}_{jk}$=1 indicates that the *spatial* distribution of demand/economic activity in West (East) Germany is not relevant for the spatial wage structure in East (West) Germany. This means that in East Germany the geographical distribution of city-district wages is not influenced by the proximity of the city-districts to the economic centres in West Germany and vice versa. This result does, therefore, indicate that the East-West German border still matters to the extent that there does *not* seem to be an effect of the *localisation* of East (West) German demand for the wages of West (East) German city-districts.[15] Or, stated differently, for the level of East German city-district wages only the total West German demand (ΣY) matters and vice versa. Here, we essentially find

[14] The F-statistic of the Wald-test of the restriction $\beta_2+\beta_3=0$ is 1.15. So the sum of the two distance parameters is not statistically significantly different from zero.

that for East (West) German wages the geography within West (East) Germany is next to irrelevant. How can this finding be explained? We can only offer some suggestions here. The strong segmentation of East and West German markets could be caused by differences in company behaviour because of differences in management style and willingness to adjust to changes in the company environment (see Rothfels and Wölfl (1998), p. 7-11). The existence of mental borders between the *Ossies* and *Wessies* might be relevant. In this case economic agents impose borders on themselves for instance because they strongly identify with "their" region and are inclined to stick to this region for their economic transactions. Another possibility, which might be relevant in the initial stage of the German re-unification, is that agents simply lack knowledge about the other region and are therefore geographically biased when it comes to their economic transactions (Van Houtum, 1998).

To check whether this third result is merely a statistical artefact, columns (2) and (3) of Table 2 give the estimation results of estimating equation (2') for different "borders". The first alternative border-assumption comes through a division of Germany as a whole in a northern and southern part (see the second column Table 2). This gives us 26 northern and 88 southern city-districts. The second border comes about by splitting West Germany in 15 northern and 73 southern city-districts (see the third column Table 2). The main point is that for these additional two border assumptions the coefficient β_3 becomes insignificant and the inclusion of borders is therefore immaterial to the estimation results thereby indicating that the only border that (still) mattered in the mid 1990s was the one between the former GDR and FRG.

[15] Note that this border effect is quite different from the border effect found by e.g. Engel and Rogers (1996) for the US and Canada. They find that the US-Canada border is powerful in introducing large variations in the movements of prices.

Table 2 Estimation Results of Hourly Wage in German Districts and Intra-Germany Border (1995) (*Nonlinear Least Squares)*

	East-West Border	North-South Border	North-South Border (only West Germany)
β_1	1.579	.174	.193
	(6.1)	(7.9)	(7.4)
β_2	.131	.170	.160
	(4.4)	(3.6)	(3.7)
β_3	-.131	.606	.422
	(-4.4)	(.0)	(.0)
β_4	-3.702	-.234	---
	(-6.7)	(-4.1)	
Constant	-14.903	2.598	2.417
	(-4.7)	(12.7)	(10.0)
Adj. R^2	0.472	0.522	0.376
Obs.	114	114	88

The t-statistics are in parentheses.

4.3. Wage Effects of improvements of the infrastructure between eastern and western Germany

At the time of the unification, July 1, 1990, it was clear that the infrastructure in eastern Germany had been neglected. Since then a sizeable share of the financial aid of the federal government has been, and still is, directed towards investments in the infrastructure. This has resulted in a substantial reduction of travel time in (eastern) Germany (see Eckey & Horn, 2000). Given the importance of transport cost in the model discussed above, one might ask, what are the consequences of a further decrease in transport costs? Table 3, presents the results on local nominal wages of a 15%-decrease in transport time, which is reasonable in the light of earlier findings (see Eckey & Horn, 2000). All 26 East German districts and only 5 of the 89 West German districts seem to be affected. In general, local nominal wage increases. However, this effect of the decrease in transport costs is only significant for West Berlin; the economic centre of eastern Germany.

