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## Trade liberalization and economic geography in transition countries: Can FDI explain the adjustment patterns of regional wages?

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### **Trade liberalization and economic geography in transition countries: Can FDI explain the adjustment patterns of regional wages?**

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# Trade liberalization and economic geography in transition countries: Can FDI explain the adjustment pattern of regional wages?\*

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## Abstract

Present paper studies the within-country regional effects of trade liberalization in transition countries. We argue that FDI inflows can be an important factor to accelerate the regional adjustment process in the home country. In order to underpin this theoretically, we first augment the new economic geography models by breaking the implied regional symmetry and by introducing capital as a second factor of production. Major contribution of our approach is that it allows for inter-regional as well as international capital mobility while labor is assumed to be immobile. Numerical simulations of our model indicate that this should contribute to faster convergence of relative regional wages in the smaller region. In addition, we examine the exact adjustment pattern of relative regional wages in five transition countries in the period 1990-2004 after they have liberalized their trade with the EU. First, we show that in four out of five transition countries there is a significant U-shaped adjustment pattern of regional wages after they opened up to foreign trade. And second, we find robust econometric confirmation that in three of the five countries FDI has contributed significantly to faster adjustment of relative regional wages.

*Keywords:* economic geography, trade costs, wages, transition countries, foreign direct investment

*JEL classification:* F16, P23, R13

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# 1 Introduction

The opening-up of former socialist countries of Central and Eastern Europe (CEECs) and their trade integration with the European Union (EU) resulted in an extensive restructuring of production. While the vast majority of studies on economic restructuring in CEECs so far dealt with inter-sectoral restructuring of production, this paper focuses on inter-regional relocation of production within individual countries. The transition from a closed economy to complete trade liberalization with the EU provides a natural experiment for assessing the relevance of the new economic geography (NEG) models. Despite scepticism about the simplifying assumptions and "overly" specific functional forms expressed by Neary (2001) in an excellent overview of the field, NEG models enable us to analyze the effects of trade liberalization on international as well as intra-national relocation of manufacturing activity. The exact pattern of relocation of manufacturing activity, however, is ambiguous and dependent on the underlying assumptions. Crucially, assumptions about inter-regional factor mobility as well as the approach to the formalization of agglomeration/dispersion forces determine the model's predictions and implications. These can be surprisingly diverse, ranging from increasing (or complete) agglomeration as in Krugman (1991a, 1991b) and Puga, Venables (1997) to a more even spread of economic activity (Krugman, Venables (1995), Puga (1999)).

So far only few studies (Brühlhart et al (2004), Crozet and Koenig (2004), Egger et al (2005), Brühlhart and Koenig (2006)) studied the effects of trade liberalization on the inter-regional relocation of production in CEECs. It is interesting, however, that while most of the empirical studies demonstrated that inter-sectoral restructuring in CEECs has been associated with massive inflows of foreign direct investments (Damijan and Rojec, 2007), the impact of FDI on inter-regional relocation of production and wage disparities has been widely neglected. The novelty of our approach compared with the above mentioned studies on CEECs is that it focuses on explaining the dynamics of regional adjustment in response to trade liberalization. Also, using longer time series on transition countries allows us to study the relocation process in greater detail as the adjustment may take longer to unravel. Finally, our contribution also lies in the introduction of international capital flows as a (possibly crucial) factor in regional development in transition economies. We develop and apply a two-country three-region NEG model based loosely on the Krugman-Venables (1995) framework, which we amend by introducing capital as a second factor of production. The results of our model closely mimic the Krugman-Venables (1996) two-region adjustment dynamics as the relative wage of the smaller home-country region displays a U-shaped response to trade liberalization. The introduction of capital allows for flows of FDI between the large foreign country and the home regions. Numerical simulations indicate that FDI flows can serve to accelerate the regional adjustment dynamics in the home country, as FDI are initially more likely to be

drawn to poorer regions characterized by lower relative costs of labor.

In the second part of the paper, we empirically analyze 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, whereby we examine how well our NEG model, which allows for international in inter-regional capital flows, can explain 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 first suggested by Krugman (1991b), or is it a non-monotonic one and associated with lesser regional polarization as suggested by more recent NEG approaches. In addition, in case of a non-monotonic response we test whether regional pattern of FDI inflows can explain the regional adjustment pattern of wages. Implications of our NEG approach are tested using a unique regional panel data for five transition countries (Bulgaria, Estonia, Hungary, Romania and Slovenia) in the period 1990-2004.

Our results suggest that the expected U-shaped adjustment pattern of relative wages is confirmed by the data in four of the five countries analyzed. In addition, after careful examination and using the appropriate panel data techniques as well as controlling for the potential endogeneity between wages and FDI, we find that in three of the five countries FDI is revealed to have the theoretically suggested effect. FDI is shown to contribute to faster adjustment of relative regional wages in regions more heavily affected by trade liberalization. Based on these findings one can argue that due to inherent imperfect inter-regional mobility of labor foreign direct investment can be an important factor which helps mitigating the potentially negative effects of trade liberalization in peripheral regions.

Structure of the paper is as follows. Section 2 briefly outlines our augmented NEG model and discusses its implications for transition countries. Section 3 discusses previous empirical studies. Section 4 describes the empirical model, while Section 5 discusses the datasets used and descriptive statistics of the crucial variables in our empirical model. Section 6 discusses econometric methodology issues and presents estimation results both for the static as well as for the dynamic specification of the model. The final section summarizes basic findings of the paper and provides some policy implications.

## 2 Theory

The opening-up of transition countries and their trade integration with the European Union (EU) has brought about large increases in trade between the two groups of countries. Data for transition countries during 1990s, however, reveal that in addition to substantive trade creation there is also evidence of vast increases in FDI flows. It is the aim of this paper to study the effects of both the reduction of barriers to foreign

trade as well as increase in FDI inflows on inter-regional adjustment process in transition countries.

## 2.1 The model

The model, presented in detail in Appendix A, is based loosely on the Krugman-Venables (1995) model, but it has been augmented to include three locations (in the spirit of Krugman, Livas Elizondo (1996)) as well as a second factor of production, capital<sup>1</sup>. As in Krugman, Venables (1995) we assume the existence of two sectors: a perfectly competitive agricultural sector producing a single homogeneous good and a monopolistic manufacturing sector producing a large number of differentiated varieties. Manufacturing varieties are produced under internal (driven by the existence of fixed costs of production) and external economies of scale (arising from the size of the local market for intermediate products). We include two factors of production (labor and capital), where labor is immobile between locations<sup>2</sup> (but perfectly mobile between sectors), while capital is perfectly mobile within a country<sup>3</sup>. Given the symmetric demand for all varieties (stemming from the Dixit-Stiglitz type CES demand function) and homogenous increasing-returns-to-scale technology the ensuing equilibrium consists of a large number of firms producing their own varieties at the same price in any given location  $r$ .

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

where  $w_r$  and  $i_r$  are the respective nominal wages and interest rates of location  $r$ ,  $n_r$  is the number of firms (varieties produced) at location  $r$ ,  $\alpha$  ( $\beta$ ) are output elasticities with respect to labor (capital), while  $\sigma$  is the elasticity of substitution. Demand for a firm's variety can be described by

$$q_r^* = \mu \sum_{s=1}^R Y_s (p_r^M)^{-\sigma} (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \quad (2)$$

with  $Y_s$  as the income of location  $s$ ,  $T_{rs}$  iceberg-type transport costs for manufacturing goods<sup>4</sup> between locations  $r$  and  $s$ ,  $G_s$  is the manufacturing price index in location  $s$  and

<sup>1</sup>This aspect of the model is akin to Martin and Rogers (1995) "footloose capital" model, where capital is considered the only mobile factor of production (and no labor mobility is allowed). However, by allowing for a wider array of agglomeration and dispersion forces our model yields substantially different implications.

<sup>2</sup>This is in stark contrast to Crozet, Koenig (2004) where perfect inter-country labor mobility is assumed. Although both assumptions are very restrictive, we believe the lack of labor mobility is a better reflection of the stylized facts about transition countries. See for instance Fidrmuc (2005) and Transition Report (2003) where very low migration intensity within transition countries is observed.

<sup>3</sup>International factor mobility is restricted to occasional direct investment (FDI).

<sup>4</sup>As is the case in Krugman, Venables (1995), we assume agricultural goods can be transported cost-

$\mu$  is a constant denoting the share of income spent on manufacturing goods. In contrast to Krugman, Livas Elizondo (1996)<sup>5</sup> we propose an asymmetric placement of locations, with the smaller of the two regions in the home country actually being closer to the large foreign market. This approach is in line with the one in Crozet and Koenig (2004) and allows for greater flexibility in switching between asymmetric and symmetric placement of locations. For modeling convenience we assume that the larger of the two home regions has to incur the same trade costs as the smaller (border) region plus an additional cost of transport between the two regions. This yields the following nominal wages in the three locations

$$\begin{aligned}
w_1 &= \alpha \left[ \left( \frac{n_1^\sigma \rho \beta^\beta}{i_1^\beta} \right) (Y_1 G_1^{\sigma-1} + Y_2 G_2^{\sigma-1} T^{1-\sigma} + Y_3 G_3^{\sigma-1} (TT^*)^{1-\sigma})^{\frac{1}{\sigma-1}} \right]^{\frac{1}{\alpha}} \\
w_2 &= \alpha \left[ \left( \frac{n_2^\sigma \rho \beta^\beta}{i_2^\beta} \right) (Y_1 G_1^{\sigma-1} T^{1-\sigma} + Y_2 G_2^{\sigma-1} + Y_3 G_3^{\sigma-1} T^{*1-\sigma})^{\frac{1}{\sigma-1}} \right]^{\frac{1}{\alpha}} \\
w_3 &= \alpha \left[ \left( \frac{n_3^\sigma \rho \beta^\beta}{i_3^\beta} \right) (Y_1 G_1^{\sigma-1} (TT^*)^{1-\sigma} + Y_2 G_2^{\sigma-1} T^{*1-\sigma} + Y_3 G_3^{\sigma-1})^{\frac{1}{\sigma-1}} \right]^{\frac{1}{\alpha}} \quad (3)
\end{aligned}$$

where  $T$  and  $T^*$  represent the transport costs (trade costs) between the two domestic regions (regions 1 and 2) and the smaller (peripheral) region 2 and the foreign country, respectively.<sup>6</sup> 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 second region's trade costs with the foreign country ( $TT^*$ ). This represents an important structural change compared with the existing NEG models as it significantly alters the dynamics of regional activity.<sup>7</sup> According to (3), relative regional wage in the home country (i.e. wage rate in peripheral relative to central region) depends on the scope of external economies of scale (number of "local" firms  $n_r$  is affected by initial factor endowments and factor mobility), the aggregate demand for the region's varieties (sum of  $Y_r G_r$ ), the return to capital ( $i$ ) in the region, home-country inter-regional ( $T$ ) and inter-country ( $T^*$ ) trade costs, as well as the elasticity of substitution between varieties of manufactured goods.

Agriculture fills the role of the residual sector, serving as a labor pool for manufacturing. As long as the agricultural sector exists in a given location<sup>8</sup> this will enable the further expansion of the manufacturing sector as labor relocates in search of higher

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lessly.

<sup>5</sup>Two-country three-region symmetric models appear also in Brühlhart, Crozet and Koenig (2004) and Crozet and Koenig (2004).

<sup>6</sup>Subscripts 1, 2 denote the central (large) and peripheral (small) home regions, respectively, while subscript 3 denotes the foreign country.

<sup>7</sup>We intentionally omit the analysis of possible equilibria common to new economic geography models (Fujita, Krugman, Venables, 1999) as our model is largely driven by the imposed asymmetries. Analysis of equilibria therefore does not yield meaningful non trivial solutions.

<sup>8</sup>This can be ensured by limiting the preference for manufacturing goods ( $\mu < 0.5$ ).

wages. The long run equilibrium in each location therefore requires that manufacturing wages equal those of the agricultural sector. In order to avoid trivial solutions, we assume decreasing marginal returns to labor in the residual sector. This ensures that, as the share of labor in agriculture decreases, the cost of labor rises, making it more costly to acquire an additional worker in manufacturing. To simplify matters, we propose that agricultural production function is linear<sup>9</sup> with respect to the amount of labor employed. The marginal product of labor, which equals the manufacturing wage in equilibrium, is therefore

$$w_r = (1 - \lambda_r)L_r \quad (4)$$

Model dynamics are hence driven by a number of counteracting forces. On one hand, there are agglomerating factors such as external economies of scale from concentrating production and a lower price level as an agglomeration grows, on the other hand, these are counteracted by transport costs in serving other locations and rising wages as the agricultural sector shrinks. As labor is completely immobile it is only footloose firms that can respond to these forces by relocating to a different region.

