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# ON THE PATTERNS OF TRADE CONVERGENCE IN EUROPEAN TRANSITION COUNTRIES<sup>1</sup>

Revised Final Report

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**JEL: C23, C73, F15, F21**

**Abstract.** In current study we analyze the convergence of trade between Central and Eastern European countries (CEECs) and European Union (EU) during the period from 1984 to 2004. In our extension of the theoretical framework of Helpman, Melitz and Rubinstein (2005) with heterogeneous firms we discuss the influence of economic fundamentals and trade cost on extensive and intensive margins of trade. Then, we use gravity model of trade to calculate potentials for CEECs trade with EU-15 countries. As a result, we develop convergence measures for CEECs exports and imports trade flows with EU-15. Moreover, we provide decomposition of trade flows on extensive and intensive margins, and construct convergence measures for each of the trade components. Finally, we analyze the mechanics of trade convergence process in selected CEECs. Current paper contributes to better understanding of trade convergence patterns in European transition countries, providing policy-makers in transition economies with useful insights on the role of different trade components in the convergence process.

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# 1 Introduction

For the last two decades Central and Eastern European countries (CEECs) enhanced their trade relations with European Union (EU). On the one hand, the process of transition from plan to market economy was activated. On the other hand, these countries began the integration process into the world economy, once the artificial trade impediments were abolished. As a result, the most radical changes occurred in trade patterns of CEECs followed by the massive shifts in both geographical and commodity trade structure. The European Union rapidly replaced the Former Soviet Union as a major trade partner for all the CEECs<sup>3</sup>. The previous empirical work<sup>4</sup> documented that, since the beginning of market transition, volumes of trade between European transition economies and EU-15 approached the potential level, predicted by the standard gravity model. In other words, controlling for difference in economic sizes of CEECs and EU-15 countries, CEECs became similar to the EU-15 in terms of trade volume. Correspondingly, we say that CEECs trade volume converged to the EU-15 level.

For the first time in the literature on trade potentials, this paper investigates the process of trade convergence in European transition countries across two dimensions: extensive and intensive margins of trade. While extensive margin relates to variety of traded product categories, intensive margin reflects trade volume per one traded category. Given that trade volume can be represented as product extensive and intensive margins, what are the consequences of trade increases through one of these trade components? In fact, the economic implications of trade growth on extensive and intensive margins may be quite different. More precisely, an increase in imports volume on the basis of expanding product variety results in greater consumer welfare increase comparatively with the same increase produced only by the rise of product quantities. This fact was clearly illustrated in "love of variety" models of international trade.

The key challenge of current paper is to provide the trade convergence decomposition on extensive and intensive margins to reveal potential forces of the empirically observed trade adjustment. We calculate trade convergence measures using gravity framework. However to analyze the forces of such process we have to step further in the theory and provide trade decomposition analysis. Obtained empirical facts about trade convergence dynamics could not

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<sup>3</sup>While in 1984 only 20% to 30% of total CEECs exports went to EU-15, by the year of 1991 this share rose to over than 60% for the most advanced CEEC economies, Hungary and Poland. In 2004 for all the CEECs, from 50% to 70% of total exports were shipped to European Union, depending on country.

<sup>4</sup>See Gros and Gonciarz (1996), Nilsson (2000), Bussi'ere, Fidrmuc and Schnatz (2004).

be straightforward explained by existing theories of international trade. We step further to the theoretical issues demanding specific model properties to analyze empirical patterns of trade convergence process. We extend theoretical framework of Helpman, Melitz, Rubinstein (2005) and Chaney (2006), allowing both extensive and intensive margins depend on economic sizes, trade cost and productivity. Our theoretical extension is helpful in explaining new empirical findings and forces of trade convergence process in European transition countries.

## 2 Literature Review

In this section we review the previous issues relating to the objectives and methodology of current research. In the recent years the plenty of studies analyzed the trade performance and trade policies of CEECs during the pre-accession period. In particular, a lot of efforts were made to calculate the potential volumes of trade between CEECs and EU-15 (see Gros and Gonciarz (1996), Nilsson (2000), Bussière, Fidrmuc and Schnatz (2004)). These studies report that while in 1989, after beginning of market reforms, the CEECs trade with European Union having a huge potential, in later years CEECs managed to boost their trade with EU, and by now they are highly integrated into the EU market.

