THE IMPACT OF EUROPEAN INTEGRATION ON ADJUSTMENT PATTERN OF REGIONAL WAGES IN TRANSITION COUNTRIES: TESTING COMPETITIVE ECONOMIC GEOGRAPHY MODELS

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ABSTRACT

In the present paper, we augment the Fujita-Krugman-Venables (*FKV*) economic geography model by breaking the implied regional symmetry and by introducing a second factor of production, capital, in order to study the within-country regional effects of trade liberalization. In contrast to the *Krugman* (1991) model, the *FKV* and our model do not predict typical core – periphery regional polarization as labor is assumed to be either imperfectly mobile and/or capital is perfectly mobile between regions. Both models result in a non-monotonic, *U*-shaped response of relative regional wages to trade liberalization. Major difference between the two approaches is that our model allows for FDI flows between countries. FDI inflows are shown to accelerate the regional adjustment process in the home country, as they are initially attracted to poor, border regions characterized by lower wages and higher returns to capital. Our model therefore results in a faster convergence of relative regional wages, i.e. in a more upward and to the right shifted *U*-shaped response of relative wages. In addition, we then examine the exact adjustment pattern of relative regional wages in five transition countries after they have liberalized their trade with the EU. We study which of the three competitive EG models is a more appropriate approximation of the actual regional adjustment pattern in selected transition countries.

1. INTRODUCTION

The opening-up of transition countries and their trade integration with the European Union (EU) provides a natural experiment for testing new economic geography (EG) models. Since the beginning of 1990s, several competitive EG models were established in order to explain spatial repercussions of trade liberalization in terms of inter-regional manufacturing relocation and evolution of relative regional wages. Despite the skepticism due to simplifying assumptions and special functional forms, expressed by Neary (2001) in an excellent overview of the field, the EG models enable us to analyze the effects of trade liberalization on international as well as intra-national relocation of manufacturing activities. While, in the absence of trade, economic activity is concentrated in locations near home economic centers, trade liberalization may lead to relocation of manufacturing activities. The exact pattern of relocation of manufacturing activity, however, is ambiguous and dependent on the underlying assumptions. Crucial here is the assumption on inter-regional factor mobility. First approach, based on the Krugman (1991a, 1991b) model, assumes perfect inter-regional mobility of labor. This approach predicts a monotonic relationship between the reduction of trade costs and the relocation of manufacturing activity. When trade is opened up, larger regions in terms of industrial activity will gain from trade liberalization due to existing agglomeration effects. Core – periphery solution, i.e. complete specialization of manufacturing activity in only one region is the likely outcome of this model. This will deteriorate the initial differences in income per capita levels due to further divergence in relative regional wages. In the real world, however, this approach is rather implausible as labor is far from being very mobile internationally. The evidence does not confirm the rise in international income inequality in recent two decades of rapid trade liberalization (see Barro and Sala-i-Martin 2001), which is the explicit implication of this model.

It is straightforward then that an EG model is needed that is more realistic and less biased in favor of complete agglomeration. Krugman and Venables (1995), Puga (1999), and in a most advanced version Fujita, Krugman and Venables (1999, *FKV*) provide such a model by dropping the assumption of perfect labor mobility. For most countries imperfect mobility of labor is characteristic and thus it is needed to study the spatial repercussions of trade liberalization in a more realistic setup. Another difference of the *FKV* model comparative to *Krugman* (1991) is that externalities driving the agglomeration now stem from input-output linkages among firms rather than from linkages between firms and consumers (home market effect). Firms benefit from being close to each other by not paying transport cost on intermediate factors of production. Depending on transport costs, this approach produces two types of equilibria. For low transport costs, core - periphery outcome is likely, while for high transport costs a symmetric equilibria with no agglomeration is possible. Hence, when trade costs fall below certain level, divergence of relative regional wages is likely as core - periphery pattern spontaneously forms. On the other side, wages serve as a spreading force. With increasing agglomeration, wages tend to increase leading to dispersion of relative regional manufacturing shares, as firms tend to relocate to regions with lower labor costs. Typically, the relationship between the regional manufacturing shares and transport costs may take the pattern of an *U-shape*. In the first stage, hence, trade liberalization may increase initial regional differences in income per capita, while further trade liberalization may bring about some convergence in relative regional wages.

Originally, the above approaches have been applied to the North-South discussion in order to address the issue of possible implications of globalization.

During the 1970's, many theorists argued that liberalization of world trade generally produced uneven development, i.e. a rise in living standards of western countries at the expense of the developing countries. In contrast, since the beginning of the 1990's, many economists as well as political leaders in western nations claimed that labor-intensive exports of emerging economies have hurt the competitive position of western countries. In effect, western countries have been hurt in terms of the stagnation of real manufacturing wages and/or higher unemployment.[1]

In the present paper, we apply and modify the second EG approach to study the within-country regional effects of trade liberalization. In doing so, we augment the Fujita-Krugman-Venables (*FKV*, henceforth) type of EG model by breaking the implied regional symmetry and by introducing a second factor of production, capital. We analyze a three-region world, with the first region being the large foreign country (EU) and the two home regions being located in a developing country. By breaking the regional symmetry different foreign trade costs for the two home regions are being assumed, where one region might benefit from its location closer to the border with the large foreign country. On the other side, while restrained mobility of labor does not allow for large inter-regional relocation of manufacturing, the introduction of capital allows either for foreign direct investment (FDI) flows to emerge between the large foreign country and domestic regions or for domestic relocation of capital. Using the simulation analysis, FDI flows have been shown to accelerate the regional adjustment process in the home country, as they are initially attracted to poor regions characterized by lower wages and higher returns to capital. In effect, when compared to the *FKV* approach, our model results in a faster convergence of poor regions demonstrated by a more *upward-and-to-the-right shifted U-shaped* pattern of regional adjustment of relative regional wages.

The central part of this paper, however, is devoted to the empirical analysis. We aim at analyzing the effects of trade liberalization with the EU on inter-regional relocation of manufacturing and inter-regional adjustment of relative wages in transition countries. We focus on the exact adjustment pattern of relative regional wages, i.e. we examine which of the above three competitive EG models is a more appropriate approximation of the actual regional adjustment pattern in selected transition countries. Specifically, we study whether the response of relative regional wages to reduction of foreign trade costs is monotonic and leading to strong regional polarization as suggested by the first *Krugman* approach, or is it a non-monotonic one and associated with lesser regional polarization as suggested by more recent EG approaches. In addition, in case of a non-monotonic response we test the propositions of a *FKV* against our approach. In doing so, impacts of FDI, of inter-regional transport costs and of western/northern region dummies on adjustment pattern of relative regional wages are being examined. Implications of the three competitive EG approaches are tested using a unique regional panel data for five transition countries (Bulgaria, Estonia, Hungary, Romania and Slovenia) in the period 1990-2000.

Our results suggest that two different EG stories are taking place in transition countries after trade liberalization in the 1990s. In the first group of countries, consisting of Hungary, Bulgaria and Romania, the *FKV* type and to some extent also the *DK* type of adjustment pattern of relative wages is revealed. The expected *U*-shaped adjustment pattern of relative wages is confirmed by the data. In addition, in Bulgaria and Hungary, FDI seem to work in line with the predictions of the *DK* model,

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[1] For an excellent discussion of the both issues refer to Krugman and Venables (1995) and Krugman (1996).

while internal transport costs and border region arguments of the *DK* model did not found any confirmation by the data. On the other hand, for Estonia and Slovenia, an inverse process is at work since an inverted *U*-shaped adjustment of relative wages is found. In addition, the distance and border effects were found to be negative after trade liberalization. This suggests that presently a *Krugman* type of regional polarization might be at work in both countries.

Structure of the paper is as follows. Section 2 first introduces an augmented EG model and then compares basic propositions of the three competitive EG models and discusses its implications for transition countries. Section 3 discusses previous empirical studies. Section 4 describes the empirical model, data and methodology used as well as discusses the results. The final section summarizes basic findings of the paper.

2. THE MODEL

The opening-up of transition countries and their trade integration with the European Union (EU) provides a natural experiment for testing new economic geography (EG) models. Trade liberalization has brought about large increases of trade with the EU. Data for transition countries during 1990s, however, reveal that despite enormous trade creation there is evidence of vast increases of FDI flows, too. It is the aim of the present paper to study the effects of both the reduction of foreign trade costs as well as FDI inflows on inter-regional adjustment process in transition countries. We follow the idea that FDI, when directed into poor home regions due to lower relative wages and higher returns to capital, may accelerate convergence of poor regions. In order to do this, in subsequent sections we introduce an augmented Fujita-Krugman-Venables (*FKV*) type of EG model by breaking the implied regional symmetry and by introducing a second factor of production, capital.

2.1. Consumer behavior

We maintain the structure of consumer behavior as in the FKV model with a two-step consumer utility maximization function. Consumers firstly maximize their utility by choosing between manufacturing goods and agricultural goods, while at the second step of consumption they determine the amount of each variety of manufactured goods consumed.[2]

We assume a CES function for the consumption of manufacturing varieties, whereby ρ represents the intensity of the preference for variety in manufactured goods and σ represents the elasticity of substitution between any two varieties of manufactured goods:

(1) $$\sigma \equiv \frac{1}{1-\rho} \qquad \rho \equiv \frac{\sigma - 1}{\sigma}$$

Following the FKV model and maintaining "iceberg transport cost" assumption, we can derive the price index for region s.