Foreign direct investment is modeled as an exogenous occurrence with the flows of direct investment coming from the large country into primarily the smaller of the two home regions as its relative cost of labor ( $w_2/i_2$ ) is below that of the larger region and, in addition, it may also benefit from region-specific investment incentive schemes. The influx of new capital in a location will directly affect the number of firms  $n_r$  in that location, the nominal wages  $w_r$  and its aggregate income  $Y_r G_r$ . In fact, as we show in the remainder of this section, such a pattern of capital flows would accelerate the underlying convergence process.

## 2.2 Implications of the model

Our framework differs substantially from the standard, symmetric new economic geography models. We grant an advantage to one of the two home regions by positioning it closer to the foreign market. With trade liberalization both home regions gain as their access to the foreign market improves, but these gains are not uniform across the range of trade costs. At the onset of liberalization the difference between the two regions is further deepened as the reduction in inter-country transport cost ( $T^*$ ) accentuates the initial agglomeration advantage of the larger home region (region 1).<sup>10</sup> As wages in region

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<sup>9</sup>

$$q_A = A((1 - \lambda_r)L_r)$$

where  $A$  is a linear function,  $\lambda_r$  is location  $r$ 's share of manufacturing workers in the labor force, while  $L_r$  is the labor endowment of region  $r$ .

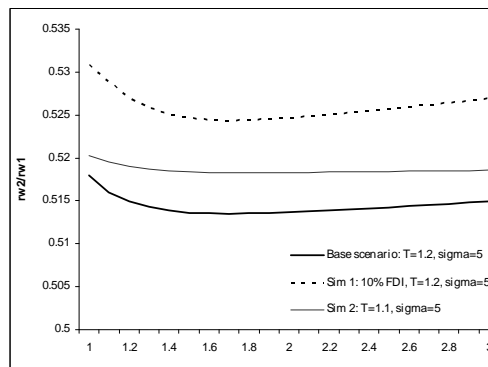
<sup>10</sup>Any reduction in inter-country trade cost is magnified by the intra-country transport cost in the case of region 1 (as can be seen in equation 3).



1 increase beyond a certain threshold value, local firms find it profitable to relocate to the smaller region (region 2). These dynamics result in the familiar U-shaped response curve of relative real wages to changes in transport costs. In addition, the setup of the model allows for the introduction of FDI.

We present simulated responses of relative real wages ( $rw_2/rw_1$ ) to trade liberalization with different parameter values in Figure 1. The baseline simulation reveals that at first lower transport costs motivate further agglomeration of economic activity in the larger home region which leads to higher real wages compared with the smaller home region. After the threshold level of trade costs has been reached, higher manufacturing wages in the larger region and improved market access in the smaller region cause firms to start relocating to the smaller, border region, which improves its relative real wage.<sup>11</sup>

Figure 1: Response of home-country relative real wages ( $rw_2/rw_1$ ) to a reduction in foreign trade costs



First of the alternative scenarios (Sim 1) explores the impact of foreign direct investment amounting to 10% of regions capital on home-country relative real wages. As noted above, we assume that the majority of FDI will be directed into the smaller home region due to its lower factor costs as well as its proximity to foreign markets. Figure 1 demonstrates that FDI improves the relative real wages of the smaller home region as well as speeds up the rate of wage convergence. The primary effect of FDI is the immediate increase in regional income, which drives an increase in the nominal wage rate of region 2 relative to the central region. With no labor mobility, the manufacturing production becomes more capital intensive implying increased labor productivity and hence wages. Secondly, increased capital endowment of the region leads to an increase in the manufacturing sector (as the number of firms increases), which in turn intensifies the positive externalities (external economies of scale). The two effects of FDI enable a much faster convergence of relative real wages as seen in Figure 1. Figure 1 also illustrates the effects of lower internal transport costs ( $T$ ) on relative real wages. As Sim 2 clearly shows lower

<sup>11</sup>All simulations were performed with Mathematica version 5.1 with parameters  $\alpha = 0.7$ ,  $\beta = 0.3$ ,  $K_f = 2$ ,  $L_f = 4$ ,  $L_1 = 220$ ,  $L_2 = 200$ ,  $L_3 = 500$ ,  $i_1 = i_2 = 0.04$ .

transport costs between the two home regions mitigate the relocation tendencies of foot-loose firms as their improved access to both home and foreign markets limit the locational advantage of the smaller home region.

The above exercise clearly shows 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 a clear example of the possible positive role of trade liberalization interacting 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**

Pioneering efforts in empirical research of new economic geography's implications were made by Gordon Hanson (1996, 1997) with the analysis of the effects of Mexican trade liberalization on its internal economic geography. From a closed economy setting, where manufacturing was concentrated near the capital city, trade liberalization caused manufacturing to relocate towards Mexico - US border. This, as Hanson shows, leads to a convergence in relative regional wages and an increase in border-region employment. In another of the earlier empirical papers on the NEG implications of trade liberalization Brülhart and Torstensson (1996) propose a non-monotonic relationship between regional integration and geographic concentration of increasing-returns industries in EU countries. They, however, find mixed evidence and prove this hypothesis only indirectly finding some support for it solely in intra-industry trade flows among EU countries. 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. Brakman, Garretsen and Schramm (2004) estimate the Helpman-Hanson empirical model (compare Helpman 1998; Hanson 2005) 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. Using specific data for 151 districts for 1994 the authors succeeded in supporting the idea of a spatial nominal wage structure in Germany. Similarly, Mion (2004) extends the Helpman model to include multiple locations and tests its implications on data for Italian provinces. Following a variant of Hanson's empirical

strategy he shows that final demand linkages influence the distribution of earnings and, in contrast to Hanson's findings, that the scope for such spatial externalities need not be limited.

Recently, research on the implications of NEG models on patterns of economic activity in transition countries as well has been undertaken. An important work on studying the regional relocation processes in transition countries has been done by the number of researchers which present their findings in a monograph edited by Traistaru, Nijkamp and Resmini (2003). They find that increasing economic integration of transition countries with the EU during the 1990s has resulted in significant inter-regional relocation of manufacturing activity in selected countries. The winners in this process are either capital regions or western and northern regions that are bordering (or closer to) the large EU markets. In a related study by Crozet and Koenig (2004) data on Romanian regions for the 1991-1997 is used and the authors find that, in line with theoretical predictions, trade liberalization favors the economic development of border regions when the positive effects are not dominated by competition pressure from the international markets.<sup>12</sup> Brühlhart and Koenig (2006) analyze the internal spatial wage and employment structures in five Central European transition economies between 1996 and 2000. It is shown that although wages and location of economic activity comply with NEG predictions, wages are discretely higher in capital regions where the service employment is strongly concentrated. The observed concentration of economic activity in capital regions (termed "the Comecon hypothesis") is significantly stronger than in EU member states. On the other hand, Egger et al (2005) study  $\sigma$ -convergence of regional wages in 8 CEECs. Using data on broad, NUTS-2 regions for the period 1991-1998 they find significant convergence of real wages in Poland and Bulgaria, only. However, they find that countries with faster growing export openness experienced larger increases in their regional disparities lending support to the notion that trade liberalization leads to an initial divergence in regional economic concentration and regional wages.<sup>13</sup>

## 4 The empirical model

A majority of the standard NEG models do not deliver very clear predictions. Most of the models (such as Krugman (1991b), Krugman-Venables (1995)) are suited for the case of two countries only (large vs. small country analysis). At the same time, predictions

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<sup>12</sup>Similar results, with trade liberalization favoring the development of EU-border regions, are also found by Resmini (2003) and Brühlhart, Crozet and Koenig (2004).

<sup>13</sup>Further support for the proposed divergence - convergence type of adjustment of relative wages after trade liberalization is found also at the national level. Polanec (2004) examines the hypotheses of absolute and conditional convergence for a sample of twenty-five transition countries over the period 1990-2002. He finds negative relationship between productivity growth and the pace of liberalization at the initial stage of transition (1990-1994), while at the later stages (1999-2002) evidence is found in favor of convergence of productivity levels among countries under examination.

of these models are not uniform and are subject to multiple equilibria depending on parameter values. In addition, these predictions change substantially with modifications in model assumptions and spatial framework.<sup>14</sup> The implications of two-country models therefore, depending on the assumptions used (factor mobility, intermediate goods, etc), range from complete agglomeration to perfect dispersion of economic activity. Closer to our formulation, the Krugman-Livas Elizondo (1996) model in a two-country three-region framework predicts that a decrease in international transport cost between the countries may foster a monotonic dispersion of economic activity inside the home country. In contrast, Alonso-Villar (2001) in a three-country framework, Monfort and Nicolini (2000) in a two-country four-region framework, and Paluzie (2001) in a two-country three-region framework, argue that trade liberalization is more likely to foster agglomeration of economic activity inside the country opening to trade. Finally, Crozet and Koenig (2004) show in a two-country three-region framework that trade liberalization is likely to favor the development of border regions.

As compared to the above NEG models, our model delivers very clear and unique predictions. After the initial divergence, regions that are located closer to the EU border (western and/or northern regions, W/N regions henceforth) will benefit in the long run from trade liberalization through larger inflows of FDI and domestic relocation of firms due to lower trade costs with the EU and due to lower wages and higher returns to capital relative to the central home region. 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. It is the FDI inflows that crucially determine the speed and the pattern of convergence.

In order to verify whether FDI has had the hypothesized impact on the dynamics of relative regional wages in transition countries after they liberalized trade since 1990 we derive a testable empirical model from our theoretical model. According to (3), relative regional wages ( $w_2/w_1$ ) depend on the relative scope for external economies of scale in both regions (i.e. number of domestic and foreign owned firms ( $n_r = n_r^D + n_r^F$ ), which are initially determined by factor endowments and factor mobility), the relative aggregate demand for the region's varieties (sum of  $Y_r G_r$ ), the elasticity of substitution ( $\sigma$ ) between varieties of manufactured goods, the return to capital ( $i$ ) in both regions as well as home-country inter-regional ( $T$ ) and international ( $T^*$ ) trade costs.

Based on this we can specify our empirical model as:

$$rW = f(rn, ri, time, FTA, BORD) \quad (5)$$

where  $rW$  ( $= w_2/w_1$ ) denotes relative regional wages,  $rn$  ( $= n_2/n_1$ ) is relative number

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<sup>14</sup>A comprehensive overview of alternative NEG models is given in Fujita et al (1999).

of firms in region 2 relative to the capital region,  $ri$  ( $= i_2/i_1$ ) denotes relative regional rental rates. We decompose relative number of firms further into domestic owned  $rn^D$  ( $= n_2^D/n_1^D$ ) and foreign owned firms  $rn^F$  ( $= n_2^F/n_1^F$ ). Hence, by construction,  $rn^F$  indicates relative importance of FDI in region  $r$  relative to the capital region. Given that the vast majority of firm in a given region are domestically owned, the relative regional size is proxied by the relative number of domestically owned firms. The relative regional size also reflects the wider array of agglomeration forces which impact broader spatial distribution of economic activity. As capital mobility is assumed to be greater than mobility of labor, we believe that interest rates are firm-specific rather than region-specific. As is the case with other unobserved firm characteristics, we employ the fixed-effects estimator to account for these variables. For transport/trade cost, we would ideally have time series data on transport cost between regions and with foreign countries as well as time series data on tariffs and other trade barriers for each individual region in the selected countries. However, as no such time-variant indicator of transport/trade cost at the regional level in selected transition countries is available, we try to account for the dynamics of transport/trade cost by including three different variables. We include *time*, which is a time trend, to account for time-related decreasing dynamics of overall transport cost.<sup>15</sup> In addition, we include *FTA*, a dummy variable for enforcement of free trade agreement between individual country and the European Union (EU). *FTA* accounts for speeding up of trade liberalization after the enforcement of FTAs. Finally, *BORD* captures border region specific dynamics of trade liberalization.

Based on the above implications of our model, we examine the spatial repercussions of trade liberalization in transition countries and explain the factors driving the adjustment pattern of regional wages by estimating the following empirical model:

$$rW_{it} = \alpha + \nu t + \omega t^2 + \beta rD_{it} + \phi rFDI_{it} + \gamma BORD_i + \lambda FTA + \varepsilon_{it} \quad (6)$$

where:

$rW_{it}$	relative regional wage (i.e. wage ratio of region $i$ to the capital region)
$t, t^2$	time effects (i.e. linear and squared time trend)
$rD_{it}$	relative size of a region calculated as the relative number of domestically owned firms in region $i$ relative to the capital region
$rFDI_{it}$	relative regional FDI calculated as the relative number of foreign owned firms in region $i$ relative to the capital region
$BORD_i$	dummy for western/northern border regions
$FTA$	dummy for enforcement of trade liberalization with the EU
$\varepsilon_{it}$	iid error term.