Several studies investigate the economic policy of CEE countries that among other factors have led to the high integration into EU market. As indicated in Kaminski (2001), initially fast trade reorientation of CEECs towards EU depended on the pace of liberalization and degree of undertrading with European Union. But later on, favorable to private sector business climate and success in FDI attraction (two thirds of which came from EU) led to industrial restructuring of these economies that implied the shift to more advanced stages of production and their involvement in finer international division of labor. As a result, the share of manufactured goods in exports to EU considerably increased and CEECs composition of trade became more similar to that of EU-15 countries.

The important point is to investigate what the trade growth means in terms of trade composition. Hummels and Klenow (2005) discussed the cross-countries' differences in quality and variety of trade depending on the size of economy. Furthermore they attempt to explore theoretical model properties which could fit in the existing empirical evidences.

Another study of Kandogan (2003) provides the analysis of factors that were behind the

exports reorientation of former CMEA<sup>5</sup> countries towards the other world markets during 1992-99. The author noticed that degree of closing gap between the actual and potential exports for these countries could be analyzed using indicators of exports patterns. He provides the analysis for various measures of exports diversification, following Funke, Ruhwedel (2003) and Hummels, Klenow (2002). Furthermore, he proceeds with a detailed intra-industry trade description. The author assumed that while the reorientation of CIS export was caused by changes in quantity at most, the reorientation of CEECs export was composed to large extent by changes in quality and variety. However, theoretical background is absent in current paper to infer about causality issues.

Further we review modern models of trade and discuss theoretical underpinnings for the following empirical analysis of CEECs trade convergence. We take special interest in the models which explain both the extensive and intensive margins of trade.

Krugman (1980) developed a simple model, in which trade between two countries occurs because they produce different varieties. Consumers love variety, and therefore buy foreign goods as well as domestic goods. Using very simplifying assumptions, Kruman model allows for a simple closed form solution. However, this comes at the cost of producing an unwanted result: while moving from closed to open economy, a home country begins to export all produced product varieties, and imports all varieties produced by a foreign country. Moreover, in the open economy export and import variety do not depend on trade costs. However, this can be hardly believed and is rejected by the recent empirical evidence.

Moving away from simplistic assumptions of Krugman model, Melitz (2003) developed a model of open economy equilibrium with heterogeneous firms. The important property of this model is endogenous selection of exporters into the export market after trade opening. Basic assumptions of Melitz model are as follows:

1. Firms are heterogeneous in terms of marginal productivity of labour
2. Firms' productivity is randomly drawn from certain probability distribution. Firms are uncertain about their productivity before starting production
3. He also introduced fixed cost of exporting into the model.

On the contrary to the Krugman model, the Melitz model with heterogeneous firms and fixed cost of exporting allows modeling the wider set of trade growth factors. At the same time,

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<sup>5</sup>Council for Mutual Economic Assistance

in the papers by Helpman, Melitz, and Rubinstein (2005) and Chaney (2006), Melitz's model is extended to allow for trade between more than two asymmetric countries. We use the setup of these recent papers and extend proposed models to discuss the impact of trade growth fundamentals on trade components: extensive and intensive margins.

### 3 Conceptual Framework

In the current section we provide the theoretical issues for the further empirical exercise. We discuss the international trade model with heterogeneous firms to obtain the theoretical background for the trade components analysis. Furthermore we propose gravity approach to estimate the development of extensive and intensive trade margins. In the end of the section, we discuss relationship between trade convergence and trade composition and introduce methodology of trade components convergence analysis.

#### 3.1 Theoretical model

Let us assume that the world consists of  $N$  countries. Let country's  $j$  utility function be standard constant elasticity of substitution (CES) function with continuum of differentiated goods:

$$U_j = \left( \int_{l \in B_j} x_j(l)^{\frac{\sigma-1}{\sigma}} dl \right)^{\frac{\sigma}{\sigma-1}}, \quad \sigma > 1 \quad (1)$$

where  $x_j(l)$  - consumption of product variety  $l$ ,  $B_j$  is a product set, available for consumption in country  $j$ , and  $\sigma$  is elasticity of substitution between various product varieties.