The iceberg type transport cost imply that if a manufacturing variety produced at location r is sold at price p_r, then the delivered (c.i.f.) price p_{rs}, of that variety at each consumption location s is given by:

[2] For details on the modeling of consumer behavior see Fujita, Krugman, Venables (1999)

(2) $$p_{rs}^{M} = p_{r}^{M} T_{rs}^{M}$$

Iceberg transport costs combined with the assumption that all varieties produced in a particular location have the same price means that, the price index *G* can be written as:

(3) $$G_{s} = \left[\sum_{r=1}^{R} n_{r} (p_{r}^{M} T_{rs}^{M})^{1-\sigma} \right]^{1/(1-\sigma)}, s = 1,..., R$$

2.2. Producer behavior

The assumption is that the agricultural good is produced using constant-returns technology under conditions of perfect competition in the markets. Manufacturing, however, is assumed to involve economies of scale arising at the level of variety. Technology is the same for all varieties and in all locations and involves a fixed input F and marginal input requirement c^M.

Here our model starts to differ from the FKV model with the inclusion of the second production input. We model the production function with both capital and labor, where economies of scale are possible in the use of both factors. Our model also assumes the existence of both internal and external economies of scale, while the FKV model proposes that only internal economies of scale are relevant. Total cost function can be written as:

(4) $$C = F_{r}^{M} + c_{r}^{M} q^{M}$$

where *C* is the total cost incurred in the production of *q* units of manufacturing products (the cost of both labor and capital used), with F_{r}^{M} representing the total fixed costs and c_{r}^{M} representing the total variable costs (see (9)). The existence of fixed cost enables us to model internal economies of scale, while external economies of scale are modeled through marginal costs. Here, we assume that the size of a region (represented by number of firms n_r) is negatively correlated with the size of the marginal cost in the region. Firms in a larger region will benefit from the existence of a large number of similar firms by achieving external economies of scale, leading to lower marginal costs. Hence, we maintain the logic of input-output linkages between firms as proposed by the *FKV* model, but we model it in a different way. These linkages are modeled by the use of intermediate goods, whereby each firm produces one intermediate and one final consumption good. The final consumption good is costlessly assembled from intermediate goods bought from other firms and all intermediate goods are used up in this process. The price of intermediate goods is falling with the number of firms due to large-scale production at the firm level as the demand for intermediates is increasing in the number of firms.[3] As all of the intermediate goods are entering each firm's production function, decreasing prices of intermediate goods induce downward slopping firm's marginal cost curve:[4]

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[3] For more details on modeling the interaction between internal and external scale economies through intermediate goods see Damijan (1999).

[4] The inclusion of intermediate goods' costs in the model would, in our opinion, unnecessarily complicate the model at this stage, due to the possibility of trade in intermediate goods between regions and the incurrence of transport costs.

(5) $$c_r^M = n_r^{-\sigma}(\frac{w_r}{\alpha})^{\alpha}(\frac{i_r}{\beta})^{\beta} \qquad F_r^M = w_r L_f + i_r K_f$$

where w_r and i_r are the nominal wage and returns to capital in region *r*, and L_f and K_f are the required fixed amounts of labor and capital.

Because of increasing returns to scale, consumers' preference for variety, and the unlimited number of potential varieties of manufactured goods, no firm will choose to produce the same variety supplied by another firm. The number of manufacturing varieties will therefore ultimately equal the number of manufacturing firms.

Solving the profit maximization problem for each individual firm at a specific location, facing a given nominal wage rate w_r^M for manufacturing workers there and a nominal returns to capital i_r^M , the profit maximizing price is:

(6) $$p_r^M(1-1/\sigma) = n_r^{-\sigma}(\frac{w_r}{\alpha})^{\alpha}(\frac{i_r}{\beta})^{\beta} \quad \text{or} \quad p_r^M = \frac{(\frac{w_r}{\alpha})^{\alpha}(\frac{i_r}{\beta})^{\beta}}{n_r^{\sigma}(1-1/\sigma)}$$

Assuming free entry and exit in response to profits or losses the zero-profit condition implies that the equilibrium output of any active firm is:

(7) $$q*_r^M = \frac{F_r^M(\sigma-1)n_r^{\sigma}}{(\frac{w_r}{\alpha})^{\alpha}(\frac{i_r}{\beta})^{\beta}}$$

If we apply Shepard's lemma (Sellgren, 1996), we can derive the demand for labor and capital when the equilibrium output is produced:

(8) $$l_r^* = L_f(\alpha\sigma - \alpha + 1) + K_f\frac{\alpha(\sigma-1)i_r}{w_r}$$

(9) $$k_r^* = K_f(\beta\sigma - \beta + 1) + L_f\frac{\beta(\sigma-1)w_r}{i_r}$$

both *l** and *k** are common to every active firm in the region, with the number of varieties produced in the region *r* equaling

(10) $$n_r = L_r^M / l* = K_r^M / k*$$

2.3. The manufacturing wage equation

Using a demand function for a single variety (*FKV*:50) the firms equilibrium level of output should satisfy:

(11) $$q* = \mu\sum_{s=1}^{R} Y_s(p_r^M)^{-\sigma}(T_{rs}^M)^{1-\sigma}G_s^{\sigma-1},$$

where Y_s represents the nominal income of region *s* (the income of the region consists of labor and capital incomes: $Y_s = L_s{*}w_s + K_s{*}i_s$).

We can turn equation (11) around and express the break-even price for every firm in a region:

(12) $$(p_r^M)^\sigma = \frac{\mu}{q^*} \sum_{s=1}^{R} Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1}$$

Using the pricing rule (6), nominal wages and nominal returns to capital for region *r* can be expressed as:

(13) $$(\frac{w_r}{\alpha})^{\alpha(\frac{\sigma-1}{\sigma})} = \frac{n_r^{\sigma-1}(\dfrac{\sigma-1}{\sigma})}{(\dfrac{i_r}{\beta})^{\beta(\frac{\sigma-1}{\sigma})}} \left[\frac{\mu}{(F(\sigma-1))} \sum_{s=1}^{R} Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \right]^{1/\sigma}$$

(14) $$(\frac{i_r}{\beta})^{\beta(\frac{\sigma-1}{\sigma})} = \frac{n_r^{\sigma-1}(\dfrac{\sigma-1}{\sigma})}{(\dfrac{w_r}{\alpha})^{\alpha(\frac{\sigma-1}{\sigma})}} \left[\frac{\mu}{(F(\sigma-1))} \sum_{s=1}^{R} Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \right]^{1/\sigma}$$

Equation (13) reveals that wages at location *r* will grow with the growth of incomes of all regions (including region *r*), which represent the firms markets, and the better the firms access to the markets (lower T_{rs}^M), and the less competition the firm faces in these markets, due to the fact that the price index decreases with the number of varieties sold (with a small number of varieties sold G_s is relatively high, therefore raising the wages in the region of origin). In addition, the augmented model with respect to the basic *FKV* model reveals that the wages depend also on the nominal returns to capital in the region causing the nominal wage rates to fall with higher returns to capital. An important property of the wage equation is also the positive relationship between wages and the number of firms producing in a region, which can be attributed to the external economies of scale.

Expressing the nominal returns to capital (14) gives the opposite relationship with the product of nominal wages and nominal returns to capital being determined by (13) and (14). With the product of the two factor costs being determined endogenously by the model, one of the two factors has to be determined exogenously. The product of wages and returns to capital is determined for a single region and applies for all firms in the region that could enter the markets.

2.4. Some normalizations

Choosing the units of measurement appropriately, we can simplify the equations and make the analysis somewhat simpler. We are free to choose the units of measurement to satisfy the following equation:

(15) $$F = \mu / \sigma$$

The wage and returns to capital equations become:

(16) $$(\frac{w_r}{\alpha})^{\alpha(\sigma-1)} = \frac{(n_r^{\sigma-1}(\rho))^\sigma}{(\dfrac{i_r}{\beta})^{\beta(\sigma-1)}} \left[\frac{1}{\rho} \sum_{s=1}^{R} Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \right]$$

$$(\frac{i_r}{\beta})^{\beta(\sigma-1)} = \frac{(n_r^{\sigma-1}(\rho))^\sigma}{(\dfrac{w_r}{\alpha})^{\alpha(\sigma-1)}} \left[\frac{1}{\rho} \sum_{s=1}^{R} Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \right]$$

2.5. Breaking the symmetry of the location of home regions

We assume three regions, one of which is a large foreign country and the other two are home regions. The *FKV* model assumes that both home regions are the same distance away from the foreign country, and therefore having the same transport costs to that country. In contrast, as we are interested in non-symmetric solution, we assume that one of the home regions is actually located closer to the foreign country than the other, thus having a cost advantage (lower *T*) in access to foreign markets.