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<sup>15</sup>The empirical specification also includes higher order values of time trends to test for the possible concavities of the temporal response of relative regional wages.

Note that as it follows from the previous discussion and from the empirical model, 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.

We expect following pattern of coefficients in our empirical model. First, in general, trade liberalization should cause a divergence of relative regional wages, but depending on the length of the datasets and the strength of dispersion forces this divergence might be overcome after certain time period. We therefore expect either a significantly negative or non-significant coefficient of the  $FTA$  variable, depending on the length of the datasets. Second, regional data for transition countries should exhibit an U-shaped curve of relative regional wages. We therefore expect a significant negative sign of the trend variable  $t$  and a significant positive sign of the squared trend variable  $t^2$ . Third, regional pattern of FDI inflows should have a significant impact on the above adjustment pattern of relative regional wages. Given the model specification we therefore expect a positive significant coefficient of the  $rFDI_{it}$  variable. And fourth, after the initial divergence W/N border regions should exhibit a faster convergence and higher levels of relative wages as compared to non-border regions. We therefore expect a significant positive coefficient of the border variable  $BORD_i$ .

The methodological issues related to estimation of (6) as well as the estimation approaches used are discussed in the Section presenting the results. Before presenting and discussing the results we discuss the data and descriptive statistics of the crucial variables in the empirical model.

## 5 Data and descriptive statistics

### 5.1 Data

We analyze propositions of our NEG model by using regional data for five transition countries that became EU members in 2004 and 2007. These countries are Bulgaria, Estonia, Hungary, Romania and Slovenia. Choice of countries is not completely arbitrary; it is simply subject to availability and quality of the data. Countries examined in our study are very 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 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 used in this paper have been collected during two research projects on re-

gional pattern of production relocation in transition countries.<sup>16</sup> The data for all countries are collected both at the NUTS-2 and NUTS-3 levels which, as opposed to other regional studies on transition countries, allows for a more precise analysis of the spatial repercussion of trade liberalization in these countries.<sup>17</sup>

Table 1 gives more information on our datasets, such as the number of regions and time of enforcement of trade liberalization with the EU (FTA). We make use of long panels of regional data at the NUTS-3 level with data starting in the early 1990s and ending as recently as possible. Due to different data availability periods covered by the datasets for individual countries do not overlap completely. For Bulgaria and Hungary our datasets cover the period 1990-1999, for Romania our dataset covers the period 1992-1999, while for Estonia and Slovenia, our datasets cover the period 1992-2004 and 1994-2003, respectively. Number of NUTS-3 regions which serve as our units of observations ranges between 12 (Slovenia) and 41 regions (Romania). Wage data are recalculated into 1994 constant prices using PPI indices. We take account of data for the manufacturing sector only, as other sectors are far less subject to trade liberalization.

Table 1: Coverage of regional data by countries

	<b>BG</b>	<b>EE</b>	<b>HU</b>	<b>RO</b>	<b>SI</b>
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	166

\* NUTS-3 regions in Slovenia

\*\* NUTS-5 regions in Slovenia

In the empirical estimations, regional data at the more disaggregated NUTS-3 level is taken for individual observations. While wage data and data on FDI do not require further explanation, some clarifications should be made with regard to the trade liberalization variable *FTA*. Unfortunately, with the exception of Slovenia, we are lacking data on the evolution of actual foreign trade barriers over the period under examination 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. But as no such data is available,

<sup>16</sup>PHARE ACE Programme research project "European integration, regional specialisation and location of industrial activity in accession countries" (Contract No. P98-1117-R) and the RTD 5th FP research project EURECO "The impact of European integration and enlargement on regional structural change and cohesion" (Contract No. HPSE-CT-2002-00118). Both projects have been financed by the European Commission.

<sup>17</sup>Another advantage of this paper is that we have access to longer panels of regional data as compared to previous studies on transition countries. In this way we believe to have the opportunity to study the complete adjustment pattern of regional economic activity and wages and the underlying factors affecting these processes.

we must rely on 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 (Slovenia) 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.

## **5.2 Evolution of relative regional wages**

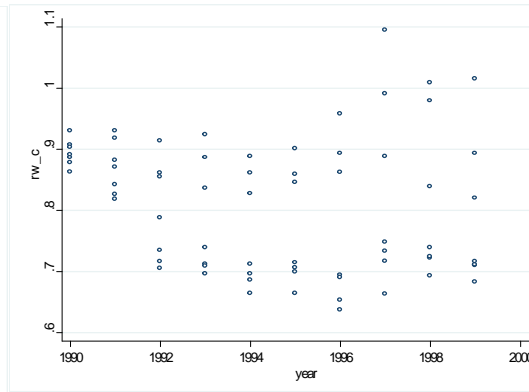
In this section, we examine the evolution of relative regional wages by individual countries. Graphic analysis depicted in Figure 2 combined with some descriptive statistics in Table A1 (in the Appendix) give us a clear insight into the pattern of relative wages after countries liberalized trade with the EU. Figure 2 reveals that all countries, with the exception of Bulgaria, experienced significant dispersion of regional wages already before the trade liberalization started. In the early 1990s, the standard deviation of regional wages in all countries was between 0.08 and 0.10 (i.e. between 9 and 15 per cent when measured with the coefficient of variation), with the exception of Bulgaria where it was below 5 per cent. On the other hand, in the early 1990s the average relative regional wage (measured by the mean or median) as compared to the central region was quite high in Bulgaria, Romania and Slovenia (92, 95 and 87 per cent, respectively), but lower in Hungary (82 per cent) and Estonia where it was only about 67 per cent of that in the central region.



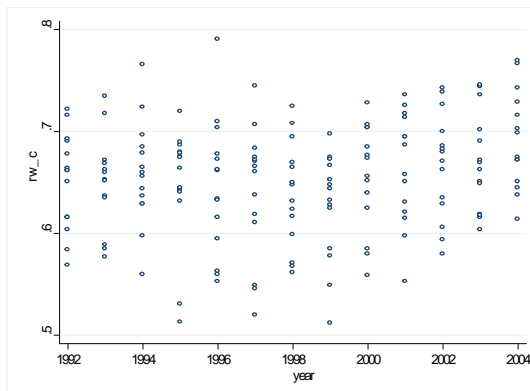
Figure 2: Pattern of relative regional wages in transition countries, 1990-2004



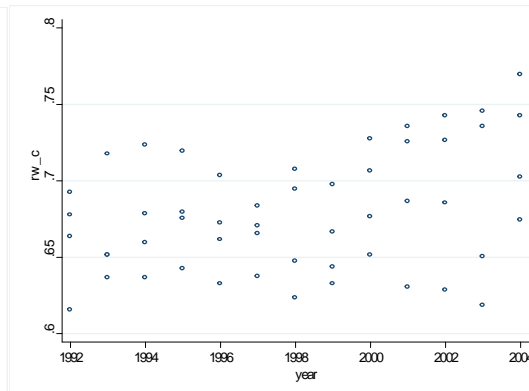
Bulgaria - all regions



Bulgaria - W/N border regions



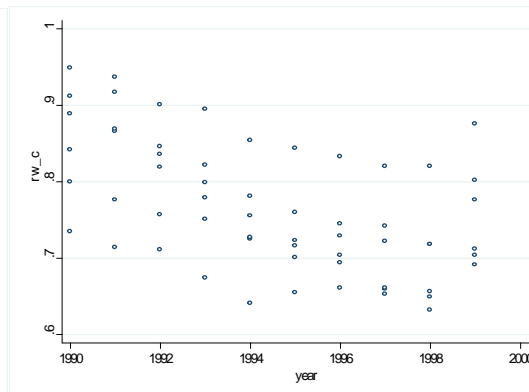
Estonia - all regions



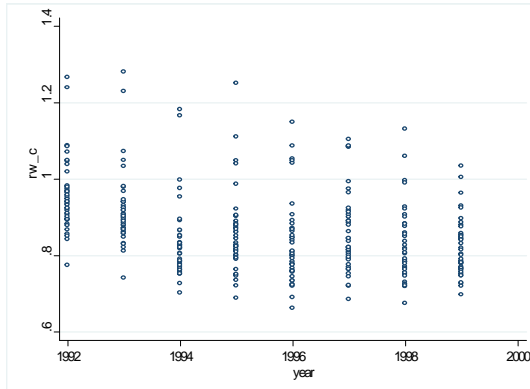
Estonia - W/N border regions



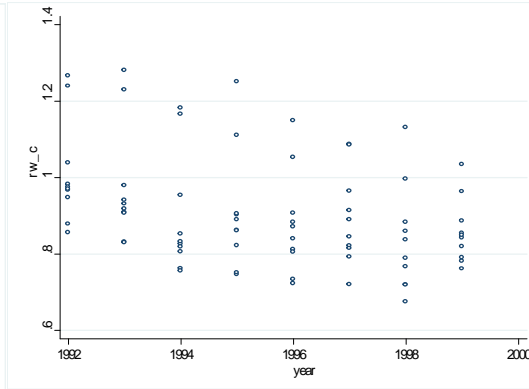
Hungary - all regions



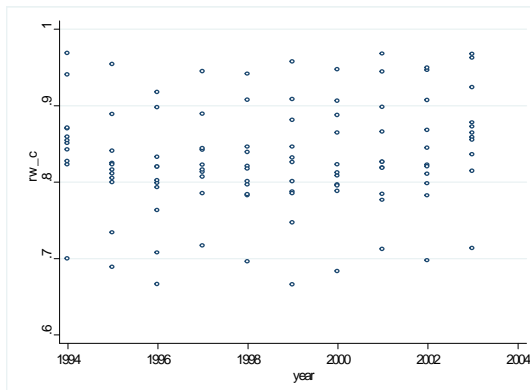
Hungary - W/N border regions



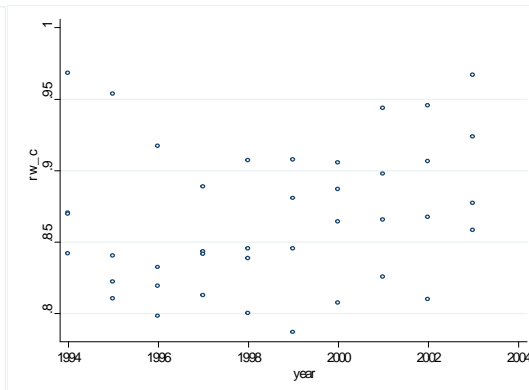
Romania - all regions



Romania - W/N border regions



Slovenia - all regions



Slovenia - W/N border regions

In line with the predictions of our model, most of the countries' relative regional wages have declined in the course of trade liberalization. In Bulgaria, Hungary and Romania the decline in the average relative regional wages until 1999 was very large - by 14 to 15 per cent relative to the central region. Only in Estonia and Slovenia relative regional wages have increased over the period - by 1 per cent in Slovenia and 5 per cent in Estonia. One has to bear in mind, however, that for Slovenia and Estonia we can track changes in regional wages until 2003 and 2004, respectively, while for the other three countries we can only observe pattern of regional wages until 1999. This may be very important since - as revealed by the Figure 2 and 3a - the evolution of relative regional wages in all of the examined countries seems to follow an U-shaped adjustment pattern. One can therefore expect that relative wages in Bulgaria, Hungary and Romania to have recovered after 1999 when our data sets end. Indeed, in Bulgaria and Romania, the lowest point in divergence of regional wages was reached in 1996, in Hungary in 1998, and in Estonia and Slovenia in 1999. Afterwards in all of the countries relative regional wages have recovered and started converging to the wage level in the central region. Furthermore, Figures 3a and 3b demonstrate that along with the process of recovering of the average relative regional wages one can also observe a clear trend of  $\sigma$ -convergence shown in the fact that standard

deviation of regional wages decreased in all of the countries after regional wages reached the lowest point. In other words, one can simultaneously observe a U-shaped adjustment pattern of relative regional wages and an inverted U-shaped trend of variation of regional wages. This can be taken as an indication of  $\sigma$ -divergence of regional wages in the very first stage of trade liberalization and of  $\sigma$ -convergence of regional wages towards the end of the period under examination. We believe that with longer time panels of regional data these trends will become even more pronounced.