Consumers spend their aggregate income  $Y_j$  on different product varieties:

$$\int_{l \in B_j} p_j(l)x_j(l)dl = Y_j \quad (2)$$

where  $p_j(l)$  is price of product variety  $l$ .

Solving consumer utility maximization problem with given budget expenditures, we get the iso-elastic demand functions, which depend on ideal price index:

$$x_j(l) = \frac{p_j(l)^{-\sigma}}{P_j^{1-\sigma}} \times \frac{Y_j}{P_j} \quad (3)$$

where  $P_j$  is an *ideal price index*:

$$P_j = \left( \int_{l \in B_j} p_j(l)^{1-\sigma} dl \right)^{\frac{1}{1-\sigma}} \quad (4)$$

Next, following Helpman, Melitz, and Rubinstein (2005) and Chaney (2006), we specify assumptions about firms. We assume that all countries have similar production technology with increasing returns to scale. The corresponding production cost function for country's  $j$  firm with productivity  $\phi$  takes the following form:

$$C_{ij}(x, \phi) = \left( f_{ij} + \frac{x}{\phi} \right) w_j \quad (5)$$

where  $x$  is output,  $f_{ij}$  and  $w_j$  denote fixed cost of starting export from country  $i$  to  $j$  and wages, respectively. Each firm from country  $i$  produces one product variety and sells it to home or foreign markets. As in the Krugman model, we assume iceberg-type cost of exporting from  $i$  to  $j$ : part  $(1 - \tau_{ij})$  of trade quantity is lost in transit. Also, following Melitz (2003), we assume fixed cost of exporting from country  $i$  to  $j$ , which is given by extra  $f_{ij}$  units of labour, needed to start exporting.

Then we can write down expressions for prices, revenue and net profit of a country  $j$ 's firm exports into country  $i$ :

$$p_{ij}(\phi) = \frac{\sigma \tau_{ij} w_i}{(\sigma - 1) \phi} \quad (6)$$

$$r_{ij}(\phi) = \left( \frac{\sigma \tau_{ij} w_i}{(\sigma - 1) \phi P_j} \right)^{1-\sigma} Y_j \quad (7)$$

$$\pi_{ij}(\phi) = \left( \frac{\sigma \tau_{ij} w_i}{(\sigma - 1) \phi P_j} \right)^{1-\sigma} \frac{Y_j}{\sigma} - w_i f_{ij} \quad (8)$$

We also specify  $\tau_{ii} = 1$  and  $f_{ii} = 0$ , so that equations (6)-(8) are valid to describe firms' sales to home market.

All firms in country  $i$  with sufficiently high productivity would earn non-zero profits on the market of country  $j$  and would be exporters. Therefore, zero-cutoff profits condition specifies the threshold level of productivity  $\tilde{\phi}_{ij}$  for exports:

$$\pi_{ij}(\tilde{\phi}_{ij}) = 0, \quad \text{hence} \quad \tilde{\phi}_{ij} = \mu w_i^{\frac{\sigma}{\sigma-1}} \times \left( \frac{f_{ij}}{Y_j} \right)^{\frac{1}{\sigma-1}} \times \frac{\tau_{ij}}{P_j} \quad (9)$$

where  $\mu$  is a constant<sup>6</sup>.

Let us assume, following Chaney (2006), that total number of firms  $N_i$  is given exogenously, and equals total labour stock,  $L_i$ . Then, we can directly specify equation for country's  $j$  ideal price index:

$$P_j^{1-\sigma} = \sum_{k=1}^N L_k \int_{\tilde{\phi}_{kj}}^{\infty} p_{kj}(\phi)^{1-\sigma} dG(\phi) \quad (10)$$

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<sup>6</sup> $\mu = \sigma^{\frac{1}{\sigma-1}} \times \left( \frac{\sigma}{\sigma-1} \right)$

Taking into account equation for export prices (6) and labour market clearing condition  $Y_i = L_i w_i$ , we can write down equation for ideal price index in the following way:

$$P_j^{1-\sigma} = \sum_{k=1}^N \frac{Y_k}{w_k} \int_{\tilde{\phi}_{kj}}^{\infty} \left( \frac{\sigma \tau_{kj} w_k}{(\sigma-1)\phi} \right)^{1-\sigma} dG(\phi) \quad (11)$$

The system of equations (9) and (11) defines both an ideal price index and threshold level of productivity for exports as functions of economic fundamentals and model parameters. However, it could not be solved explicitly until we do not specify parametric form of firm productivity distribution,  $G(\phi)$ .