The wage and price index equations in this specific case are, respectively:

$$(17)\qquad \left[(\frac{w_1}{\alpha})^{\alpha}(\frac{i_1}{\beta})^{\beta}\right]^{(\sigma-1)} = (n_1^{\sigma}\rho)^{\sigma-1}\left[Y_1G_1^{\sigma-1} + Y_2G_2^{\sigma-1}T^{1-\sigma} + Y_3G_3^{\sigma-1}T^{1-\sigma}(T^*)^{1-\sigma}\right]$$

$$\left[(\frac{w_2}{\alpha})^{\alpha}(\frac{i_2}{\beta})^{\beta}\right]^{(\sigma-1)} = (n_2^{\sigma}\rho)^{\sigma-1}\left[Y_1G_1^{\sigma-1}T^{1-\sigma} + Y_2G_2^{\sigma-1} + Y_3G_3^{\sigma-1}(T^*)^{1-\sigma}\right]$$

$$\left[(\frac{w_3}{\alpha})^{\alpha}(\frac{i_3}{\beta})^{\beta}\right]^{(\sigma-1)} = (n_3^{\sigma}\rho)^{\sigma-1}\left[Y_1G_1^{\sigma-1}T^{1-\sigma}(T^*)^{1-\sigma} + Y_2G_2^{\sigma-1}(T^*)^{1-\sigma} + Y_3G_3^{\sigma-1}\right]$$

$$(18)\qquad G_1^{1-\sigma} = \frac{L_1}{l_1^*}p_1^{1-\sigma} + \frac{L_2}{l_2^*}p_2^{1-\sigma}T^{1-\sigma} + \frac{L_3}{l_3^*}p_3^{1-\sigma}(T^*)^{1-\sigma}T^{1-\sigma}$$

$$G_2^{1-\sigma} = \frac{L_1}{l_1^*}p_1^{1-\sigma}T^{1-\sigma} + \frac{L_2}{l_2^*}p_2^{1-\sigma} + \frac{L_3}{l_3^*}p_3^{1-\sigma}(T^*)^{1-\sigma}$$

$$G_3^{1-\sigma} = \frac{L_1}{l_1^*}p_1^{1-\sigma}T^{1-\sigma}(T^*)^{1-\sigma} + \frac{L_2}{l_2^*}p_2^{1-\sigma}(T^*)^{1-\sigma} + \frac{L_3}{l_3^*}p_3^{1-\sigma},$$

where T^* represents the transport costs (trade costs) of trade between the smaller (peripheral) region 2 and the foreign country. We assume that the central region's costs of trade with the foreign country are the product of its transport costs with region 2 and the smaller region's trade costs with the foreign country.

Equation (17) can be further simplified to:

$$(19)\qquad w_1 = \alpha\left[\left(\frac{n_1^{\sigma}\rho\beta^{\beta}}{i_1^{\beta}}\right)\left(Y_1G_1^{\sigma-1} + Y_2G_2^{\sigma-1}T^{1-\varsigma} + Y_3G_3^{\sigma-1}(TT^*)^{1-\sigma}\right)^{\frac{1}{\sigma-1}}\right]^{\frac{1}{\alpha}}$$

$$w_2 = \alpha\left[\left(\frac{n_2^{\sigma}\rho\beta^{\beta}}{i_2^{\beta}}\right)\left(Y_1G_1^{\sigma-1}T^{1-\sigma} + Y_2G_2^{\sigma-1} + Y_3G_3^{\sigma-1}(T^*)^{1-\sigma}\right)^{\frac{1}{\sigma-1}}\right]^{\frac{1}{\alpha}}$$

$$w_3 = \alpha\left[\left(\frac{n_3^{\sigma}\rho\beta^{\beta}}{i_3^{\beta}}\right)\left(Y_1G_1^{\sigma-1}(TT^*)^{1-\sigma} + Y_2G_2^{\sigma-1}(T^*)^{1-\sigma} + Y_3G_3^{\sigma-1}\right)^{\frac{1}{\sigma-1}}\right]^{\frac{1}{\alpha}}.$$

According to (19), relative regional wage in the home country w_2/w_1 (i.e. wage rate in peripheral relative to central region) depends on: the scope of external economies of scale (number of firms n_r is affected through initial factor endowments and factor mobility), the aggregate demand for the region's varieties (sum of Y_rG_r), the return to capital (*i*) in the region, inter-regional (*T*) as well as international (T^*) trade costs, and the elasticity of substitution between varieties of manufactured goods. Hence, demand for products is larger with higher incomes, but is decreased by trade (transport costs) and price levels in the target markets.

2.6. Implications of the model

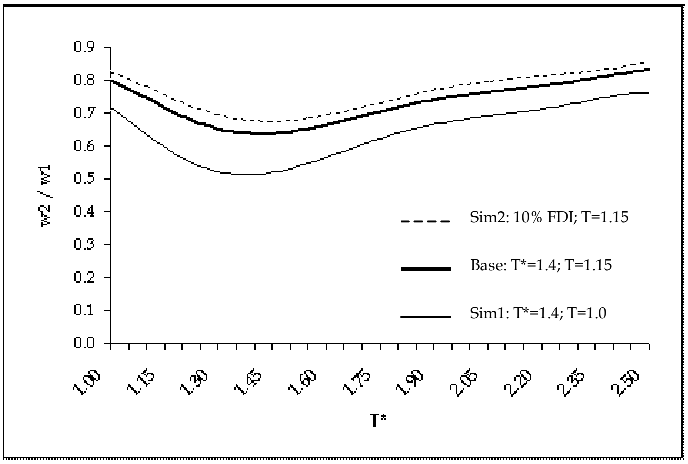
Let us examine basic implications of our model. In this approach, different foreign trade costs for the two home regions (*1*, *2*) are being assumed, where the smaller region *2* is potentially benefiting from its location closer to the border with the large foreign country (*3*). Production in manufacturing is characterized by monopolistic competition and internal economies of scale as well as by an interaction between the external economies of scale and trade costs. The latter implies that, in the absence of trade, inter-regional trade costs in the home country prevent the agglomeration effects to prevail completely. When trade opens up, there will be a trade off between agglomeration effects and existing differences in relative factor costs affecting the pattern of the inter-national as well as inter-regional manufacturing relocation. Immediately after the trade liberalization the small border region will lose manufacturing shares relative to the core region due to the agglomeration effects. There are two factors that might turn around the process of complete regional agglomeration in the home country after trade liberalization. First, like in the *FKV* approach increasing wages in the larger region, when there is no labor mobility, will prevent from complete agglomeration. Second, lower wages and higher returns to capital in the home country will attract FDI flows from the large foreign country. These flows may benefit the small border region due to lower relative wages and lower trade costs with the foreign country. Small border region might also benefit from domestic relocation of capital closer to large foreign markets. Hence, a convergence in relative home wages is expected after some threshold of foreign trade costs has been reached. Our model (for convenience, let us call it *DK* model) thus predicts, similarly to the *FKV*, an *U*-shaped adjustment pattern of relative regional wages in the home country. The crucial difference between the outcomes of the two competitive models, however, is in the time moment when the convergence or relative wages starts and in the extent of convergence. In other words, with FDI the convergence of relative regional wages will start at an earlier point in time (i.e. at higher trade costs) and small region's wages will converge to an absolutely higher level than in the *FKV* model.

The differences in the implications of the both competitive models can be easily seen by simulating the adjustment pattern of relative regional wages under different assumptions. In order to do so, we simulate the wage ratio w_2/w_1 (i.e. wage rate in peripheral relative to central region) subject to reduction in foreign trade costs, to internal trade costs as well as to FDI inflows. Note, that *FKV* and *DK* model are not directly comparable as they use different methods of modeling the agglomeration effects as well as they differ in the number of production factors employed. Nevertheless, one can easily demonstrate the differences between the two by simulating the response of relative regional wages in the *DK* model to introduction of internal transport costs and FDI.

Let us assume that the central home region is 20 per cent larger than the peripheral home region in terms of factor endowments (i.e. L_1 = 200, K_1 = 86 and L_2 = 160, K_2 = 68), while the foreign country is much larger (L_3 = 1000, K_3 = 428), and the crucial elasticities amount to α = 0.7, β = 0.3 and σ = 1.5. Figure 1 shows some basic simulations.[5] Base simulation reveals a typical *U*-shaped response of home relative regional wages to reduction of foreign trade costs, which occurs within reasonable trade costs (in the range T^*= [1, 2]).[6] Note that this outcome is not comparable to the *FKV* outcome, which concentrates on adjustment of wages between two countries when they liberalize bilateral trade. In contrast, *DK* approach produces the same type of adjustment pattern of relative wages between two home regions after trade barriers with the large foreign country have been removed. At this point it is worth noting that home relative wages cease to decrease (diverge) as foreign trade costs fall below T^* = 1.45), i.e. to some 31 per cent[7]. Below this threshold, the smaller (border) region catches up with the larger home region due to its proximity to the large foreign country and due to increasing wages in the larger region.

As discussed above, in the absence of foreign trade home transport costs serve to prevent the agglomeration effects to prevail completely in the home country. In our first exercise, home transport costs were set to reasonable 13% of the value of shipped goods (*T* = 1.15). What is the response of home relative wages when there are no home transport costs (*T* = 1.0)? As revealed in the Figure 1, the existence of home internal transport costs is substantial. When these transport costs, amounting to 13 per cent of shipped goods, are removed, the agglomeration in the home country will take a larger effect and the small home region will lag behind the larger region in terms of wages by some 20-25 per cent more than in the base scenario. Despite the fact that small home region is only 20 per cent smaller than the large region in terms of factor endowments, in the worst case, it's wage rate will amount only to some 50 per cent of large region's wage rate when there are no internal transport costs. This is only to indicate the strength of the agglomeration effects.

Figure 1: Response of home relative regional wages to reduction in foreign trade costs with different home transport costs



[5] Mathematica version 4.1 has been used to perform all of the model simulations.