Figure 3: Properties of relative regional wages (means and standard deviations), by countries, 1990-2004

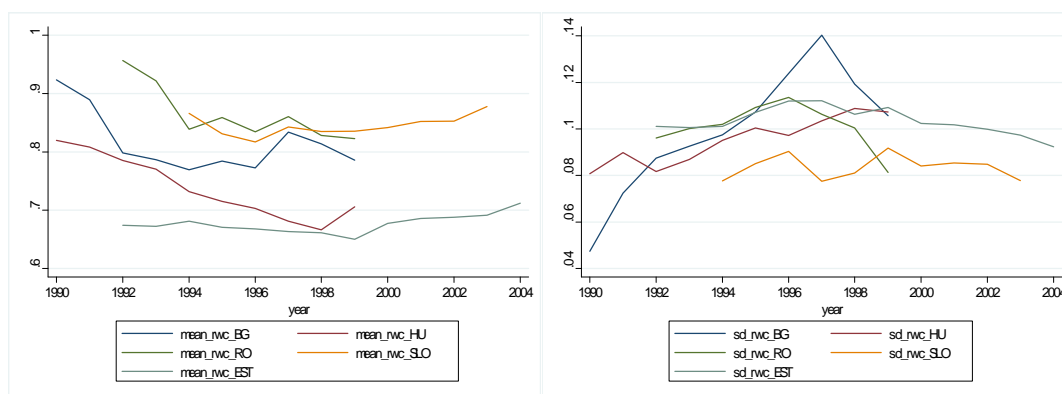
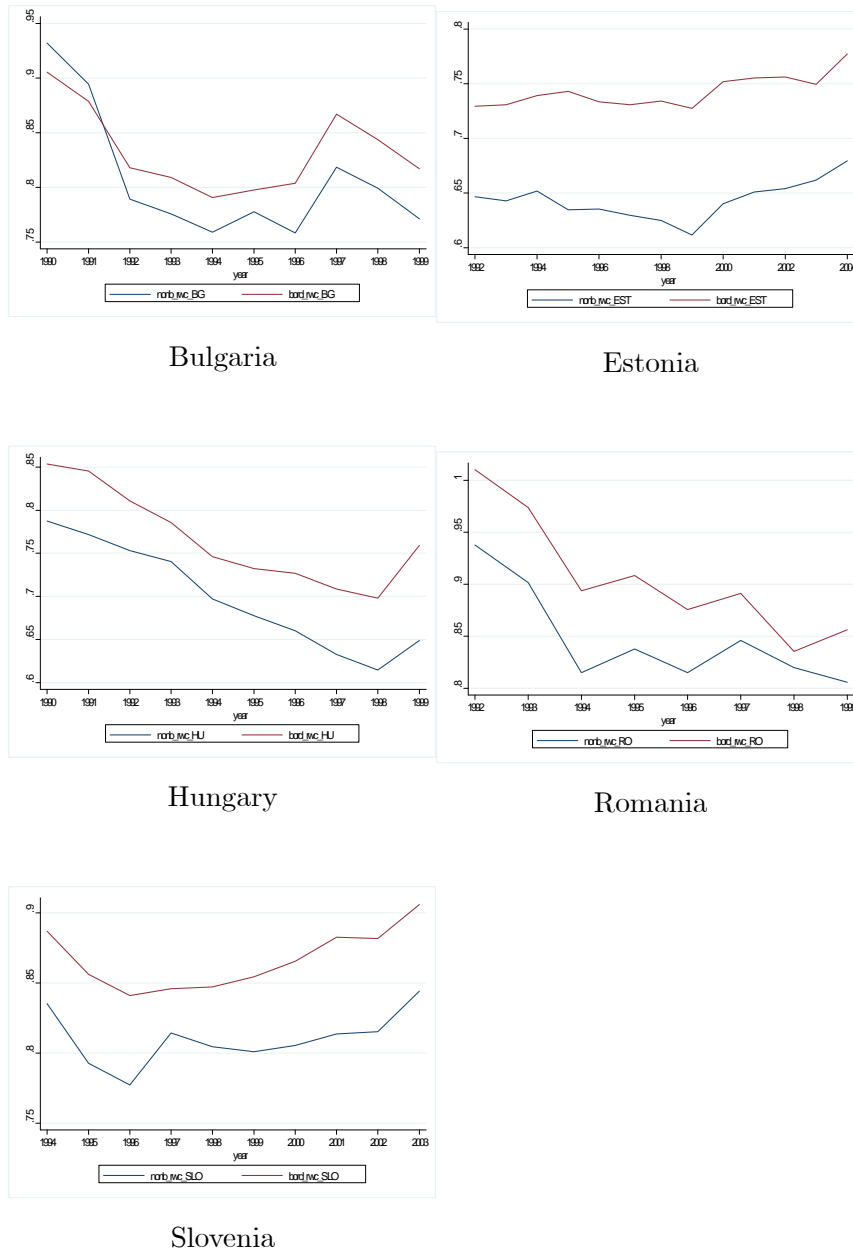


Figure 3a: Means

Figure 3b: Standard deviations

Second important issue that requires closer examination are the differences in adjustment pattern of relative wages between W/N border and non-border regions. Our model predicts that after the initial downturn W/N border regions will attract new firms and start catching up with the central region at a faster pace than non-border regions. A number of studies for individual transition countries (Traistaru, Nijkamp and Resmini (2003)) confirm these predictions by showing a clear trend of shifting manufacturing activity towards either the capital or the W/N border regions during the 1990s. As a consequence, relative regional wages adjusted accordingly. Figure 4 reveals that after countries opened up to trade relative wages in W/N border regions have decreased at a lower rate and have started recovering earlier and at a faster pace than non-border regions. These trends are particularly pronounced in Bulgaria, Estonia, Hungary and Slovenia. With the exception of Romania, in all countries the wage differential between the W/N border and non-border regions increased over the period. It remains to be shown how much of this faster adjustment pattern in W/N border regions can be attributed to increased economic activity brought about by FDI.

Figure 4: Mean relative regional wages in W/N border and non-border regions, by countries, 1990-2004



### 5.3 Evolution of relative regional FDI

As revealed in Table 2, 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 (World Investment Report, 2001). 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 2: Inward FDI stock as percentage of GDP, by countries, 1990-2004 (in %)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
<b>Bulgaria</b>	1	2	2	2	4	3	6	10	13	19	18	20	24	25	32
<b>Estonia</b>	...	...	5	15	12	19	19	25	35	47	51	56	65	79	85
<b>Hungary</b>	2	6	9	14	17	25	29	39	44	48	49	53	56	58	61
<b>Romania</b>	2	3	4	4	4	2	3	7	10	15	18	19	17	23	25
<b>Slovenia</b>	...	...	7	8	9	10	10	11	13	13	15	13	19	16	25

Source: UNCTAD, World Investment Report 2001-2006.

As we assume in our 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. Figure 5 depicts the pattern of relative regional presence of foreign investment firms (FIEs)<sup>18</sup> in W/N border and non-border regions in individual countries.<sup>19</sup> 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 considerable cautiousness. As we only deal with the data on number of firms and not with the data on their output, this may introduce some bias into our findings.

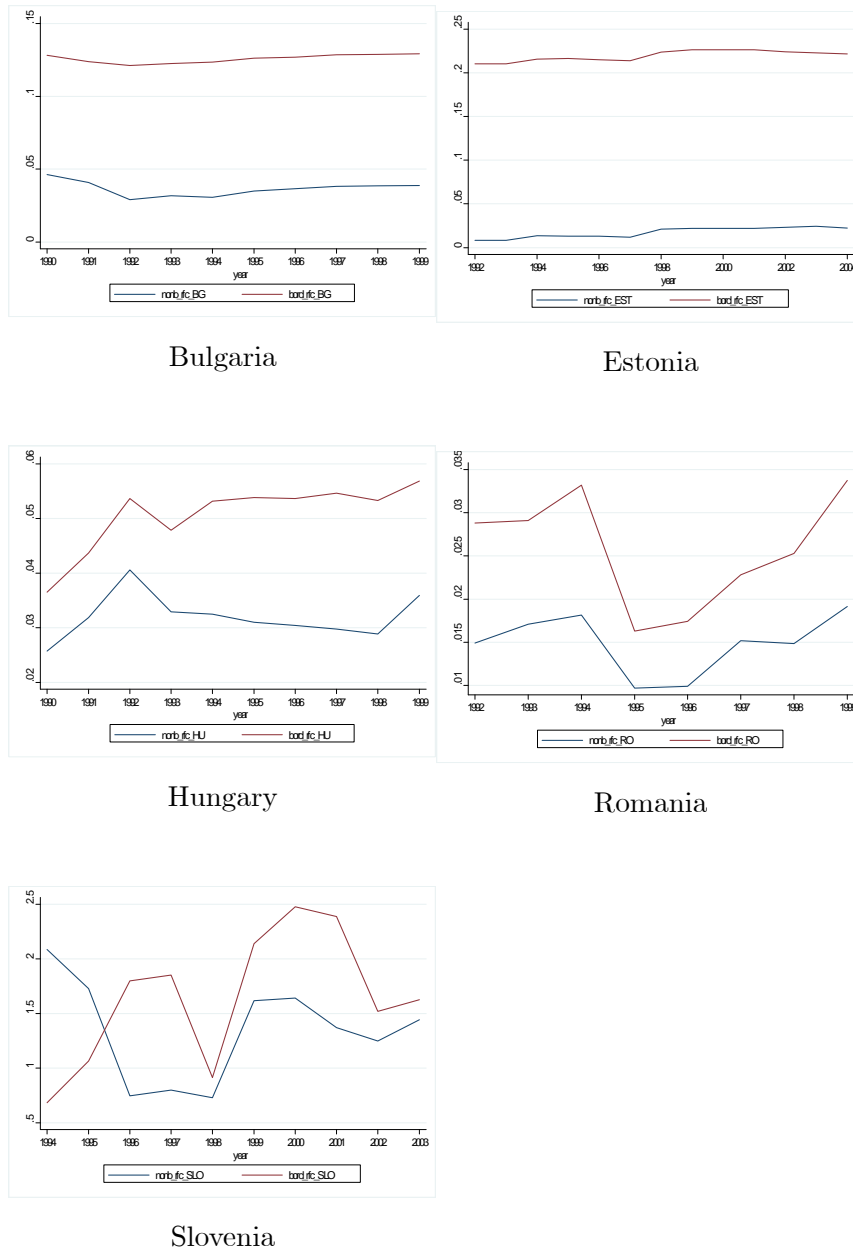
Figure 5 shows that, with the noted exception of Slovenia, FDI inflows in transition countries are very polarized since the vast majority of FDI inflows into manufacturing industries is directed into the capital region. On average, the share of FDI by regions is well below 10 per cent, in Romania even below 5 per cent of the level achieved by the central region. This evidence is in line with findings of Alessandrini and Contessi (2001) who found that the majority of FDI inflows in transition countries have been directed into the central regions and traditional economic centers.<sup>20</sup> Nevertheless, the regional pattern of manufacturing FDI does, by and large, correspond to the one suggested by our model. First of all, in all five countries relative regional shares of FDI in W/N border regions are substantially (up to 3-times) higher than in non-border regions. And second, this differential has further increased along the process of trade liberalization as W/N border regions succeeded in attracting relatively more FDI than non-border regions. To sum up, as W/N border regions continue to receive larger FDI inflows than other peripheral regions they should therefore exhibit relatively faster economic growth and faster catch up of relative wages compared with the central region.

<sup>18</sup>We consider all enterprises where foreign ownership constitutes at least 10 per cent of the ownership structure as foreign owned enterprises.

<sup>19</sup>Refer to Table A2 in Appendix for more detailed descriptives statistics on regional pattern of FDI.

<sup>20</sup>In the late 1990s some governments (e.g. Bulgaria and Romania) started to actively attract foreign capital into dissadvantaged and poorer regions, which will likely benefit all regions.

Figure 5: Mean relative regional FDI in W/N border and non-border regions, by countries, 1990-2004



## 6 Results

### 6.1 Econometric approach

Before we turn to the estimation results of our empirical model (6), a few words need to be said about the methodology of estimations. There are two important issues to be discussed with respect to the specification of the model (6). The first issue refers to the importance of idiosyncratic regional effects in the panel data framework due to the

specific structure of the error term, and the second one refers to a problem of potential endogeneity between relative regional wages and FDI.

First, in the above empirical model strong individual regional effects can be expected. Therefore, one must make specific assumptions regarding the error structure. We assume the error term  $u_{it}$  has following properties:

$$\begin{aligned} u_{it} &= \eta_i + e_{it} & (i = 1, \dots, n; t = 1, \dots, T) \\ E[\eta_i | x_{it}] &\neq 0 & \text{and} & E[e_{it} | x_{it}, \eta_i] = 0 \\ e_{it} &\sim N(0, \sigma^2) & & \end{aligned} \tag{7}$$

According to (7), we assume that some unobserved individual regional effects are present ( $\eta_i$ ), which are time invariant and correlated with the right-hand-side regressors in (6). The remaining disturbances ( $e_{it}$ ) are assumed to be normally distributed with zero mean and constant variance. Note that for sake of convenience, henceforth we will refer to specification (6) as the static specification of the model. Our data is structured as regional panel data for a time span of 7 to 13 years (depending on the country in question), which requires an explicit account of the region specific effects. With the above structure of the model the use of ordinary least squares (OLS) estimator is not justified anymore, but one should refer to one of the usual estimators dealing with individual effects. In general, using static specification of the empirical model in the panel data framework there are two well-known ways of controlling for this bias. The first option is to employ 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. We are interested in observing the pattern of changes in relative regional performance over time induced by external shocks such as trade liberalization. Given that different regions are likely to respond idiosyncratically to trade liberalization, the FE estimator seems the natural choice. Therefore, in (7) we have specified our assumptions about the structure of the error term, which enables us to take explicit control of these effects. 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 and the trade liberalization dummy). When performing regular FE estimations these variables are differenced out and therefore dropped from the estimation procedure. In order to avoid this, we employ the RE estimator as it allows us to obtain estimates of the time-invariant *BORD* and *FTA* variables as well.