Let now consider

$$U_{ij} = 1 - G(\tilde{\phi}_{ij}) \quad (12)$$

and

$$V_{ij} = \int_{\tilde{\phi}_{ij}}^{\infty} \phi^{\sigma-1} dG(\phi) \quad (13)$$

where  $U_{ij}$  is fraction of country's  $i$  firms that export to country  $j$ ; and  $V_{ij}/U_{ij}$  is aggregate productivity measure for country's  $i$  exporters to  $j$ . Using these variables, we can write down equation for aggregate exports  $X_{ij}$  from country  $i$  to  $j$ :

$$X_{ij} = \left( \frac{\sigma \tau_{ij} w_i}{(\sigma-1)P_j} \right)^{1-\sigma} Y_j N_i V_{ij} \quad (14)$$

Where

$$P_j^{1-\sigma} = \sum_{k=1}^N \left( \frac{\sigma \tau_{kj} w_k}{\sigma-1} \right)^{1-\sigma} \frac{Y_k}{w_k} \times V_{kj} \quad (15)$$

System of equations (9), (12)-(15) determines equilibrium levels of aggregate bilateral exports, ideal price indexes, and threshold level of productivity for exporting<sup>7</sup>. In what follows, we will analyze properties of the model, with all variables having equilibrium values.

Herein we infer about trade composition which is principal for a future empirical exercise. In presented model we define extensive margin of exports as number of exporting firms, and intensive margin of exports as an exports value per firm. Then we can formally write down analytic expressions for extensive margin ( $EM_{ij}$ ) and intensive margin ( $IM_{ij}$ ) of exports from country  $i$  to  $j$ :

$$EM_{ij} = L_i U_{ij} \quad (16)$$

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<sup>7</sup>Paper by Melitz (2003) contains precise proof of existence and uniqueness of equilibrium in a similar model.

Then due to labour market clearing condition,

$$EM_{ij} = \frac{Y_i}{w_i} \times U_{ij} \quad (17)$$

$$IM_{ij} = \left( \frac{\sigma \tau_{ij} w_i}{(\sigma - 1) P_j} \right)^{1-\sigma} Y_j \times \left( \frac{V_{ij}}{U_{ij}} \right) \quad (18)$$

Note that  $\left( \frac{V_{ij}}{U_{ij}} \right)^{\frac{1}{\sigma-1}}$  is a measure of aggregate productivity among exporting firms. Furthermore the product of extensive and intensive margins equals to the value of exports.

In the following table we summarize model's properties and represent the impact of different variables in model on extensive and intensive margins of trade. Mathematical proofs and further discussion of model's properties are presented in Appendices.

| Model's Variable                  | Extensive Margin (EM) | Intensive Margin (IM) |
|-----------------------------------|-----------------------|-----------------------|
| Exporter's size                   | +                     | +                     |
| Importer's size                   | +                     | +                     |
| Fixed trade cost                  | -                     | +                     |
| Variable trade cost               | -                     | -                     |
| Share of exporting firms          | +                     | +/-                   |
| Average productivity of exporters | +/-                   | +                     |

Table 1: Model's properties

Note that the fixed trade costs exhibit different impact on trade components. Thus, other things being equal, growth in extensive margin supported by the decrease of intensive margin of trade, could be the evidence of fixed trade costs' decrease. At the same time, we could not distinguish implicitly the effect of average firms' productivity on extensive margin as the property of developed model.

Thus, in current paper we show that trade models with heterogeneous firms and fixed cost of exporting are able to describe the impact of economic fundamentals on trade growth of extensive and intensive margins. The major result is that both extensive and intensive margin depend on economic sizes of trading partners, trade cost and aggregate productivity. The next step is an empirical part and herein Helpman, Melitz and Rubinstein (2005) show that under certain assumptions<sup>8</sup> bilateral trade flows in this model can be represented by generalized gravity

<sup>8</sup>They assume that  $V_{ij}$  is decomposable in a proper way and that transportation cost  $\tau_{ij}$  are symmetric

equation. In the following empirical framework, having the respective theoretical background, we use gravity-type equations for both extensive and intensive margins of trade flows.