[6] A reader should note that this outcome is not general per se. First, it holds in a very limited range of low transport costs only. When transport costs exceed the value of T^* = 5 the shape of relative wage curve becomes very complex. Second, the above outcome holds only when size differential between both regions is sufficiently large but not too large. For low values of size differential the relative wage curve is subject to multiple equilibria. Hence, Neary's (2001) critique is extremely relevant.

[7] Actual transport cost is calculated as $t = (T-1)/T$, i.e. when T*= 1.45, t is equal to (1.45-1)/1.45 = 31%.

Let us now examine the impact of FDI coming from the large foreign country. Due to lower wages, the FDI will be presumably directed to the smaller home region. FDI increases capital stock of the small home region by, let's say, 10 per cent and hence expand its production possibilities. Figure 1 demonstrates that FDI helps the smaller home region to catch up faster and in the larger extent. First, FDI increases almost immediately the wage rate in the small region relative to the central one simply through expansion of its factor endowments. With no labor mobility, the manufacturing production becomes more capital intensive implying increased productivity and hence wages. Second, one can also observe that the catch up in the case of FDI starts earlier - at some 35 per cent of foreign trade costs ($T^* = 1.55$) than in the base scenario. This second effect, of course, is also caused by expanded production potential of the small region, which enables it to start catching up earlier, i.e. at higher foreign trade costs.

Above exercises show clearly that FDI is very important for developing countries in order to motivate a more evenly distributed pattern of development. Trade liberalization in Mexico and the rise of maquiladoras provide an excellent example of the possible positive role of trade liberalization in hand with FDI inflows by inducing more even geographic pattern of development. Hanson (1997) demonstrates how trade liberalization between Mexico and the U.S. affected manufacturing to relocate towards Mexico - US border leading to convergence in relative regional wages. A similar pattern of adjustment process might well be expected in transition countries where complete trade liberalization with the EU has been associated with vast inflows of FDI. It remains to be seen, however, in the subsequent sections whether these expectations are justified.

3. PREVIOUS EMPIRICAL STUDIES

Empirical literature gives some, although not conclusive, support to the theoretical EG predictions. There are a number of studies dealing with the implications of EG models. First group of papers studies the impact of trade liberalization between countries on international as well as interregional relocations of manufacturing activities. Most of the studies is concerning the EG implications for the EU specialization patterns. The most famous empirical paper, however, is probably the Hanson (1997) study on Mexico. Second group of papers studies the impact of within-country transport costs on the structure of wages, location costs, etc. In this section we provide a short overview of both groups of papers.

We start the first group of empirical papers on EG implications of trade liberalization with the Brülhart and Torstensson (1996) study on EU. They examine the EG implications for the EU specialization pattern and propose a non-monotonic relationship between regional integration and geographic concentration of increasing-returns industry. They prove, however, this EG hypothesis only indirectly and find some support for it in intra-industry trade (IIT) flows among EU countries in the period 1961-1991. The authors refer to a link between production localization of industries and the pattern of trade flows. In industries characterized by significant IRS that are internal to the firm the production is likely to be concentrated in one location near center and the pattern of trade between countries will be of inter-industry type. In industries with less pronounced IRS production will be more dispersed and intra-industry trade is the likely outcome. Brülhart and Torstensson in fact provide evidence that IRS industries are subject to relatively low IIT and that IIT flows increase at early stages of integration, but decrease when intra-union trade costs fall below certain threshold. One should note, however, that the above link between IRS and the pattern of trade differs completely from standard predictions of new trade theories. Krugman-Helpman-Lancaster type of trade models (see Krugman 1979, 1980, Helpman 1981, and Lancaster 1980) based on monopolistic competition, production differentation and internal IRS induces dispersion of production and intra-industry trade flows are the outcome. Markusen-Melvin-Panagariya type of trade models (see Markusen and Melvin 1981, Panagariya 1981) based on external IRS and homogenous goods induce production localisation and inter-industry pattern of trade. Hence, Brülhart - Torstensson's approach conforms more to the latter case with external IRS than to the case with internal IRS. The problem, however, is that they present their results according to the Pratten (1988) and the OECD classifications of sectors with internal IRS. Hence, the question arises whether new trade theories failed to describe the real world problems or Brülhart and Torstensson created a theoretical-empirical mismatch.

Forslid, Haaland and Midelfart-Knarvik (2002) use a large scale CGE model to simulate the effects of economic integration on the location of industrial production. They discover a non-monotonic relationship between trade liberalization and concentration of production (inverted *U*-shape) for industries driven by economies of scale, while a monotonic relationship is observed for comparative advantage driven industries.

Hanson (1997) provides evidence on the effects of trade liberalization between Mexico and USA. Under the closed economy, Mexican manufacturing was concentrated near the capital city. Trade liberalization then affected manufacturing to relocate towards Mexico - US border leading to convergence in relative regional wages. Davis and Weinstein (1999) find support for the existence of economic geography in eight of the nineteen manufacturing sectors in Japan in 1985. Midelfart-Knarvik, Overman and Venables (2000) develop and estimate a model of the location of industries across countries. They use sectoral data for European Union member countries over the period 1980 to 1997 and show that geography matters as industries dependent on backward and forward linkages tend to locate close to centers of manufacturing supply and demand.

Hallet (2000) investigates the occurrence and development of regional specialization and concentration in the European Union without analyzing the causes of such changes. The paper instead focuses on documenting the development of regional specialization and concentration in the European union from 1980 to 1995, with data limitations sometimes causing the observed period to shorten to only ten years. The author uses simple indexes of specialization and concentration (concentration, clustering measure, centrality measure and income measure) to show the trends of specialization and concentration for 199 European regions and 17 industries. The empirical results point to an increasingly similar specialization of regions from manufacturing into services, which could work towards reducing the probability of region specific shocks. The concentration measures show a dispersion of agriculture and processing of its products (as well as other day-to-day services) following patterns of arable land and settlements while manufacturing industries with high economies of scale are concentrated in fewer regions.

The second group of empirical papers on EG starts with the De la Fuente (2000) study on Spain. He investigates the sources of productivity convergence among Spanish regions in the period from 1955 to 1991. The paper argues that the high conversion rates observed for the Spanish regions in the given period are due in large part to technological diffusion (to so-called catch-up effect) and to reallocation of resources across regions. The empirical results of panel data analysis indicate significant positive correlation between capital deepening variables (which include gross capital formation and employment growth), human capital investment variable (as measured by the share of employees that started secondary education) and technological diffusion (residual term of the estimated growth equation) and the dependent variable: the growth rate of relative productivity of a region compared with the "average region". The empirical results support the proposed correlation only when fixed effects estimator is used, while random effects estimator shows the importance of the omitted region specific variables (the error factor captures all of the unobserved regional characteristics that have affected the productivity differentials).

Hanson (2000a) examines the spatial correlation of wages and consumer purchasing power across U.S. countries, whereby seeing whether regional product-market linkages contribute to spatial agglomeration. The structural model of this paper is heavily based on Krugman's "home market effect". The paper first examines a simple market potential function where the proximity to consumer markets is the prime determinant of nominal wages for a given location as seen in the following estimated equation:

(3) $$\Delta \log(w_{jt}) = \alpha_1 \left[\sum_k Y_{kt} e^{\alpha_2 d_{jk}} - \sum_k Y_{kt-1} e^{\alpha_2 d_{jk}} \right] + \varepsilon_{ijt}$$

where w_{jt} represents nominal wages in region j at time t , Y_{kt} is income in region *k* at time *t* and d_{jk} is distance between regions *j* and *k*.

The data for U.S. counties from 1970 to 1990 confirms the predicted negative relationship of nominal wages to transport costs to demand markets and a positive relationship to consumer income in demand markets at 1 per cent significance level, where this simple market potential function explains around 20 per cent of the nominal wage variation in the observed period. The paper also examines an augmented market potential function whose parameters reflect the importance of scale economies and transport costs, the stability of spatial agglomeration patterns and their evolution over time. The data conform somewhat better to this function with the R-square rising in all estimated variants of the function. The inclusion of the two new dependent variables - wages and housing stock - lessens the importance of market potential while enlarging the effect of distance. The impact of personal income and wages in surrounding locations on nominal wages in the given location are expectedly positive, while the variable housing stock in surrounding locations has, in contrast to theoretical predictions, a positive effect on nominal wages.

Brakman, Garretsen and Schramm (2002) estimate the Helpman-Hanson empirical model (compare Helpman 1998; Hanson 2000a) using data for Germany. An advantage of the Helpman-Hanson model is that it incorporates the fact that agglomeration of economic activity increases the prices of local (non-tradable) services. The model thus provides a powerful spreading force, which leads to less extreme outcomes than the basic model of the new economic geography by Krugman (1991). Using specific data for 151 districts for 1994 the authors succeeded in supporting the idea of a spatial nominal wage structure in Germany.

Finally, Overman, Redding, Venables (2001) present a survey of empirics as pertaining to the field of EG. The paper focuses on the general effects the EG has on the volume of trade, income levels and structure of production and offers a structural model to provide the basis for research work in the paper as well as research work of other authors. The authors first estimate (relating to the gravity model of trade) the elasticity of trade volumes with respect to distance at around –1 and the elasticity of trade volumes with respect to transport cost at around –3 indicating the importance of location for the competitiveness of firms in foreign markets[8]. The other important implications of the research are the effects of access of a country (firms) to the world markets and it's access to foreign suppliers to GDP per capita of that country. The effects appear to be very strong (positive and statistically significant at the 1 per cent significance level) and explain around 35 per cent of cross-country variation of gross domestic product per capita. The final part of the analysis focuses on the effects of economic geography and factor endowments as determinants of industrial structure in a given location, whereby the results imply that increasing returns manufacturing is disproportionately drawn into larger markets as opposed to smaller markets.