Another important issue refers to the fact that though we imply that FDI is an exogenous occurrence in the model the actual regional pattern of FDI inflows is not independent of regional characteristics. On the contrary, regional pattern of FDI is determined endogenously as it is attracted to domestic regions according to either the agglomeration forces

or to lower relative regional wages. An important consequence of this is the endogeneity between relative regional wages ( $rW_{it}$ ) and relative regional FDI ( $rFDI_{it}$ ) in the specification of our model. This means that model (6) captures dynamic processes in the regions as the current inflow of FDI is determined endogenously by previous relative regional wages, and present FDI determines the future relative regional wages. More specifically, the endogeneity between  $rW_{it}$  and  $rFDI_{it}$  implies that the error term  $u_{it}$  is correlated with  $rFDI_{it}$ . This can be seen clearly if the error term  $u_{it}$  is rewritten accordingly:

$$u_{it} = \eta_i + (\nu_{it} + m_{it}) \quad (i = 1, \dots, n; t = 1, \dots, T) \quad (8)$$

with the assumptions:

$$\nu_{it} = \rho\nu_{it-1} + e_{it}$$

$$e_{it}, m_{it} \sim \text{MA}(0)$$

where the remaining error term  $e_{it}$  is decomposed into  $\nu_{it}$  which is an autoregressive regional shock, while  $m_{it}$  represents serially uncorrelated measurement error. Note that all RHS regressors of the model (6) are potentially correlated with region-specific effects  $\eta_i$  as well as with both autoregressive shocks  $\nu_{it}$  and measurement errors  $m_{it}$ .

The time dimension of panel data enable us to capture these dynamics of adjustment directly by including the lagged dependent as well as lagged independent variables. Hence, a dynamic version of the relative regional wage model (6) can then be written as:

$$\begin{aligned} rW_{it} = & \rho rW_{it-1} + \nu t + \omega t^2 + \beta rD_{it} + \rho\beta rD_{it-1} + \phi rFDI_{it} + \rho\phi rFDI_{it-1} \\ & + \gamma BORD_i + \lambda FTA + \eta_i(1 - \rho) + e_{it} + (m_{it} - \rho m_{it-1}) \end{aligned} \quad (9)$$

In the above dynamic specification of the model we deal with the perfect simultaneity as not only present and lagged dependent variables are correlated, but also lagged dependent variable (wages) are assumed to be correlated with present independent variables (FDI), and vice versa. Applying OLS estimator to the model specification (9) would inevitably lead to inconsistent and biased coefficients. The OLS estimator is unbiased and consistent when all explanatory variables are exogenous and are uncorrelated with the individual specific effects. This, however, is not the case in our model, which includes lagged variables. One can show that the OLS estimator will be seriously biased due to correlation of the lagged dependent variable with the individual specific effects as well as with the independent variables. This is due to the fact that  $rW_{it}$  is a function of  $\eta_i$  in (9), and then  $rW_{it-1}$  is also a function of  $\eta_i$ . As a consequence,  $rW_{it-1}$  is correlated with the error term, which renders the OLS estimator biased and inconsistent, even if the  $\nu_{it}$  and  $m_{it}$  in (8) are not serially correlated. This holds also whether the individual effects are considered fixed or random (see Hsiao 1986, Baltagi 1995, Wooldridge 2002).

Therefore, in estimating (9) one should refer to one of the usual instrumental variable



methods that are applied in the dynamic panel data framework. A natural choice of approach that allows for controlling for the unobserved heterogeneity and simultaneity in (9) is the application of GMM (general method of moments) estimators. There are two possible choices of application of the GMM approach to dynamic panel data. Difference GMM (diff-GMM) method uses lagged levels as instruments for first-differenced equation. However, as shown by Arellano and Bover (1995), lagged level instruments used in diff-GMM approach are weak instruments for first-differenced equation. Arellano and Bond (1998), and Blundell and Bond (1998, 1999) suggest that an application of the system GMM (sys-GMM) estimators is a more appropriate approach to dynamic panel data than using diff-GMM estimators. If model is estimated in levels, corresponding instruments for  $x_{it-3}$  are  $x_{it-1}$ ,  $x_{it-2}$  and  $\Delta x_{it-1}$  (where  $x$  stands generally for all included variables), and so on for higher time periods. This approach allows for a larger set of lagged levels' and first-differences' instruments and therefore to exploit fully all of the available moment conditions. Hence, the system GMM approach maximizes both the consistency as well as the efficiency of the applied estimator. The only drawback of the sys-GMM approach to dynamic panel data is that either balanced panel data or longer time series are required since the first two years of observations are used up as instruments.

## 6.2 Results of the static model specification

In this section we provide basic estimation results of our empirical model (6) using OLS and RE estimator.<sup>21</sup> Table 3 provides OLS estimations which serve as a benchmark for comparison with RE estimations as well as for the GMM estimations following in the next subsection. Note that we provide estimations of the model (6) both with and without the initial level of the dependent variable ( $irW_{it}$ ). This is to check the robustness of the coefficients of main explanatory variables. As expected, the evolution of relative regional wages is determined by the initial relative performance of individual regions relative to the capital region. With the initial relative regional wages excluded from the model, the coefficients of main variables increase, while their signs remain fairly robust. It is only in the case of Bulgaria and Hungary, where the sign of the coefficient on the relative regional size proxied by the relative number of domestically owned firms ( $rD_{it}$ ) is affected by the initial relative regional wages. On the other side, the sign of the coefficient on relative regional importance of FDI ( $rFDI_{it}$ ) seems to be unaffected by the initial relative regional wages.

Overall, the OLS results are in line with our expectations and can be summarized as follows. First, in all countries, with the exception of Romania, estimations return negative and significant coefficient for trend variable  $t$  and positive and significant coefficient on

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<sup>21</sup>In order to assess robustness of the estimated coefficients on the impact of FDI on wages ( $rFDI_{it}$ ) we also ran FE estimates. We find the sign and significance (but not the size) of the  $rFDI_{it}$  coefficients very closely resemble those obtained by the RE estimations.

squared trend variable  $t^2$ .<sup>22</sup> This result confirms our predictions of an U-shaped response of relative regional wages to trade liberalization.

Second, in all countries, with the exception of Hungary, the estimated coefficient of relative regional FDI ( $rFDI_{it}$ ) is significantly positive. Hence, FDI is shown to contribute positively to the actual pattern of adjustment of regional wages. Regions with relatively higher shares of foreign firms relative to the capital region have experienced higher growth of relative wages. In other words, foreign owned firms in individual regions seem to helped at restructuring the regional manufacturing sectors and gave rise to the relative regional wages. For Hungary, the finding of insignificant impact of FDI on regional wages comes as a surprise, since Hungary has attracted large inflows of foreign capital during 1990s. The obvious explanation for this finding is that the vast majority of FDI in Hungary has been directed to the central region, and has, in turn, not contributed to regional convergence of wages. Note, that the positive impact of FDI is confirmed in addition to the relative regional size proxied by the number of domestic firms, which by large determine the relative regional wages.

Table 3: Impact of trade liberalization and FDI on the adjustment pattern of relative regional wages in transition countries [OLS estimates]

	Pooled	Pooled	BG	BG	EE	EE	HU	HU	RO	RO	SI	SI
$rW_{it}$	0.816		1.137		0.298		0.834		0.568		0.727	
	[31.57]***		[8.11]***		[5.40]***		[16.83]***		[12.38]***		[10.10]***	
$t$	-0.047	-0.043	-0.050	-0.079	-0.038	-0.038	-0.052	-0.047	-0.004	-0.002	-0.043	-0.039
	[12.96]***	[8.30]***	[4.03]***	[5.93]***	[6.43]***	[5.72]***	[6.36]***	[3.19]***	[0.48]	[0.14]	[3.76]***	[2.39]**
$t^2$	0.003	0.003	0.003	0.005	0.002	0.002	0.003	0.002	-0.000	-0.001	0.004	0.003
	[12.06]***	[7.48]***	[3.98]***	[5.65]***	[6.70]***	[6.08]***	[4.15]***	[2.09]**	[0.06]	[0.72]	[4.30]***	[2.81]***
$rFDI_{it}$	0.048	0.091	0.191	0.709	1.207	0.928	0.051	0.531	0.315	0.766	0.022	0.018
	[10.02]***	[13.96]***	[1.61]	[4.78]***	[4.60]***	[3.20]***	[0.21]	[1.29]	[2.19]**	[4.38]***	[4.48]***	[2.60]**
$rD_{it}$	-0.047	0.129	-0.907	0.294	-0.019	0.069	-0.357	3.884	0.020	0.078	0.087	0.176
	[6.47]***	[19.75]***	[1.70]*	[0.54]	[0.16]	[0.52]	[0.33]	[2.37]**	[0.57]	[1.65]*	[2.04]**	[2.96]***
$BORD_{it}$	0.009	0.024	0.045	0.015	0.031	0.035	0.009	0.084	-0.004	0.013	0.011	0.052
	[2.12]**	[4.00]***	[4.06]***	[1.47]	[4.64]***	[4.97]***	[0.82]	[6.54]***	[0.50]	[1.32]	[1.17]	[4.11]***
$FTA_{it}$	0.020	-0.003	0.034	0.021	0.031	0.019	0.031	-0.002	-0.074	-0.054	0.047	0.048
	[2.55]**	[0.29]	[2.18]**	[1.21]	[1.95]*	[1.00]	[1.83]*	[0.05]	[6.82]***	[3.35]***	[2.18]**	[1.57]
$Constant$	0.238	0.776	0.812	0.678	0.530	0.731	0.559	-3.124	0.339	0.760	0.272	0.812
	[12.75]***	[71.78]***	[1.60]	[1.27]	[12.19]***	[46.72]***	[0.51]	[1.86]*	[6.00]***	[13.84]***	[4.69]***	[25.61]***
Observations	1002	1002	232	232	144	144	177	177	208	208	103	103
R-sq	0.71	0.42	0.63	0.49	0.46	0.41	0.82	0.52	0.63	0.36	0.68	0.34
Bootstrap reps	500	500	500	500	500	500	500	500	500	500	500	500

Notes: (a) dependent variable: relative regional wage  $rW_{it}$ , i.e. wage in the  $i$ -th region relative to the capital region; (b) Robust t-statistics in brackets. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

Third, coefficient  $BORD$  is significantly positive in all countries with the exception of Romania indicating that W/N border regions do have higher wages due to higher economic concentration. Wage differential between W/N border regions and the remainder

<sup>22</sup>Time trend variables to the third and fourth power have also been included in various specifications further confirming the empirical relevance of the proposed U-shaped response curve.

of regions ranges between 1.5 and 8.2 per cent depending on the country in question, while the average wage premium of W/N border regions over all of the countries amounts to 2.4 per cent (with the initial relative wages excluded). And fourth, the evidence of negative impact of trade liberalization under the FTAs with the EU is being found only in the case of Romania. This can be explained by the fact that the decline of relative regional wages went along with the general economic decline in each of the countries, which took place several years before the formal FTAs with the EU were initiated.