Table 3 Change in nominal wage because of a shock in transport costs
(15%-decrease in time of travel between East German districts and West German districts)

	Relative change in nominal wage ($\Delta\log(w_j)$)	Standard deviation of $\Delta\log(w_j)$
Weimar	0.00621	0.00585
Potsdam	0.00254	0.00206
Jena	0.00252	0.00282
Wismar	0.00237	0.00282
Zwickau	0.00232	0.00302
West Berlin (West Germany)	0.00198	0.00085
Halle	0.00163	0.00177
Dessau	0.00154	0.00253
Gera	0.00120	0.00167
Plauen	0.00060	0.00102
Hof (West Germany)	0.00058	0.00070
Brandenburg an der Havel	0.00057	0.00104
Leipzig	0.00056	0.00061
Greifswald	0.00052	0.00070
Stralsund	0.00043	0.00057
Hoyerswerda	0.00035	0.00072
Erfurt	0.00031	0.00036
Chemnitz	0.00026	0.00042
Schwerin	0.00022	0.00025
East Berlin	0.00007	0.00007
Cottbus	0.00004	0.00007
Dresden	0.00002	0.00004
Frankfurt (Oder)	0.00002	0.00005
Braunschweig (West Germany)	0.00001	0.00002
Coburg (West Germany)	0.00001	0.00002
Suhl	0.00001	0.00002
Görlitz	0.00001	0.00002
Magdeburg	0.00001	0.00001

$\Delta\ln(w_j) \cong d\ln(w_j) = 0.15.\hat{\alpha}_1.\hat{\alpha}_2.\frac{\sum_{i=1}^{n_j} Y_i.d_{ij}e^{-\hat{\alpha}_2.d_{ij}}}{\sum_{i=1}^{114} Y_i.e^{-\hat{\alpha}_2.d_{ij}}}$, where the numerator on the RHS represents the sum of all discounted GDP's in East German districts, if district j is West German, and the sum of all discounted GDP's in West German districts, if district j is East German; $\hat{\alpha}_1, \hat{\alpha}_2$ are the nonlinear least-squares estimates reported in Column (2) of Table 1.

4.4. Wage Effects of a Demand Shock in Essen

Given the central role of the distance parameter in the above analysis of the spatial wage structure for Germany, we finally turn our attention to the question how a demand shock in a particular region affects the regional pattern of wages in the German city-districts. Based on Hanson (1998, 1999) the following experiment was conducted: the GDP of city-district Essen

in the *Ruhrgebiet* area was increased by 10% and we then checked what this implied for wages in our 114 city-districts. It is here that the localised nature of demand linkages in Germany comes to the fore. Table 4 shows the results for the city-districts that are nearest to Essen. The GDP shock leads (not surprisingly) to the largest wage increase in Essen itself (wages on Essen increase by 2.3%). As one moves away from Essen the magnitude of the wage increase quickly gets smaller. Travelling more than one hour by car one arrives at city-districts whose nominal wages are not affected anymore by the GDP shock. This result shows that the effect of a local demand shock on wages is geographically rather limited. For example, Hanson (1999, p. 20), performing a similar experiment for the USA, finds that a local demand shock still has an effect on the nominal wage in a county at a distance of 885 kilometers. Hence, the demand-linkages are indeed strongly localised for the case of Germany compared to the USA.

Table 4 Change in nominal wage because of an increase in economic activity in Essen of 10% (German city-districts nearby Essen)

	Relative change in nominal wage ($\Delta\log(w_j)$)	Standard deviation of $\Delta\log(w_j)$	Minutes of travel by car with destination Essen
Essen	0.02271	0.00042	0
Mülheim an der Ruhr	0.00753	0.00215	9
Oberhausen	0.00652	0.00206	10
Bottrop	0.00610	0.00211	11
Gelsenkirchen	0.00582	0.00201	11
Bochum	0.00444	0.00180	13
Duisburg	0.00383	0.00167	14
Herne	0.00355	0.00165	15
Düsseldorf	0.00083	0.00063	25
Dortmund	0.00094	0.00071	25
Krefeld	0.00041	0.00039	32
Wuppertal	0.00039	0.00038	32
Hagen	0.00032	0.00033	34
Solingen	0.00025	0.00027	36
Leverkusen	0.00020	0.00022	37
Remscheid	0.00013	0.00016	41
Mönchengladbach	0.00009	0.00011	44
Köln	0.00004	0.00006	47
Hamm	0.00003	0.00005	52
Münster	0.00001	0.00002	59