4. EMPIRICAL VERIFICATION OF ECONOMIC GEOGRAPHY EFFECTS IN TRANSITION COUNTRIES

So far, we are not aware of any comparative study on economic geography in transition countries or on spatial repercussions of recent trade liberalization in transition countries. In this section we try to fill this gap by verifying basic implications of the *Krugman*, *FKV* and *DK* economic geography models using the panel of regional data for five accession countries. In the subsequent section we will first discuss the empirical model used and how we expect different implications of the competitive EG models to appear in empirical estimations. Then we proceed to discussion of the data employed and to an analysis of the time pattern of relative regional wages and FDI inflows in each of the transition countries. Finally, after a short discussion of methodological issues we provide some results of econometric estimations of our empirical model.

4.1. The Empirical model

There are clear implications of the above discussed *Krugman*, *FKV* and *DK* models for transition countries. The *Krugman* model predicts a monotonic decline in relative regional wage throughout the period after trade liberalization has been initiated. *FKV* model predicts an *U*-shaped response of relative regional wages to reduced foreign trade barriers in transition countries. In the first years after trade liberalization relative wages in peripheral regions will decline while after some threshold the wages in peripheral regions will start catching up with the central region. *DK* model predicts that after a country has liberalized its trade with the EU its pattern of inter-regional manufacturing relocation will be determined by a trade off between agglomeration effects, remaining trade costs and existing differences in relative factor costs. With unchanged inter-regional transport costs, regions that are located closer to the EU border (western and/or northern regions, *W/N regions* henceforth) will benefit from trade liberalization through larger inflows of FDI due to lower trade costs with the EU and due to lower wages and higher returns to capital relative to the central home region. Some domestic resources might also relocate to border regions. As a result, after the initial downturn border regions will converge to the home capital region in terms of relative wages (and returns to capital) and relative manufacturing output. In non-border regions this adjustment pattern might be less pronounced. Hence, regional data for transition countries should exhibit an *U*-shaped curve of relative wages. The crucial difference relative to the *FKV* model, however, is in the

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8 These estimates are given on the basis of research work of other authors (see Hummels 1999a, 1999b, 2001).

speed of convergence, in the importance of FDI factor and in the faster convergence of W/N border regions.

In order to examine the spatial repercussions of trade liberalization in transition countries and to search for differences between the three competitive models, we estimate the following empirical model of relative regional wages:

(20) $$ln\ rW_{it} = \alpha + \nu t + \omega t^2 + \kappa\, ln\ rPROD_{it} + \delta\, ln\ irVAe_i + \phi\, ln\ rFDI_{it} + \beta\, lnDIST_i + \gamma BORD_i + \lambda FTA_t + \mu\, lnDIST{*}FTA_{it} + \sigma BORD{*}FTA_{it} + \rho \Sigma R + u_{it}$$

where:

rW	relative regional wage (i.e. wage ratio of region *r* to the capital region)
t, t^2	time effects (i.e. linear and squared time trend
rPROD	relative regional output (i.e. output ratio of region *r* to capital region)
irVAe	initial regional efficiency differential
rFDI	ratio of output of foreign firms to total regional output
DIST	distance to the capital
BORD	dummy for western/northern border regions
FTA	dummy for enforcement of trade liberalization with the EU
ΣR	broader regional dummies
u_{it}	error term.

In the above empirical model strong individual regional effects can be expected. Therefore, one should make specific assumptions regarding the error structure. We assume that individual regional effects are fixed (specific to the region and time invariant), hence, we assume the error term u_{it} has following properties:

(21) $$u_{it} = c_i + e_{it} \qquad (i = 1, \ldots, n;\ t = 1, \ldots, T)$$

$$\mathrm{E}[c_i | x_{it}] \neq 0 \quad \text{and} \quad \mathrm{E}[e_{it} | x_{it}, c_i] = 0$$

$$e_{it} \sim N(0, \sigma^2)$$

According to (21), we assume that there are present some unobserved individual regional effects c_i which are time invariant and correlated with the right-hand-side regressors in (20). We will account for them in our estimations by using fixed-effects (within) estimator with underlying specific time-demeaning transformation of the data in order to get rid of these effects. The remaining disturbances e_{it} are assumed to be normally distributed with zero mean and constant variance.

Table 1: Parameter predictions of competitive EG models

	Krugman	*FKV*	*DK*
t	-	ambiguous (+, -)	ambiguous (+, -)
t^2	- or insignificant	+	+
rFDI	insignificant	insignificant	+
rPROD	+	+	+
DIST	ambiguous (+, -)	ambiguous (+, -)	ambiguous (+, -)
BORD	ambiguous (+, -)	ambiguous (+, -)	ambiguous (+, -)
FTA	-	insignificant	+ or insignificant
DIST*FTA	-	insignificant	+ or insignificant
BORD*FTA	-	insignificant	+ or insignificant

According to the model specification (20), one can interpret predictions of the three competitive models in the way as summarized in the Table 1. Basically, the only variable, the sign of which may be predicted with certainty, is the relative output variable *rPROD* which accounts for the agglomeration effects. The larger the relative regional output the larger relative regional wage might be expected. On the other side, no general inference can be made upon the initial regional conditions in all of the transition countries (hence, distance and border effects can be of either sign). In each of the former socialist countries initial relative regional wages might depend on the past specific regional policies and on the extent of the initial openness to trade, etc. We can be more conclusive for the period after trade liberalization (FTA) has been initiated. If the *Krugman* model is to apply to transition countries, one may expect a monotonic negative time pattern of relative wages (negative sign of t) and that negative distance and border effects will become more pronounced over time. In the *FKV* setting, an *U*-shaped time pattern of relative wages is expected (hence, a positive sign of t^2). In a short panel ($T < 10$), there is no justification to expect significant distance, border and trade liberalization effects on relative regional wages. The reason behind is, of course, a non-linear response of relative wages to trade liberalization. However, over time (with $T > 10$) one may expect these effects to become more pronounced and positive. Similarly, if the *DK* model is to work in transition countries in the 1990s, one may expect an *U*-shaped time pattern of relative wages and positive distance and trade liberalization effects on relative regional wages. In addition to it, however, positive impact of FDI and a faster upward trend of relative regional wages in the W/N border regions are expected.

The estimation results are presented in section 4.3.2. after discussion of the data and estimation approach.

4.2. Time pattern of relative wages and FDI inflows in transition countries

4.2.1. Data

We analyze propositions of competitive EG models by using regional data for five transition countries that are eligible for accession to the EU after 2004. These countries are Bulgaria, Estonia, Hungary, Romania and Slovenia. Choice of countries is not arbitral; it is simply subject to availability of the data. Countries examined in our study are quite heterogeneous both in terms of their level of development and advancement of transition process as well as in terms of their distance to the core of the EU. One may thus expect that the distance and border effects in more distant countries like Bulgaria and Romania, which are also less advanced, will be less pronounced as compared to the EU bordering transition countries like Estonia, Hungary and Slovenia.

The data have been collected during the Phare ACE project on regional pattern of production relocation in transition countries. The data for Bulgaria, Estonia, Hungary and Romania are collected at the NUTS-2 and NUTS-3 levels and cover the period 1990-1999 (Bulgaria and Hungary) and the period 1992-1999 (Estonia and Romania). For Slovenia, which lacks the official regional statistics, the data are aggregated from individual firm level data to the desired level of regional aggregation (NUTS-3 and NUTS-5 levels) and cover the period 1994-2000. All the data are recalculated into 1994 constant prices using PPI indices. The data in our database comprise many aspects of regional performance, we explore only a small part of it. We take account only of data for the manufacturing sector, as other sectors are far less subject to trade liberalization.

As it follows from the previous discussion and from the empirical model discussed above, in all of the subsequent analyses and empirical estimations we use relative regional indicators in order to capture inter-regional relocation patterns in particular transition country. Relative regional indicators for wages and FDI are thus calculated as a ratio of *r*-th region performance to the capital (*c*) region performance. In the empirical estimations, regional data at the NUTS-3 (NUTS-5 for Slovenia) level is taken for individual observations, while NUTS-2 (NUTS-3 for Slovenia) regional dummies are taken in order to control for broader regional effects.

Table 2: Descriptive statistics of regional data by countries

	BG	EST	HU	RO	SLO
Data coverage	1990-99	1992-99	1990-99	1992-99	1994-00
Enforcement of FTA	1994	1994	1992	1993	1997
No. of NUTS-2 regions*	6	5	7	8	12
No. of NUTS-3 regions**	28	15	20	41	170

* NUTS-3 regions in Slovenia** NUTS-5 regions in Slovenia

While wage data does not need more discussion, some clarifications should be made with regard to the FDI data. With the exception of Slovenia we do not dispose with the data on relative importance of FDI in terms of output at the regional level. What we do have is the data on number of foreign owned and domestic firms by regions. The ratio between the two for each region has been taken to proxy for relative importance of FDI in each region. Of course, this is a very rough approximation, as the study for ten transition countries by Damijan et al. (2002) has demonstrated that foreign owned firms in transition countries are much larger in terms of output and employment, more capital intensive, etc. relative to their domestic owned counterparts in the same sectors. The role of FDI in inter-regional manufacturing relocation in the present study, hence, is by default underestimated.