The RE estimations (see Table 4) which control for common regional effects almost entirely replicate the above discussed OLS estimations. Again, an U-shaped response of relative regional wages to trade liberalization is confirmed for all countries except Romania. Estimated coefficients of all relevant variables are slightly higher than in case of OLS. The average wage differential between W/N border and non-border regions over all of the countries is estimated to 3.0 per cent (in comparison to 2.4 per cent in case of OLS estimates). These estimates are similar to those obtained by Brühlhart and Koenig (2006) who estimate average wage gradients of border regions in five transition countries to 2.7 per cent.<sup>23</sup>

Table 4: Impact of trade liberalization and FDI on the adjustment pattern of relative regional wages in transition countries [Random effects estimates]

	Pooled	Pooled	BG	BG	EE	EE	HU	HU	RO	RO	SI	SI
$irW_{it}$	0.804 [16.57]***		1.354 [5.91]***		0.274 [5.73]***		0.829 [19.85]***		0.576 [15.06]***		0.753 [11.30]***	
$t$	-0.042 [15.28]***	-0.046 [16.38]***	-0.031 [2.61]***	-0.042 [3.48]***	-0.032 [5.05]***	-0.032 [5.26]***	-0.049 [7.60]***	-0.049 [6.22]***	-0.004 [0.44]	-0.003 [0.43]	-0.041 [4.29]***	-0.041 [4.23]***
$t^2$	0.003 [14.80]***	0.003 [15.79]***	0.002 [2.83]***	0.003 [3.61]***	0.002 [5.90]***	0.002 [6.22]***	0.003 [4.91]***	0.003 [3.98]***	-0.000 [0.05]	-0.000 [0.31]	0.003 [4.84]***	0.003 [4.94]***
$rFDI_{it}$	0.039 [6.14]***	0.042 [5.90]***	0.522 [1.97]**	0.640 [2.20]**	0.686 [2.14]**	0.651 [2.02]**	-0.176 [0.97]	0.282 [1.56]	0.138 [0.84]	0.364 [1.67]*	0.012 [2.91]***	0.011 [2.61]***
$rD_{it}$	-0.044 [3.36]***	0.089 [6.23]***	-1.853 [3.96]***	-1.370 [2.84]***	0.042 [0.29]	0.063 [0.41]	0.556 [0.50]	0.869 [0.74]	0.003 [0.12]	0.014 [0.47]	0.023 [0.66]	0.029 [0.72]
$BORD_{it}$	0.006 [0.62]	0.030 [1.84]*	0.048 [2.64]***	0.009 [0.43]	0.034 [6.26]***	0.038 [7.13]***	0.007 [0.74]	0.062 [7.23]***	-0.003 [0.43]	0.009 [1.22]	0.012 [1.93]*	0.051 [7.55]***
$FTA_{it}$	0.004 [0.65]	0.005 [0.88]	0.046 [3.82]***	0.042 [3.31]***	0.028 [1.36]	0.027 [1.11]	0.020 [1.31]	0.017 [0.99]	-0.076 [8.54]***	-0.071 [6.91]***	0.044 [2.84]***	0.044 [3.04]***
$Constant$	0.243 [6.85]***	0.824 [53.04]***	1.550 [3.34]***	2.322 [4.88]***	0.527 [14.41]***	0.703 [29.52]***	-0.384 [0.34]	-0.054 [0.04]	0.353 [7.47]***	0.862 [22.98]***	0.275 [4.98]***	0.858 [35.89]***
Observations	1002	1002	232	232	144	144	177	177	208	208	103	103
R-sq	0.71	0.39	0.62	0.47	0.45	0.39	0.82	0.49	0.63	0.34	0.66	0.28
Bootstrap reps	500	500	500	500	500	500	500	500	500	500	500	500

Notes: (a) dependent variable: relative regional wage  $rW_{it}$ , i.e. wage in the  $i$ -th region relative to the capital region; (b) Robust t-statistics in brackets. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

<sup>23</sup>Note, however that Brühlhart and Koenig (2006) estimate wage gradients for a different set of transition countries (Czech Republic, Hungary, Poland, Slovenia and Slovakia) and for a different time period (1996-2000).

### 6.3 Results of the dynamic model specification

In this section we provide robustness checks for the OLS and RE estimations by estimating the dynamic specification of the model (9). We apply the sys-GMM econometric method by allowing for instruments (levels and first differences) to take up to 4 lags. In Table 5 we report estimations of the coefficients taken from the first step estimations, while the specification tests are taken from the second step estimations.<sup>24</sup> Identically to the OLS and RE estimations, the GMM estimations also confirm an U-shaped response of relative regional wages to trade liberalization in all countries except Romania. Furthermore, GMM estimations corroborate our previous findings that in at least 3 out of 5 countries this U-shaped response of relative regional wages is being driven in an important extent by the FDI. The only difference with respect to the OLS and RE estimations is that the GMM estimations return a marginally insignificant coefficient of relative regional FDI for Estonia. For the other three countries, Bulgaria, Romania and Slovenia, the positive and significant coefficient on FDI remains fairly robust.also to the GMM approach. Of the other variables of importance, the border wage premium is being estimated to 2.5 per cent on average of the five countries, which is closer to the OLS than to the RE estimates. The same is true for individual country estimations of wage gradients of border regions, which are slightly lower than those obtained by the OLS and RE estimations. The largest wage differential in W/N border region relative to the non-border regions is being estimated in Hungary (8.6 per cent), followed by Slovenia (5.3 per cent) and Estonia (3.5 per cent), while for Bulgaria and Romania the border coefficients are insignificant (but lower than the average).

These findings are in line with the predictions of the Crozet-Koenig (2004) model showing that trade liberalization generally favors the development of the border region when competition pressure from international markets is not too high. Crozet and Koenig also use data for Romanian NUTS-3 regions for the period 1990-1997 and claim to confirm this thesis. They, however, test a different model not directly comparable to ours. They show that urbanization of the regions is driven by their initial state of urbanization and initial market potential, while high nominal wage level in particular is shown to favor urban growth. This means that trade liberalization fosters growth of the existing economic centers in Romania. This finding is in line with our results as we don't find higher wage levels in the Romanian W/N border regions indicating that there was not much relocation of economic activity towards border regions after trade liberalization started.

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<sup>24</sup>In Table 5 we omit reporting the coefficients on the lagged relative regional FDI and lagged relative regional size ( $rFDI_{it-1}$  and  $rD_{it-1}$ , respectively).

Table 5: Impact of trade liberalization and FDI on the adjustment pattern of relative regional wages in transition countries [GMM estimates]

	<b>Pooled</b>	<b>BG</b>	<b>EE</b>	<b>HU</b>	<b>RO</b>	<b>SI</b>
$rW_{it}$	0.083 [1.24]	0.228 [3.22]***	0.418 [3.89]***	0.451 [3.31]***	-0.204 [-1.42]	0.035 [0.20]
$t$	-0.041 [7.46]***	-0.079 [3.52]***	-0.026 [4.28]***	-0.033 [4.58]***	0.001 [0.13]	-0.039 [4.51]***
$t^2$	0.002 [6.47]***	0.005 [3.58]***	0.002 [4.83]***	0.001 [2.58]***	-0.001 [1.31]	0.003 [5.03]***
$rFDI_{it}$	0.071 [4.88]***	0.679 [2.19]**	0.835 [1.52]	0.617 [0.79]	0.657 [2.57]**	0.019 [2.08]**
$rD_{it}$	0.104 [6.81]***	0.216 [0.22]	0.118 [0.43]	4.231 [1.41]	0.065 [1.73]*	0.164 [1.72]*
$BORD_i$	0.025 [1.76]*	0.016 [0.55]	0.035 [2.51]**	0.086 [2.48]**	0.010 [0.51]	0.053 [1.92]*
$FTA$	0.002 [0.21]	0.022 [1.76]*	-0.010 [0.54]	-0.018 [0.65]	-0.080 [12.09]***	0.051 [5.22]***
<i>Constant</i>	0.796 [52.59]***	0.757 [0.76]	0.706 [40.11]***	-3.504 [1.14]	0.799 [18.08]***	0.811 [24.73]***
Observations	1002	232	144	177	208	103
Hansen [p]	0.43	0.27	0.17	0.21	0.14	0.65
Chi2 [p]	0.00	0.00	0.00	0.00	0.00	0.00
AR1 [p]	0.00	0.00	0.02	0.95	0.00	0.08
AR2 [p]	0.34	0.08	0.51	0.05	0.27	0.18

Notes: (a) dependent variable: relative regional wage  $rW_{it}$ , i.e. wage in the  $i$ -th region relative to the capital region; (b) Robust t-statistics in brackets. \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

## 7 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 present a model building on the assumption that labor is perfectly immobile between regions, which, due to increasing wages in the core region, prevents complete agglomeration in the home country. This produces a typical non-monotonic, U-shaped response of relative regional wages to trade liberalization. In addition, we introduce a second factor of production, capital, which is perfectly mobile and which enables us to account for FDI flows between countries. In numerical simulations, FDI inflows are shown to accelerate the regional adjustment process in the home country, as they are drawn to poor border regions characterized by lower wages and, in case of imperfect labor mobility, higher returns to capital as well as by higher market potential due to their closer locations to larger EU markets. Compared to the workhorse new economic geography models (such as Krugman and Venables (1995)), our model therefore results in a faster convergence of relative regional wages, in a more upward and rightwardly shifted response of relative wages.

In the second part of the paper we then turn to the examination of the implications of our model with regard to the pattern of manufacturing relocation and the adjustment pat-

tern of relative regional wages in five transition countries after they have liberalized their trade with the EU. Two empirical issues are of a particular interest to us. First, we study whether the response of relative regional wages to trade liberalization is non-monotonic. And in addition to it, we test whether the pattern of regional FDI inflows, falling trade costs after trade liberalization and the relocation of manufacturing activity towards western/northern regions can explain the adjustment pattern of relative regional wages in five transition countries. These implications are tested using a unique regional panel data for five transition countries (Bulgaria, Estonia, Hungary, Romania and Slovenia) in the period 1990-2004.

Our estimates show that notwithstanding the econometric method used (OLS, RE and GMM estimations) the predictions of our model are robustly confirmed. We find very strong evidence that in most of the analyzed transition countries trade liberalization has caused a decline and divergence of relative regional wages, but the relative wages then adjusted to the shock mainly by economic geography factors. A U-shaped response of relative regional wages to trade liberalization is confirmed for all countries except Romania. On the other hand, with lower international trade costs, the western/northern border regions closer to the EU economic centers benefitted most in terms of economic activity by attracting domestic as well as foreign firms. It is shown that international flows of capital, as the most mobile factor of production, have contributed significantly in at least 3 out of 5 transition countries to the faster adjustment of economic activity and to faster convergence of relative regional wages after trade liberalization.

To summarize our findings, we can conclude that in Central and Eastern European countries important inter-regional relocations of manufacturing activity have taken place after trade liberalisation with the EU and that inflows of FDI mostly to the capital and border regions have helped foster these adjustment processes. However, as economic integration with the EU provides important opportunities for individual regions, it can also have severe polarization effects. Based on our findings policy makers in the affected transition countries should be careful at designing proper policy measures to either foster the adjustment processes in more fortunate regions or to help at overcoming the polarization effects in less fortunate regions. In line with the suggestions by Traistaru, Nijkamp and Resmini (2003) policy makers should in particular aim at further economic restructuring within the prospering regions, at attracting foreign direct investment as well as at enhancing the innovative and technological potential of local firms by building scientific and technological capabilities of local labor force and firms. For regions that have lesser locational advantages income polarization is likely to be more severe. In overcoming this, policy makers should concentrate at upgrading local infrastructure, building of schemes for supporting local entrepreneurship as well as at the human resources development. However, as shown by Baldwin et al (2003), policy makers should be aware of the fact that most of their policy measures might have non-linear effects. For example, an improve-

ment of infrastructures inside the poor domestic region may have no effect until certain threshold is reached where convergence occurs within the poor and the rich region. On the other hand, improvements in the infrastructures that facilitate trade between regions may have no effect until certain threshold is reached where divergence occurs between the two regions. This calls for very careful and thoughtfully designed regional economic policies.

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# Appendix A

## Consumer behavior

In line with Krugman, Venables (1995) we model a simple economy producing manufacturing and agricultural goods,

$$U = M^\mu A^{1-\mu} \quad (\text{A1})$$

where  $M$  is a composite index of manufacturing goods consumption,  $A$  is the consumption of agricultural good and  $\mu$  is a constant representing the strength of the preference for manufacturing goods. The manufacturing goods index is described by

$$M = \left[ \int_0^n m(i)^\rho di \right]^{1/\rho}, \quad 0 < \rho < 1 \quad (\text{A2})$$

with  $m(i)$  denotes the consumption of each available variety,  $n$  is the range of available varieties and  $\rho$  stands for the intensity of the preference for variety in manufactured goods<sup>25</sup>

With income  $Y$  and manufacturing (agricultural) prices  $p(i)$  ( $p^A$ ) the budget constraint is

$$p^A A + \int_0^n p(i)m(i)di = Y \quad (\text{A3})$$

Solving the two-tier cost minimization problem yields the uncompensated demand function for manufacturing varieties<sup>26</sup>

$$m(j) = p(j)^{-\sigma} \mu Y / G^{-(\sigma-1)} \quad \text{for } j \in [0, n] \quad (\text{A4})$$

where the price index ( $G$ ) represents the minimum cost of attaining a unit of composite index  $M$ ,

$$G \equiv \left[ \int_0^n p(i)^{1-\sigma} di \right]^{1/(1-\sigma)} \quad (\text{A5})$$

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

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<sup>25</sup>The elasticity of substitution between manufacturing varieties ( $\sigma$ ) can be obtained by setting

$$\sigma \equiv \frac{1}{1-\rho}$$

<sup>26</sup>and agriculture

$$A = (1-\mu)Y/p^A$$

location  $s$  is given by:

$$p_{rs} = p_r T_{rs} \quad (\text{A6})$$

where  $T_{rs}$  are transport costs between locations  $r$  and  $s$ . Transport costs, combined with equal prices for all varieties in a given location, mean that price index for location  $r$  ( $G_r$ ) can be rewritten as:

$$G_s = \left[ \sum_{r=1}^R n_r (p_r T_{rs})^{1-\sigma} \right]^{1/(1-\sigma)}, \quad s = 1, \dots, R \quad (\text{A7})$$

## Producer behavior

Manufacturing is assumed to involve economies of scale arising at the level of variety. Technology is the same for all varieties, in all locations and involves a fixed input  $F$  and marginal input requirement  $c^M$ .