Bonn	0.00001	0.00002	60
Aachen	0.00000	0.00000	75

$\Delta \ln(w_j) \cong d\ln(w_j) = 0.1.\hat{\beta}_1.\frac{Y_1.e^{\{-\hat{\beta}_2 - \hat{\beta}_3.\varphi_{1j}\}.d_{1j}}}{\sum_{i=1}^{114} Y_i.e^{\{-\hat{\beta}_2 - \hat{\beta}_3.\varphi_{ij}\}.d_{ij}}}$, where region 1 is Essen, and $\hat{\beta}_1$, $\hat{\beta}_2$, $\hat{\beta}_3$ are the nonlinear least-squares estimates reported in the first column of Table 2.

One might argue that the results shown in Table 4 are to be expected because of the relatively small GDP of a single city-district like Essen. To check for this, we conducted the same experiment but now for the *Regierungsbezirk Düssseldorf* which consists of 10 city-districts.[16] Again, it turned out that the impact of the demand shock on the wages of other city-districts is at best very limited

5. Conclusions

In this paper we have tried to establish whether a spatial wage structure might be relevant to describe the economic situation in post-unification Germany. If such a spatial wage pattern exists this is indirect evidence in favour of the new economic geography approach because in this approach wages are higher for regions which have easy access to relatively larger markets. Although it is very difficult to estimate the equilibrium conditions of the new economic geography model directly, we find support for a spatial wage structure for German city-district wages, and hence indirectly for the relevance of a new economic geography model for Germany. We also find that demand linkages in Germany are strongly localised and that the "old" border still matters to the extent that economic interactions between western and eastern Germany are still limited compared to the situation within these two parts of Germany. Although we did not test against the alternative hypothesis of the relevance of a neoclassical model, our estimations results for a spatial wage structure for German city-district wages are at least consistent the view that the new economic geography model matters for Germany.

[16] These city-districts are: Düssseldorf, Essen, Duisburg, Krefeld, Mönchengladbach, Mülheim, Oberhausen, Remscheid, Solingen and Wuppertal.

Appendix: Reduced form of the long-run equilibrium in the new economic geography model in Germany

We argued in the main text of this paper that the long-run equilibrium is not appropriate for Germany, especially since the Unification in 1990. However, if we do use this (somewhat unrealistic) assumption of long-run equilibrium, we are able to do an empirical exercise, which yields structural German parameters of the new economic geography model. What are the results of this exercise (for more details we refer to Brakman, Garretsen, van Marrewijk and Schramm, 2000)?

One of the main equations in the Krugman (1991) model is the nominal wage equation:

$$w_j = \left[\sum_k Y_k I_k^{\varepsilon-1} T^{D_{jk}(1-\varepsilon)} \right]^{1/\varepsilon}, \qquad (4)$$

in which w is the wage rate, Y is income, I is the price index of manufacturing goods, ε is the Dixit-Stiglitz elasticity of substitution, T is the transport cost parameter, and $T_{jk} = T^{D_{jk}}$, where D_{jk} is the distance between locations j and k; transport costs T is of the iceberg-type and defined as the number of goods that have to be shipped in order to ensure that one unit arrives over one unit of distance.

As there are no time series available on price index I at the local level, Hanson rewrites equation (1) by assuming that the equilibrium real wages are equal between regions (long-run equilibrium) and by imposing the equilibrium condition for the housing market.[17] In logarithms:

$$\log(W_j) = k_0 + \varepsilon^{-1} \log\left(\sum_k Y_k^{\varepsilon+(1-\varepsilon)/\delta} H_k^{(1-\delta)(\varepsilon-1)/\delta} W_k^{(\varepsilon-1)/\delta} T^{(1-\varepsilon)D_{jk}} \right), \qquad (5)$$

where k_0 is a constant, H_k is the housing stock in region k, and δ is the share of income spent on manufactures. Note that equation (2) includes the three structural parameters of the core model, namely part of income spent on manufactures, δ, the substitution elasticity, ε and the transport costs, T.