Similarly, with the exception of Slovenia, there is lack of data for the evolution of foreign trade barriers over the specified period both at the country level as well as at the regional level. Ideally, one should take the time pattern of actual foreign trade barriers (tariffs, NTBs) at the regional level and estimate the impact of their reduction on spatial repercussions in each country. Instead, we are stuck with the data on the date of enforcement of the free trade agreement (FTA) with the EU. This, however, imposes several problems. First, in some of the countries a FTA has been enforced at the beginning of the period under examination, which of course eliminates the reference period needed for comparison of the EG effects before and after trade liberalization. Second, some of the examined countries have unilaterally liberalized their trade even before the enforcement of the FTA. Third, FTAs enforced by the EU were designed asymmetrically in favor of transition countries. Hence, the enforcement date of the FTA does not imply that trade barriers have been reduced linearly from that point on. In all of the countries, trade barriers for most sensitive goods have been eliminated at the end of the examined period. However, there is little one can do about it. What remains is to be cautious when discussing the results. On the other hand, we have separately estimated the model with Slovenian data by using either the FTA dummy variable or the data on actual tariffs applied by regions. Both estimations, however, do not differ significantly in terms of the signs and significance of the parameters for trade liberalization.

4.2.2. Evolution of relative regional wages

In this section, we examine the evolution of relative regional wages by individual countries. Graphic analysis comprised in Figure 1 combined with some descriptive statistics given in Table 3 gives us a very nice insight into the pattern of relative wages during 1990s. Table 3 reveals that, with the exception of Slovenia, in the beginning of trade liberalization in early 1990s there was little dispersion of regional wages in the examined countries. The average relative regional wages in all of the countries exceeded 80 per cent of that in the central region and the coefficient of variation of relative wages was well below 10 per cent. The exception here is Slovenia, where average relative wage amounted to 66 per cent of the central region's wage and the coefficient of variation exceeded 35 per cent. One can think of two possible reasons for these divergent initial positions between Slovenia and the group of other transition countries. The first and most obvious explanation lies in the fact that before 1990 Slovenia was relatively more open to international trade than other transition countries. Exposure to trade and a kind of semi-market economy had been affected Slovenian regional development well before 1990 while other transition countries have additionally sheltered their economies by preventing large regional disparities through special regional policies. Another explanation stems from the level of aggregation used in the calculations. For Slovenia, data at NUTS-5 (community) level is used while for other countries NUTS-3 data is used, which of course levels out a lot of variation. This is confirmed when we apply a coefficient of variation normalized by square root of number of observations. In this case, variation of relative regional wages in Slovenia becomes very similar to that of other transition countries.

Table 3: Changes in relative regional wages in transition countries in 1990s

	BG (1990)	BG (1999)	EST (1992)	EST (1999)	HU (1990)	HU (1999)	RO (1992)	RO (1999)	SLO (1994)	SLO (2000)
All regions										
Mean	0.924	0.786	0.840	0.667	0.820	0.706	0.957	0.706	0.660	0.692
Std. Error	0.009	0.020	0.031	0.026	0.018	0.024	0.015	0.014	0.019	0.016
Std. Deviation	0.047	0.106	0.119	0.099	0.081	0.107	0.096	0.090	0.246	0.213
Coef. of variation	5.1%	13.5%	14.2%	14.9%	9.8%	15.2%	10.0%	12.7%	37.3%	30.8%
Norm. coef. of variation[9]	1.0%	2.5%	3.7%	3.8%	2.2%	3.4%	1.6%	2.0%	2.9%	2.4%
N	28	28	15	15	20	20	41	41	170	170
W/N border regions										
Mean	0.906	0.817	0.849	0.732	0.854	0.759	1.010	0.736	0.667	0.752
Std. Error	0.013	0.042	0.040	0.070	0.032	0.029	0.043	0.027	0.042	0.051
Std. Deviation	0.040	0.127	0.089	0.156	0.078	0.072	0.137	0.085	0.222	0.270
Coef. of variation	4.4%	15.6%	10.5%	21.3%	9.2%	9.4%	13.6%	11.5%	33.3%	35.9%
Norm. coef. of variation	1.5%	5.2%	4.7%	9.5%	3.8%	3.9%	4.3%	3.6%	6.3%	6.8%
N	9	9	5	5	6	6	10	10	28	28
Non-W/N border regions										
Mean	0.932	0.771	0.836	0.635	0.805	0.683	0.940	0.696	0.659	0.680
Std. Error	0.011	0.022	0.043	0.010	0.021	0.030	0.013	0.016	0.021	0.017
Std. Deviation	0.049	0.094	0.136	0.032	0.080	0.114	0.074	0.090	0.251	0.199
Coef. of variation	5.3%	12.2%	16.3%	5.0%	9.9%	16.7%	7.8%	13.0%	38.2%	29.2%
Norm. coef. of variation	1.2%	2.8%	5.2%	1.6%	2.7%	4.5%	1.4%	2.3%	3.2%	2.5%
N	19	19	10	10	14	14	31	31	142	142

Source: Authors' calculations.

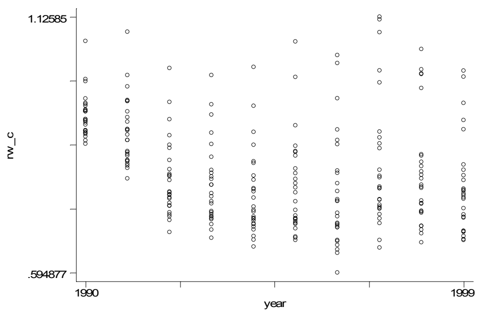
More importantly, however, is how trade liberalization has affected regional development in individual countries. Again, with the exception of Slovenia, relative wages in all of the countries have declined substantially until the end of 1990s. On average, relative regional wage diminished by 15-20 percentage points relative to the central region and the variation has increased to almost 15 per cent, which implies increased regional disparities. In contrast, in Slovenia relative regional wages have increased slightly – on average by some 3-percentage points – and variation has fallen. It is interesting to note, that according to the propositions of the *DK* model, the drop in relative regional wages in all countries has been much smaller (in Slovenia, the increase was higher) in W/N border regions, implying that here economic geography might be at work.

Let us now turn to the pattern of changes in relative regional wages throughout the 1990s. Figure 2 shows clearly that only in case of Bulgaria a clear *U*-shaped adjustment pattern of regional wages can be observed. This pattern better is even more pronounced in W/N border regions where a two-tier regional development can be observed. In Hungary, a clear negative trend of relative wages is evident, but the data suggest that the downturn has been reached by 1998 and that afterwards a rise in regional wages is on the way. For Bulgaria and Hungary, hence, one might expect *FKV* and *DK* models to be at work. On the other side, in Romania significant negative trend of relative regional wages is revealed implying *Krugman* type of divergence. The same applies also for Romanian W/N border regions. In Slovenia, no clear adjustment

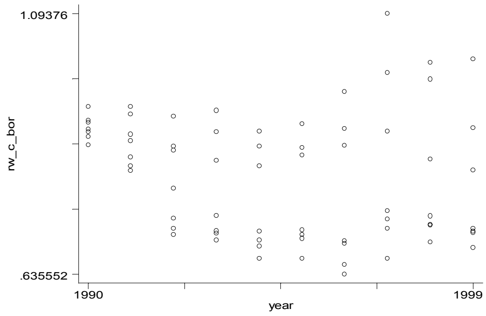
[9] Normalized coefficient of variation is a coefficient of variation normalized by a square root of number of observations (N). This is to ensure better comparability of variation across countries. As the variation of data for countries with more disaggregated data is biased upward one should take account of this.

pattern for all regions is visible, but a weak upward trend can be observed for W/N regions after 1997. The latter might speak in favor of the *DK* explanation of regional adjustment. In contrast to above four countries, Estonia exhibits a clear picture of an inverted *U*-shaped pattern of regional adjustment. An explanation for this might lie in the fact that the core manufacturing production is based around Tallinn in W/N border regions. Since early 1990s, these regions benefited enormously from large FDI inflows, especially in non-manufacturing sectors, which triggered off a steep rise in wages. Recently, regions that are more distant from the capital cannot keep pace anymore with the rapidly expanding capital region of Tallinn. Strong migrations of qualified labor to the central region are apparent, which implies that a typical *Krugman* type of regional polarization might take place in Estonia.