Here our model starts to differ from the Krugman-Venables 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.<sup>27</sup> Our model also assumes the existence of both internal and external economies of scale. Total cost function can be written as:

$$C = F^M + c_r^M q^M \quad (\text{A8})$$

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  $F^M$  representing the total fixed costs and  $c^M$  representing the total variable costs. 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 basic logic of input-output linkages of Krugman, Venables (1995), but propose a simplified version<sup>28</sup>:

$$c_r = n_r^{-\sigma} \left( \frac{w_r}{\alpha} \right)^\alpha \left( \frac{i_r}{\beta} \right)^\beta \quad F_r^M = w_r L_f + i_r K_f \quad (\text{A9})$$

where  $w_r$  and  $i_r$  are the nominal wage and return to capital in region  $r$ , and  $L_f$  and  $K_f$  are the required fixed amounts of labor and capital. 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 and a nominal return to capital ( $i_r^M$ ), the profit maximizing price

<sup>27</sup>In contrast to Martin and Rogers (1995) we do not assume a complete repatriation of mobile factor's earnings as well as forego using an ad hoc capital migration equation. Instead, we propose perfect inter-country capital mobility and restrict foreign investment to a one off exogenous occurrence.

<sup>28</sup>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.

is:

$$p_r^M = \frac{\left(\frac{w_r}{\alpha}\right)^\alpha \left(\frac{i_r}{\beta}\right)^\beta}{n_r^\sigma (1 - 1/\sigma)} \quad (\text{A10})$$

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:

$$q_r^{*M} = \frac{F_r^M (\sigma - 1) n_r^\sigma}{\left(\frac{w_r}{\alpha}\right)^\alpha \left(\frac{i_r}{\beta}\right)^\beta} \quad (\text{A11})$$

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

$$\begin{aligned} l_r^* &= L_f (\alpha^2 \sigma - \alpha^2 + 1) + K_f \frac{\alpha (\sigma - 1) i_r}{w_r} \\ k_r^* &= K_f (\beta^2 \sigma - \beta^2 + 1) + L_f \frac{\beta (\sigma - 1) w_r}{i_r} \end{aligned} \quad (\text{A12})$$

both  $l^*$  and  $k^*$  are common to every active firm in the region, with the number of varieties produced in the region  $r$  equaling<sup>29</sup>

$$n_r = \min [L_r^M / l_r^*, K_r^M / k_r^*] \quad (\text{A13})$$

with  $L_r^M$  ( $K_r^M$ ) are the labor (capital) endowments of region  $r$ . As was the case in Krugman, Venables (1995), we propose that agricultural output depends only on the share of labor employed in that sector,  $(1 - \lambda)$ , according to the increasing and concave production function  $A((1 - \lambda_r)L_r)$ . This is meant to ensure that, as labor gets drained from the agricultural sector, the wage increases.<sup>30</sup> In the long-run equilibrium when none of the sectors has completely contracted manufacturing wages satisfy

$$w_r = A'((1 - \lambda_r)L_r) \quad \lambda_r \in (0, 1) \quad (\text{A14})$$

when both sectors operate, manufacturing and agricultural wages equalize.<sup>31</sup> Agricultural

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<sup>29</sup>Labor market clearing condition for region  $r$  is therefore given by

$$L_r^M = n_r l_r^*$$

<sup>30</sup>A similar solution is applied in Puga, Venables (1996) and in the quantity version of the market access effect in Brülhart, Koenig (2006).

<sup>31</sup>In case of corner point solutions, when only one of the sectors survives in the long run, the respective wages would satisfy

$$\begin{aligned} w_r &\geq A'((1 - \lambda_r)L_r) & \lambda_r &= 1 \\ w_r &\leq A'((1 - \lambda_r)L_r) & \lambda_r &= 0 \end{aligned}$$

wages hence function as a dispersion force in the model, ensuring that larger locations (in terms of labor) face greater pressure on the manufacturing wages. Additionally, agricultural goods serve as a numeraire and are freely tradeable.

## The manufacturing wage equation

Using a demand function for a single variety (A4) and summing over all locations the firms equilibrium level of output should satisfy:

$$q_r^* = \mu \sum_{s=1}^R Y_s (p_r^M)^{-\sigma} (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \quad (\text{A15})$$

where  $Y_s$  represents the nominal income of region  $s$  (consisting of labor and capital incomes:  $Y_s = A(1 - \lambda_s)L_s + \lambda_s L_s w_s + K_s i_s$ ).

Using (A15) and the pricing rule (A10) the nominal wages and nominal returns to capital for region  $r$  can be expressed as:

$$\left(\frac{w_r}{\alpha}\right)^{\alpha\left(\frac{\sigma-1}{\sigma}\right)} = \frac{n_r^{\sigma-1} \left(\frac{\sigma-1}{\sigma}\right)}{\left(\frac{i_r}{\beta}\right)^{\beta\left(\frac{\sigma-1}{\sigma}\right)}} \left[ \frac{\mu}{F(\sigma-1)} \sum_{s=1}^R Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \right]^{1/\sigma} \quad (\text{A16})$$

$$\left(\frac{i_r}{\beta}\right)^{\beta\left(\frac{\sigma-1}{\sigma}\right)} = \frac{n_r^{\sigma-1} \left(\frac{\sigma-1}{\sigma}\right)}{\left(\frac{w_r}{\alpha}\right)^{\alpha\left(\frac{\sigma-1}{\sigma}\right)}} \left[ \frac{\mu}{F(\sigma-1)} \sum_{s=1}^R Y_s (T_{rs}^M)^{1-\sigma} G_s^{\sigma-1} \right]^{1/\sigma} \quad (\text{A17})$$

Equation (10) reveals that wages at location  $r$  grow with the growth of incomes of all regions (including region  $r$ ), which represent the firms markets, 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). 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 (10) gives the analogous relationship with the product of nominal wages and nominal returns to capital being determined by (10) and (10). 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.

## 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. In contrast to Krugman, Livas Elizondo (1996), we are interested in a non-symmetric set up, thus assume that one of the home regions is actually located closer to the foreign country than the other, thus having a transport cost advantage in accessing foreign markets.

The wage and price index equations in this specific case are<sup>32</sup>, respectively:

$$\begin{aligned}
 w_1 &= \alpha \left[ \left( \frac{n_1^\sigma \rho \beta^\beta}{i_1^\beta} \right) (Y_1 G_1^{\sigma-1} + Y_2 G_2^{\sigma-1} T^{1-\sigma} + Y_3 G_3^{\sigma-1} (TT^*)^{1-\sigma})^{\frac{1}{\sigma-1}} \right]^{\frac{1}{\alpha}} \\
 w_2 &= \alpha \left[ \left( \frac{n_2^\sigma \rho \beta^\beta}{i_2^\beta} \right) (Y_1 G_1^{\sigma-1} T^{1-\sigma} + Y_2 G_2^{\sigma-1} + Y_3 G_3^{\sigma-1} T^{*1-\sigma})^{\frac{1}{\sigma-1}} \right]^{\frac{1}{\alpha}} \\
 w_3 &= \alpha \left[ \left( \frac{n_3^\sigma \rho \beta^\beta}{i_3^\beta} \right) (Y_1 G_1^{\sigma-1} (TT^*)^{1-\sigma} + Y_2 G_2^{\sigma-1} T^{*1-\sigma} + Y_3 G_3^{\sigma-1})^{\frac{1}{\sigma-1}} \right]^{\frac{1}{\alpha}} \quad (A18)
 \end{aligned}$$

$$\begin{aligned}
 G_1^{1-\sigma} &= \frac{L_1^M}{l_1^*} p_1^{1-\sigma} + \frac{L_2^M}{l_2^*} p_2^{1-\sigma} T^{1-\sigma} + \frac{L_3^M}{l_3^*} p_3^{1-\sigma} T^{1-\sigma} T^{*1-\sigma} \\
 G_2^{1-\sigma} &= \frac{L_1^M}{l_1^*} p_1^{1-\sigma} T^{1-\sigma} + \frac{L_2^M}{l_2^*} p_2^{1-\sigma} + \frac{L_3^M}{l_3^*} p_3^{1-\sigma} T^{*1-\sigma} \\
 G_3^{1-\sigma} &= \frac{L_1^M}{l_1^*} p_1^{1-\sigma} T^{1-\sigma} T^{*1-\sigma} + \frac{L_2^M}{l_2^*} p_2^{1-\sigma} T^{*1-\sigma} + \frac{L_3^M}{l_3^*} p_3^{1-\sigma} \quad (A19)
 \end{aligned}$$

The above system of equations represents a two-factor version of the Krugman-Livas Elizondo (1996) model, which becomes clearer if the location (and endowments) of the two home regions were made symmetric. The model transformed in that manner would yield the usual solutions familiar from the NEG literature.

<sup>32</sup>We also choose units of measurement so that we can further simplify the equations and make the analysis more manageable:

$$F = \mu/\sigma$$



## Appendix B

Figure B1: Response of home relative regional wages to a reduction in foreign trade costs with elasticity of substitution<sup>33</sup>

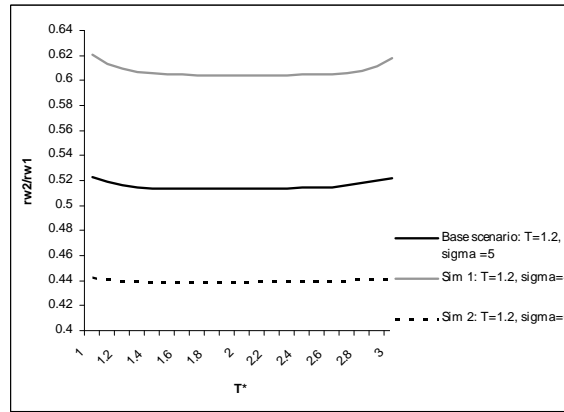


Figure B2: Response of home relative regional wages to a reduction in foreign trade costs with different size ratios between the two home regions<sup>34</sup>

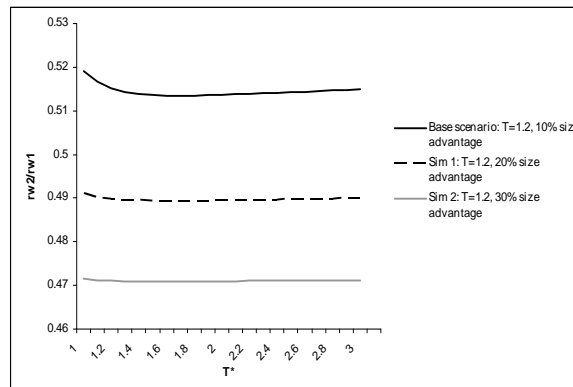
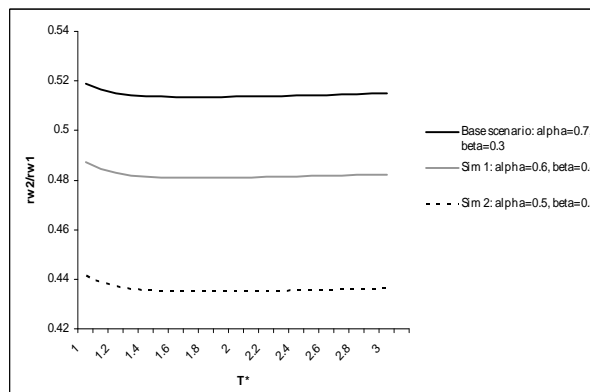


Figure B3: Response of home relative regional wages to a reduction in foreign trade costs with alternative factor elasticities



<sup>33</sup>The parameters used in the simulations were the same as the ones used in Figure 1 apart from the elasticity of substitution.

<sup>34</sup>The size of the region is measured in terms its labor endowment. The relative size of the smaller home region (relative to the central region) is therefore  $L2/L1$ .