[17] By applying the Helpman's (1998) extension of the Krugman (1991) model, Hanson can get rid of the unobservable I and introduce the observable variable of the local housing stock. To get from wage equation (4) to equation (5) use (i) the equilibrium for the housing market: $P_j H_j = (1-\delta) Y_j$ (the value of the fixed stock of housing equals the part of income spent on housing), where H is the housing stock, P is the price of housing, δ is

For the estimation of the structural parameters of the model we extend the sample of 114 city-districts with 37 aggregated country districts, constructed using 326 German country districts. The total number of districts in our sample is thus 151. The extra explanatory variable of the housing stock is represented by the total local stock of rooms in residential dwellings. Accounting for the productivity gap between East and West Germany and the two types of districts, city and country districts, we add two dummies to wage equation (5): a dummy which is 1 for East German districts and 0 otherwise and a dummy which is 1 for a country district and 0 otherwise. As the estimates of the coefficients of the two dummies are immaterial for the conclusions with respect to the structural parameters they are not reported here.

Table 5 Estimating the structural parameters for Germany

	Coefficient	standard error	t-statistic
δ	1.869	0.887	2.105
ε	3.914	0.618	6.327
Log(T)	0.008	0.001	7.257

Adj. R^2 = 0.481; number of observations = 151; non-linear least squares

*Standard error

Table 3 reveals a spatial wage structure in Germany: T is significantly positive. One can also observe the substitution elasticity e. The point estimate indicates that the price markup over marginal costs is 34% in the manufacturing sector. Less satisfactory is the estimate of d. Regression results indicate that a large part of German income is spent on manufacturing goods. In fact, more than total income is spent on these type of goods. However, d does not significantly exceed 1.

Instead of estimating d, we can also use existing information about this share of income. We consulted statistical information on German expenditure shares, which is relatively easy to obtain. The appropriate δ can be chosen either as 1 - 0.32002, with 0.32002 being the part of income spent on non-tradable services, see panel a of Table 4, or as 1 - 0.17153, with 0.17153

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the part of income spent on manufacturing goods, and (ii) real wage equalization between regions: $W_j / P_j^{1-d} I_j^d = W_k / P_k^{1-d} I_k^d$.

being the part of income spend on non-tradable housing services, see panel b of Table 4.[18] We thus estimate equation (5) again, restricting the parameter δ to either of the two values above. The results are reported in panels a and b of Table 6.

Table 6 Structural parameters for Germany, restricting d

Panel a. δ = 0.67998 = 1- share spend on non-tradable services

	Coefficient	standard error	t-statistic
ε	2.876	0.276	10.409
Log(T)	0.009	0.001	7.278

Adj. R^2 = 0.455; number of observations = 151; non-linear least squares

Panel b. δ = 0.82847 = 1- share spend on housing services

	Coefficient	standard error	t-statistic
ε	3.100	0.318	9.734
Log(T)	0.009	0.001	7.568

Adj. R^2 = 0.465; number of observations = 151; non-linear least squares

*Standard error

As is clear from Table 6, restricting the part of income spent on manufactures to 0.68 or 0.82 reduces the estimated elasticity of substitution between manufacturing varieties from almost 4 to roughly 3, and thus increases the estimated mark-up over marginal costs from 1/3 to ½.[19] The restrictions have virtually no impact on the estimated size and significance of the transport costs *T*.

[18] Based on the weights in the German CPI, February 1999, Federal Statistical Office Germany

[19] A 50%-markup may seem rather high. However, Hall (1988) measuring the markup in US industry arrives at a markup of 120%, 106% and 210% in the construction, durable goods and nondurable goods sectors, respectively.

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