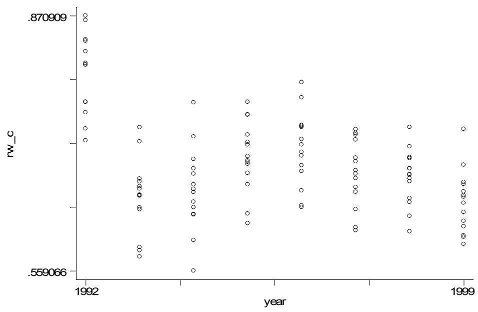
Figure 2: Evolution of relative regional wages in transition countries



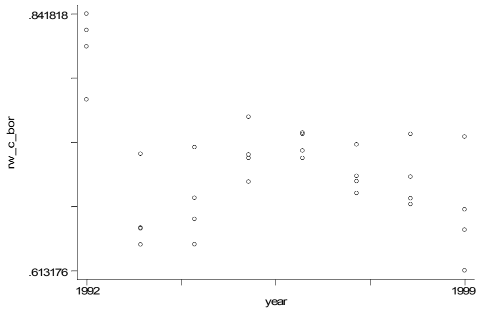
Bulgaria, 1990-99 – All regions



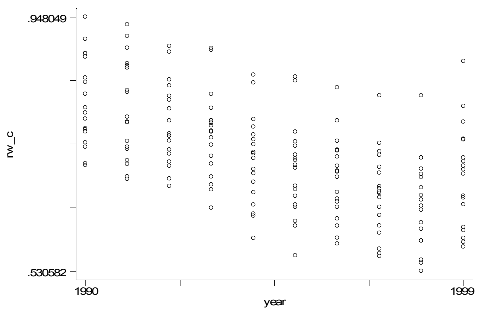
Bulgaria, 1990-99 – W/N regions



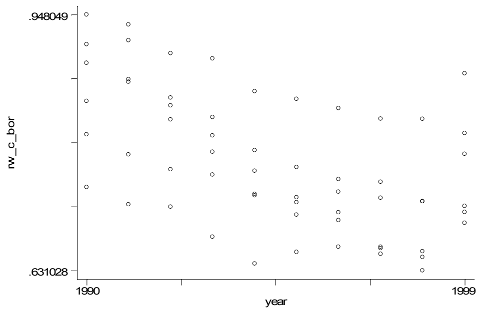
Estonia, 1992-99 – All regions



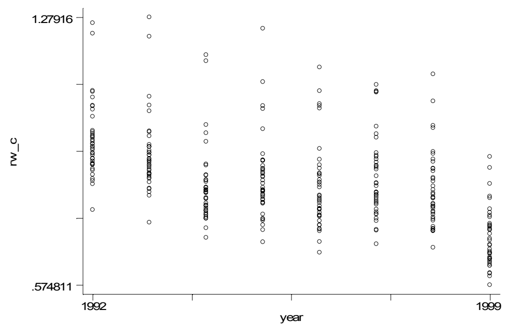
Estonia, 1992-99 – W/N regions



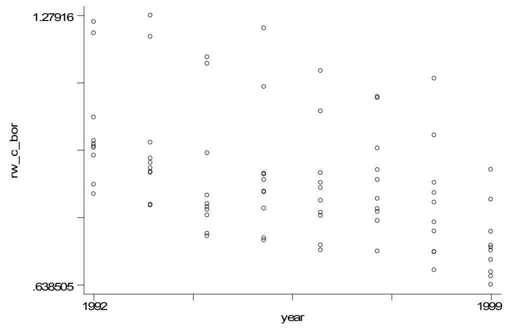
Hungary, 1990-99 – All regions



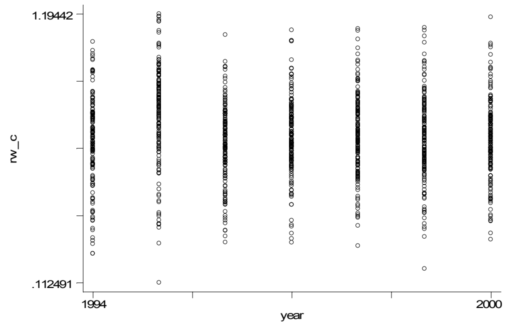
Hungary, 1990-99 – W/N regions



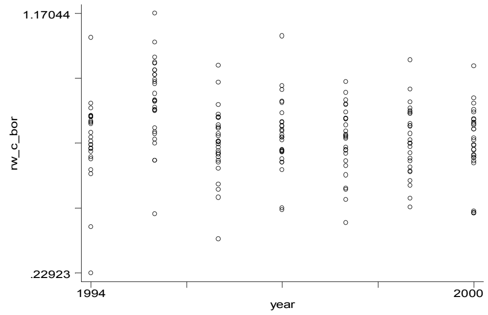
Romania, 1992-99 – All regions



Romania, 1992-99 – W/N regions



Slovenia, 1994-2000 – All regions



Slovenia, 1994-2000 – W/N regions

4.2.3. Evolution of relative regional FDI

As revealed in Table 4, selected transition countries have been subject to substantial FDI inflows during 1990s. The share of all transition countries in world FDI flows increased from 0.2 per cent in 1990 to 2.3 per cent in 2000. In countries under examination the stock of FDI throughout the 1990s accumulated to some 15 – 50 per cent of GDP. Major recipient of FDI in absolute terms among selected countries is Hungary, while in relative terms (as a share of GDP) FDI play the most important role in Estonia.

Table 4: Pattern of FDI inflows to transition countries, 1990-2000 (in $ mill.)

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	1990-2000 (as % of GDP)
Bulgaria	4	56	42	40	105	90	109	498	537	819	1,002	19.9
Estonia	…	…	58	160	225	205	150	262	581	305	398	47.9
Hungary	311	1,459	1,471	2,339	1,146	4,453	1,983	2,085	2,036	1,944	1,957	39.9
Romania	-18	37	73	94	341	419	263	1,224	2,031	1,041	998	16.1
Slovenia	4	65	111	113	128	176	185	321	165	181	181	13.0

Source: UNCTAD, World Investment Report 2001.

As proposed by the *DK* model, regional pattern of FDI inflows is determined by (i) differences in relative factor costs, (ii) trade costs between home country and foreign country as well as trade costs between home regions, and (iii) agglomeration effects. Table 5 shows the pattern of relative regional presence of foreign investment firms (FIEs). Here, in absence of more appropriate data, number of FIEs relative to number of domestic firms serves as an effective measure of regional importance of FDI. As discussed earlier, these indicators should be interpreted with a large portion of cautiousness. As we only deal with the data on number of firms and not with the data on their output, this may bias our findings in an important way. Nonetheless, with some exception of Bulgaria and Estonia, the regional pattern of FDI does not correspond to that suggested by the *DK* model. In general, the importance of FDI by regions is quite low. On average, the share of FIEs by regions is well below 10 per cent and this has not changed much throughout the 1990s. In Bulgaria and Estonia these shares in W/N border regions are substantially higher and amount to, respectively, 13 and 23 per cent in 1999. In Hungary, Romania and Slovenia, the opposite is true as non-W/N border regions account for substantially higher shares of FDI.

Table 5: Regional pattern of FDI by countries, 1990-2000

	BG (1990)	BG (1999)	EST (1992)	EST (1999)	HU (1990)	HU (1999)	RO (1992)	RO (1999)	SLO (1994)	SLO (2000)
All regions										
Mean	0.073	0.068	0.076	0.090	0.084	0.095	0.042	0.047	0.041	0.030
Std. Error	0.037	0.036	0.066	0.065	0.049	0.048	0.024	0.024	0.017	0.011
Std. Deviation	0.197	0.189	0.256	0.253	0.218	0.215	0.155	0.154	0.221	0.141
Coef. of variation	271.3%	279.1%	338.4%	279.7%	260.6%	225.5%	366.9%	330.4%	542.8%	466.9%
Norm. coef. of variation	51.3%	52.7%	87.4%	72.2%	58.3%	50.4%	57.3%	51.6%	41.6%	35.8%
N	28	28	15	15	20	20	41	41	170	170
W/N border regions										
Mean	0.128	0.129	0.211	0.227	0.037	0.057	0.029	0.034	0.041	0.033
Std. Error	0.109	0.109	0.197	0.193	0.008	0.010	0.012	0.008	0.019	0.018
Std. Deviation	0.327	0.327	0.441	0.433	0.021	0.024	0.039	0.025	0.100	0.096
Coef. of variation	254.9%	253.4%	209.7%	190.9%	56.2%	41.4%	134.9%	74.1%	245.9%	291.7%
Norm. coef. of variation	85.0%	84.5%	93.8%	85.4%	22.9%	16.9%	42.7%	23.4%	46.5%	55.1%
N	9	9	5	5	6	6	10	10	28	28
Non-W/N border regions										
Mean	0.046	0.039	0.008	0.022	0.104	0.112	0.047	0.051	0.041	0.030
Std. Error	0.021	0.013	0.004	0.007	0.070	0.069	0.032	0.032	0.020	0.013
Std. Deviation	0.092	0.057	0.013	0.023	0.260	0.258	0.178	0.177	0.238	0.149
Coef. of variation	199.1%	147.0%	158.9%	106.1%	250.9%	230.3%	380.7%	348.8%	584.1%	500.8%
Norm. coef. of variation	45.7%	33.7%	50.2%	33.6%	67.1%	61.6%	68.4%	62.7%	49.0%	42.0%
N	19	19	10	10	14	14	31	31	142	142

Source: Authors' calculations.

This evidence is in line with findings of Alessandrini and Contessi (2001) who found that the vast majority of FDI inflows in transition countries has been directed into the central regions and traditional economic centers. To sum up, with the exception of Bulgaria and Estonia, little evidence, at least using this rough method, is found in favor of the suggestions of the *DK* model, which proposes the majority of FDI to flow into W/N border regions. It remains to be seen in the formal tests what is the exact impact of regional FDI on regional wage structure.