# Appendix C

Table A1: Pattern of relative regional wages, by countries, 1990-2004

	min	max	mean	med	std. dev.	N	min	max	mean	med	std. dev.	N
<b>Bulgaria</b>	<b>All regions</b>						<b>W/ N border regions</b>					
1990	0.862	1.076	0.924	0.912	0.047	28	0.862	1.000	0.905	0.898	0.040	9
1991	0.790	1.095	0.889	0.876	0.072	28	0.817	1.000	0.879	0.870	0.061	9
1992	0.679	1.019	0.798	0.775	0.087	28	0.704	1.000	0.818	0.795	0.098	9
1993	0.667	1.004	0.786	0.769	0.093	28	0.695	1.000	0.809	0.786	0.109	9
1994	0.649	1.021	0.769	0.741	0.097	28	0.663	1.000	0.791	0.788	0.113	9
1995	0.663	1.075	0.784	0.766	0.107	28	0.663	1.000	0.798	0.796	0.112	9
1996	0.595	1.046	0.773	0.744	0.124	28	0.636	1.000	0.804	0.853	0.138	9
1997	0.647	1.126	0.834	0.783	0.140	28	0.662	1.094	0.867	0.887	0.156	9
1998	0.658	1.059	0.814	0.784	0.119	28	0.692	1.008	0.844	0.838	0.130	9
1999	0.662	1.014	0.786	0.762	0.106	28	0.682	1.014	0.817	0.812	0.127	9
<b>Estonia</b>	<b>All regions</b>						<b>W/ N border regions</b>					
1992	0.568	1.000	0.674	0.661	0.101	15	0.615	1.000	0.729	0.677	0.154	5
1993	0.576	1.000	0.672	0.652	0.101	15	0.636	1.000	0.731	0.651	0.154	5
1994	0.559	1.000	0.681	0.659	0.101	15	0.636	1.000	0.739	0.678	0.149	5
1995	0.512	1.000	0.671	0.674	0.107	15	0.642	1.000	0.743	0.679	0.146	5
1996	0.552	1.000	0.668	0.661	0.112	15	0.632	1.000	0.734	0.672	0.151	5
1997	0.519	1.000	0.663	0.665	0.112	15	0.637	1.000	0.731	0.670	0.151	5
1998	0.561	1.000	0.661	0.647	0.106	15	0.623	1.000	0.734	0.694	0.152	5
1999	0.511	1.000	0.650	0.643	0.109	15	0.632	1.000	0.728	0.666	0.154	5
2000	0.558	1.000	0.677	0.673	0.102	15	0.651	1.000	0.752	0.706	0.142	5
2001	0.552	1.000	0.686	0.686	0.102	15	0.630	1.000	0.755	0.725	0.143	5
2002	0.579	1.000	0.688	0.679	0.100	15	0.628	1.000	0.756	0.726	0.143	5
2003	0.603	1.000	0.691	0.669	0.097	15	0.618	1.000	0.750	0.735	0.150	5
2004	0.613	1.000	0.712	0.698	0.092	15	0.674	1.000	0.777	0.742	0.130	5
<b>Hungary</b>	<b>All regions</b>						<b>W/ N border regions</b>					
1990	0.704	1.000	0.820	0.810	0.081	20	0.734	0.948	0.854	0.865	0.079	6
1991	0.681	1.000	0.808	0.805	0.090	20	0.713	0.936	0.846	0.867	0.086	6
1992	0.670	1.000	0.785	0.767	0.082	20	0.710	0.900	0.811	0.827	0.068	6
1993	0.634	1.000	0.770	0.765	0.087	20	0.673	0.894	0.786	0.788	0.074	6
1994	0.585	1.000	0.732	0.725	0.095	20	0.640	0.853	0.746	0.740	0.070	6
1995	0.556	1.000	0.715	0.709	0.100	20	0.654	0.843	0.732	0.719	0.064	6
1996	0.576	1.000	0.703	0.694	0.097	20	0.660	0.832	0.727	0.716	0.059	6
1997	0.555	1.000	0.681	0.663	0.104	20	0.652	0.819	0.709	0.691	0.066	6
1998	0.531	1.000	0.667	0.652	0.109	20	0.631	0.819	0.698	0.686	0.070	6
1999	0.570	1.000	0.706	0.701	0.107	20	0.690	0.875	0.759	0.743	0.072	6
<b>Romania</b>	<b>All regions</b>						<b>W/ N border regions</b>					
1992	0.772	1.264	0.957	0.939	0.096	41	0.854	1.264	1.010	0.971	0.137	10
1993	0.739	1.279	0.922	0.901	0.100	41	0.828	1.279	0.974	0.923	0.155	10
1994	0.700	1.180	0.839	0.819	0.102	41	0.754	1.180	0.894	0.827	0.157	10
1995	0.687	1.249	0.859	0.831	0.109	41	0.744	1.249	0.908	0.874	0.157	10
1996	0.660	1.147	0.834	0.803	0.113	41	0.721	1.147	0.876	0.854	0.134	10
1997	0.683	1.102	0.861	0.835	0.106	41	0.718	1.085	0.891	0.866	0.122	10
1998	0.673	1.129	0.828	0.804	0.100	41	0.673	1.129	0.835	0.811	0.140	10
1999	0.695	1.032	0.823	0.801	0.081	41	0.759	1.032	0.856	0.844	0.085	10
<b>Slovenia</b>	<b>All regions</b>						<b>W/ N border regions</b>					
1994	0.698	1.000	0.866	0.856	0.078	12	0.841	0.968	0.887	0.869	0.055	4
1995	0.688	1.000	0.831	0.818	0.085	12	0.810	0.953	0.856	0.831	0.066	4
1996	0.665	1.000	0.817	0.810	0.090	12	0.797	0.916	0.841	0.825	0.052	4
1997	0.715	1.000	0.843	0.821	0.078	12	0.812	0.888	0.846	0.842	0.031	4
1998	0.695	1.000	0.835	0.818	0.081	12	0.800	0.906	0.847	0.841	0.044	4
1999	0.664	1.000	0.835	0.828	0.092	12	0.786	0.907	0.854	0.862	0.052	4
2000	0.682	1.000	0.842	0.817	0.084	12	0.807	0.905	0.865	0.875	0.043	4
2001	0.711	1.000	0.852	0.825	0.085	12	0.825	0.943	0.883	0.881	0.050	4
2002	0.696	1.000	0.853	0.832	0.085	12	0.809	0.945	0.882	0.886	0.058	4
2003	0.712	1.000	0.878	0.867	0.078	12	0.858	0.966	0.906	0.900	0.049	4

Source: Authors' calculations.

Table A2: Pattern of relative regional FDI, by countries, 1990-2004

	min	max	mean	med	std. dev.	N	min	max	mean	med	std. dev.	N
<b>Bulgaria</b>	<b>All regions</b>						<b>W/ N border regions</b>					
1990	0.000	1.000	0.073	0.018	0.197	28	0.000	1.000	0.128	0.021	0.327	9
1991	0.002	1.000	0.068	0.015	0.192	28	0.002	1.000	0.124	0.014	0.329	9
1992	0.001	1.000	0.059	0.009	0.189	28	0.002	1.000	0.121	0.007	0.330	9
1993	0.002	1.000	0.061	0.011	0.189	28	0.002	1.000	0.123	0.010	0.329	9
1994	0.002	1.000	0.060	0.012	0.189	28	0.002	1.000	0.124	0.012	0.329	9
1995	0.003	1.000	0.064	0.015	0.189	28	0.003	1.000	0.126	0.015	0.328	9
1996	0.004	1.000	0.066	0.015	0.189	28	0.004	1.000	0.127	0.017	0.328	9
1997	0.004	1.000	0.067	0.016	0.189	28	0.004	1.000	0.129	0.021	0.327	9
1998	0.004	1.000	0.068	0.017	0.189	28	0.004	1.000	0.129	0.022	0.327	9
1999	0.005	1.000	0.068	0.017	0.189	28	0.005	1.000	0.129	0.022	0.327	9
<b>Estonia</b>	<b>All regions</b>						<b>W/ N border regions</b>					
1992	0.001	1.000	0.076	0.005	0.256	15	0.005	1.000	0.210	0.009	0.442	5
1993	0.001	1.000	0.076	0.005	0.256	15	0.005	1.000	0.210	0.009	0.442	5
1994	0.002	1.000	0.081	0.011	0.255	15	0.011	1.000	0.216	0.011	0.439	5
1995	0.001	1.000	0.081	0.012	0.255	15	0.012	1.000	0.217	0.012	0.438	5
1996	0.002	1.000	0.080	0.010	0.255	15	0.010	1.000	0.215	0.010	0.439	5
1997	0.002	1.000	0.079	0.009	0.255	15	0.008	1.000	0.214	0.010	0.440	5
1998	0.006	1.000	0.089	0.021	0.253	15	0.021	1.000	0.224	0.029	0.434	5
1999	0.006	1.000	0.090	0.023	0.253	15	0.023	1.000	0.227	0.033	0.433	5
2000	0.006	1.000	0.090	0.023	0.253	15	0.023	1.000	0.227	0.033	0.433	5
2001	0.006	1.000	0.090	0.023	0.253	15	0.023	1.000	0.227	0.033	0.433	5
2002	0.006	1.000	0.090	0.023	0.252	15	0.022	1.000	0.224	0.033	0.434	5
2003	0.006	1.000	0.090	0.022	0.253	15	0.022	1.000	0.223	0.033	0.435	5
2004	0.006	1.000	0.089	0.020	0.253	15	0.020	1.000	0.222	0.033	0.435	5
<b>Hungary</b>	<b>All regions</b>						<b>W/ N border regions</b>					
1990	0.014	1.000	0.084	0.030	0.218	20	0.014	0.074	0.037	0.032	0.020	6
1991	0.014	1.000	0.089	0.035	0.216	20	0.027	0.080	0.044	0.039	0.019	6
1992	0.014	1.000	0.097	0.041	0.215	20	0.041	0.086	0.054	0.050	0.017	6
1993	0.013	1.000	0.090	0.038	0.216	20	0.037	0.082	0.048	0.042	0.017	6
1994	0.012	1.000	0.091	0.039	0.216	20	0.038	0.096	0.053	0.047	0.022	6
1995	0.010	1.000	0.091	0.038	0.216	20	0.038	0.098	0.054	0.048	0.022	6
1996	0.011	1.000	0.091	0.039	0.216	20	0.037	0.098	0.054	0.048	0.022	6
1997	0.010	1.000	0.090	0.041	0.216	20	0.036	0.096	0.055	0.049	0.021	6
1998	0.011	1.000	0.090	0.039	0.216	20	0.034	0.093	0.053	0.048	0.020	6
1999	0.011	1.000	0.095	0.044	0.215	20	0.032	0.095	0.057	0.058	0.023	6
<b>Romania</b>	<b>All regions</b>						<b>W/ N border regions</b>					
1992	0.002	1.000	0.042	0.009	0.155	41	0.004	0.130	0.029	0.012	0.039	10
1993	0.002	1.000	0.044	0.011	0.155	41	0.003	0.114	0.029	0.016	0.034	10
1994	0.002	1.000	0.046	0.013	0.155	41	0.004	0.130	0.033	0.018	0.040	10
1995	0.000	1.000	0.035	0.007	0.155	41	0.003	0.067	0.016	0.009	0.019	10
1996	0.000	1.000	0.036	0.008	0.155	41	0.004	0.065	0.017	0.011	0.018	10
1997	0.003	1.000	0.041	0.011	0.155	41	0.004	0.077	0.023	0.015	0.022	10
1998	0.002	1.000	0.041	0.010	0.154	41	0.003	0.073	0.025	0.019	0.022	10
1999	0.002	1.000	0.047	0.016	0.154	41	0.006	0.088	0.034	0.028	0.025	10
<b>Slovenia</b>	<b>All regions</b>						<b>W/ N border regions</b>					
1994	0.044	8.143	1.477	0.359	2.338	12	0.188	1.829	0.683	0.356	0.769	4
1995	0.055	6.767	1.420	1.000	1.926	12	0.186	2.351	1.064	0.858	1.004	4
1996	0.144	3.161	1.118	0.978	0.838	12	0.956	3.161	1.798	1.538	0.961	4
1997	0.207	2.945	1.166	1.168	0.767	12	1.213	2.945	1.851	1.624	0.789	4
1998	0.272	2.357	0.814	0.696	0.598	12	0.681	1.436	0.914	0.770	0.353	4
1999	0.377	3.898	1.740	1.311	1.165	12	1.270	2.663	2.138	2.310	0.603	4
2000	0.407	3.554	1.866	1.719	1.128	12	2.110	3.300	2.476	2.247	0.555	4
2001	0.414	3.085	1.679	1.536	0.969	12	2.024	3.085	2.389	2.223	0.478	4
2002	0.315	2.562	1.318	1.033	0.748	12	0.951	2.146	1.519	1.490	0.616	4
2003	0.832	2.578	1.467	1.123	0.646	12	1.079	2.230	1.626	1.598	0.619	4

Source: Authors' calculations.