4.3. Results

4.3.1. Methodology

Before we turn to the estimation results of our empirical model (20), a few words need to be said about the methodology of our estimations. Our data is structured as regional panel data for a time span of 7 to 10 years, which requires an explicit account of the region specific effects. Without explicit control for this one might get biased estimates of coefficients since FDI inflows, output growth and changes in relative wages might be correlated over time or subject to random shocks. In general, using static specification of the empirical model there are two well-known ways of controlling for this bias. First obvious option is employing the fixed effects (FE) estimator, which assumes fixed (constant) region specific effects over time, which are correlated with the right-hand-side regressors. On the other side, random effects (RE) estimator assumes that region specific effects are random and only reflected in the error term; i.e. uncorrelated over time. From substantial point of view, we are interested in observing the pattern of changes in relative regional performance over time induced by external shocks such as trade liberalization. Of course, it is straightforward to assume that individual region will respond homogenously to external shocks throughout the period. Hence, in this case FE estimator is a natural choice. Therefore, in (21) we have specified our assumptions about the structure of the error term, which enables us to take explicit control of these effects. In the next section we present F-tests for the presence of individual (regional) effects, which is the formal justification for using the panel data techniques instead of OLS. In addition, irrespective of the superiority of FE estimator in the present case, we conduct also formal Hausman tests in order to test for the validity of model specification.

An important drawback of FE estimator in the present case, however, is that some of the crucial variables in our empirical model are time invariant (such as border dummies, transport costs proxied by road distances in kilometers and the trade liberalization dummy for countries that have liberalized their trade with the EU already in the beginning of the period that is covered in our data). When performing regular FE estimations these variables are differenced out and therefore dropped from the estimation procedure. In order to avoid this, we employ a trivial trick: we have multiplied all of the time invariant variables by time trend. After differentiating from individual means, which is the underlying procedure in FE estimations, this gives time varying values of parameters under consideration. Of course, one needs to be cautious with the interpretations, since the regression coefficients obtained through this transformation are to be interpreted in terms of rates of growth. Yet, all that matters in our estimations is the sign and significance of the parameters, which are not altered by above modifications.

4.3.2. Results

Table 6 provides basic estimation results of our empirical model (20) using FE estimator. F-tests performed confirm the presence of strong individual (regional) effects and justify the use of panel data techniques instead of OLS. In addition, the Hausman specification tests that test for systematic differences between FE and RE estimators confirm superiority of the FE estimator.

The results suggest two different EG stories in transition countries after trade liberalization in the early 1990s. In the first group of countries, consisting of Hungary, Bulgaria and Romania, the *FKV* type and to some extent also the *DK* type of adjustment pattern of relative wages is revealed. The expected *U*-shaped (i.e. positive sign of t^2) adjustment pattern of relative wages is confirmed by the data. In addition, in Bulgaria and Hungary, FDI seem to work in line with the predictions of our model (coefficients are close to be significant at 10 per cent). On the contrary, FDI stocks in Romania are significantly negatively correlated with the relative regional wages. However, in none of the three countries, the adjustment pattern of manufacturing relocation and of relative regional wages (as expected, both are highly correlated) is being affected by the distance from the capital or by border. This is true both for the period before official trade liberalization with the EU as well as for the period after it.

One can argue that while the FDI argument is being confirmed the internal transport costs and border region arguments of the *DK* model do not find any confirmation by the data. On the other hand, these results might only reveal that the process of manufacturing relocation and the adjustment pattern of regional wages are non-linear, as predicted both by the *FKV* and *DK* models. Hence, linear estimators of dummy variables cannot account for this dynamics.

Table 6: Impact of trade liberalization on the adjustment pattern of relative regional wages in transition countries

	BG	EST	HU	RO	SLO
t	-0.019	***-0.665**	-0.018	-0.051	*****0.077**
	(-0.33)	(-3.61)	(-0.29)	(-0.69)	(2.63)
t^2	****0.003**	***-0.024**	*****0.002**	***0.010**	***-0.038**
	(2.40)	(-3.26)	(4.84)	(1.65)	(-8.75)
rPROD	****0.675**	0.131	*****0.186**	****0.641**	****0.501**
	(1.99)	(0.14)	(3.66)	(2.57)	(2.20)
irVA/emp	0.001	*****0.022**	2.229	*-0.030**	-0.0001
	(0.73)	(2.93)	(0.05)	(-1.67)	(-0.67)
rFDI	2.356	0.156	1.370	*-0.254**	0.003
	(1.61)	(0.82)	(1.64)	(-1.93)	(0.10)
DISTANCE	-0.012	*****0.092**	0.007	-0.001	0.008
	(-1.17)	(2.75)	(0.44)	(-0.08)	(0.95)
BORDER	0.080	0.115	0.027	0.016	0.007
	(1.57)	(1.06)	(0.91)	(0.22)	(0.09)
FTA	-0.017	*****0.738**	0.009	-0.009	*****0.241**
	(-0.34)	(3.30)	(0.12)	(-0.70)	(4.82)
DIST*FTA	0.011	**-0.099**	-0.009	-0.0001	**-0.021**
	(1.28)	(-2.41)	(-0.57)	(-0.13)	(-2.07)
BORD*FTA	-0.008	**-0.105**	0.012	-0.002	0.013
	(-0.70)	(-2.43)	(0.68)	(-1.19)	(0.73)
Broad region dummies	Yes	Yes	Yes	Yes	Yes
Number of obs.	234	98	180	280	1001
Adj R^2	0.632	0.793	0.875	0.660	0.075
F test for individual effects	21.2	13.8	41.3	8.7	14.1
Hausman chi^2 test	39.0	51.7	24.8	65.7	42.0
Prob>chi^2	0.002	0.000	0.074	0.000	0.009

Notes: (a) results obtained by fixed effects (within) estimations; (b) t-statistics according to robust standard errors in parentheses; (c) dependent variable: relative regional wage, i.e. wage in the *r*-th region relative to the capital region.

On the other hand, in Estonia and Slovenia, an inverse process is at work since an inverted *U*-shaped (i.e. negative sign of t^2) adjustment of relative wages is found. In addition, while initially the distance and border effects were found to be positive, after official trade liberalization both parameters became negative. It indicates that recently, after initial favorable regional development, more distant individual regions cannot keep pace anymore with the rapidly expanding capital regions in both countries. Impact of FDI is found to be insignificant. In effect, strong migrations of qualified labor to the central regions are apparent, which is promoted also by smaller size of these two countries and hence smaller adjustment costs. This suggests that presently a *Krugman* type of regional polarization might be at work in both countries. But this trend may well be reverted in the next years and both countries might follow the *FKV* and *DK* adjustment pattern.

5. CONCLUSIONS

The present paper analyzes the effects of trade liberalization with the EU on inter-regional relocation of manufacturing and inter-regional adjustment of relative wages in transition countries. We start with an overview of implications of the three competitive EG models. The *Krugman* model predicts a monotonic response of relative regional wages to reduction of foreign trade costs, strong migration flows of labor towards the core region, and thus a typical core – periphery regional polarization. Fujita-Krugman-Venables (*FKV*) and Damijan-Kostevc (*DK*) model argue that labor is imperfectly mobile between regions, which due to increasing wages in the core region prevents from complete agglomeration in the home country. Both models result in a non-monotonic, *U*-shaped response of relative regional wages to trade liberalization. Major difference between the two approaches is that *DK* model introduces a second factor of production, capital, which allows for FDI flows between countries. FDI inflows are shown to accelerate the regional adjustment process in the home country, as they are initially attracted to poor, border regions characterized by lower wages and higher returns to capital. *DK* model therefore results in a faster convergence of relative regional wages, i.e. comparative to *FKV* approach, in a more upward and to the right shifted *U*-shaped response of relative wages.

In the second part of the paper we then turn to the examination of the pattern of manufacturing relocation and the adjustment pattern of relative regional wages in five transition countries after they have liberalized their trade with the EU. We study which of the three competitive EG models is a more appropriate approximation of the actual regional adjustment pattern in selected transition countries. More specifically, we examine whether the response of relative regional wages to trade liberalization is monotonic and leading to strong regional polarization as suggested by the first *Krugman* approach, or is it a non-monotonic one and associated with lesser regional polarization as suggested by more recent EG approaches. In addition, in case of a non-monotonic response we test the propositions of a *FKV* against the *DK* approach. In doing so, impact of FDI, of inter-regional transport costs and of western/northern region dummies on adjustment pattern of relative regional wages are being examined. Implications of the three competitive EG approaches are tested using a unique regional panel data for five transition countries (Bulgaria, Estonia, Hungary, Romania and Slovenia) in the period 1990-2000.

Summing up our empirical findings, the results suggest that two different EG stories are taking place in transition countries after trade liberalization in the 1990s. In the first group of countries, consisting of Hungary, Bulgaria and Romania, the *FKV* type and to some extent also the *DK* type of adjustment pattern of relative wages is revealed. The expected *U*-shaped adjustment pattern of relative wages is confirmed by the data. In addition, in Bulgaria and Hungary, FDI seem to work in line with the predictions of the *DK* model, while internal transport costs and border region arguments of the *DK* model did not found any confirmation by the data. On the other hand, in Estonia and Slovenia, an inverse process is at work since an inverted *U*-shaped adjustment of relative wages is found. In addition, the distance and border effects were found to be negative after trade liberalization. This suggests that presently a *Krugman* type of regional polarization might be at work in both countries. But this trend may well be reverted in the next years and both countries might follow the *FKV* and *DK* adjustment pattern.

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