### 3.2 Data description

In current research we use data on bilateral trade flows between EU-15 countries and those between CEECs and EU-15 countries. Trade flows of Baltic States and Ukraine with EU-15 are also included into the data sample. We draw the corresponding data from our own the combination of NBER-UN (period 1962-2000) and UNSD COMTRADE Databases (period 2001-2004).

While the major focus of our research is to infer about the composition of trade and its dynamics we use disaggregated data on commodity trade. The first data source which have been used in current research is NBER-UN world trade database<sup>9</sup> (available at *www.nber.org/data*). This database contains disaggregated data for imports of 72 reporting countries that are classified by 4-digit SITC rev.2 level. In particular, the set of reporting countries includes all of EU-15 countries and major part of CEECs for the years 1962-2000. Furthermore, throughout the database description it was stated that the reported data on imports are more accurate than the exports records. That is the reason why the exports data were constructed via imports records of a destination country.

Once we need data on trade flows quantities, we had to use sample starting from 1984. Neither NBER-UN nor COMTRADE database have quantity records for the earlier period. In fact NBER-UN is systemized and corrected version of COMTRADE database for a period till year 2000. One of the specific reasons for corrections was that a certain country reported a large amount of commodity imports only at 3-digit level. In this case basically the following three correction methods were used:

- when possible, commodity imports at 3-digit level was distributed across corresponding 4-digit categories on the basis of exporting countries records;
- when possible, the remaining part of commodity imports was distributed across corresponding 4-digit categories on the basis of corresponding distributions in the nearest years;
- finally, when the first two methods not applicable, the remaining commodity imports were distributed across corresponding 4-digit categories on the basis of the combined imports

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<sup>9</sup>The description of this database can be found by reference <http://www.nber.org/papers/w11040>.

from all source countries.

In particular, the set of countries for which specific corrections were made includes: Austria, Belgium, Czech Republic, Denmark, France, Germany, Hungary, Ireland, Italy, Netherlands, Poland, Spain, Sweden and the United Kingdom.

Although NBER-UN database provides us with relevant commodity trade data, it has some limitations with regard to our research purposes. Firstly, there is a lack of reporting countries: imports records of Estonia, Latvia, Lithuania and Ukraine<sup>10</sup>. Secondly, this database does not contain trade data for the years 2001 and later. That is the reason why in current research the absent data is obtained from UNSD COMTRADE database<sup>11</sup>. In particular, we downloaded 4-digit trade data (classified by SITC rev.2) from UNSD website for CEECs and EU-15 (2001-2004), Ukraine (1996-2004), Estonia (1995-2004), Latvia (1994-2004), Lithuania (1992-2004). To make data sample obtained from different sources appropriate for the further estimation, we had to provide trade records adjustment following NBER-UN methodology described above. The records of product categories which were traded less than \$100.000 were not included, since NBER-UN Database also does not provide these records. As the result of data adjustment procedure we obtain required compilation of NBER-UN and UNSD COMTRADE Databases for EU-15, CEECs, Baltic states and Ukraine for the period 1984-2004.

For the gravity framework and trade decomposition issues we also collected the following data:

- GDP and population of trading partners. Such data for EU-15 countries, CEE and CIS countries could be obtained from UNSD National Accounts<sup>12</sup> in current US dollars for the years 1984-2004;
- The bilateral trade barriers are proxied by distance between capital cities of trade partners; the corresponding data provided at the web-site <http://www.indo.com>.

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<sup>10</sup>The exports data by 4-digit SITC Rev.2 commodity groups for these countries are available from imports records of their trade partners for the years 1992 and later.

<sup>11</sup>web-site <http://unstats.un.org/unsd/comtrade>

<sup>12</sup>web-site <http://unstats.un.org/unsd/snaama>

### 3.3 Econometric specification

In current section, we provide our model specification and describe several alternative procedures of trade potentials' calculation for the countries which enhanced trade relations with EU-15. In more general aspect, calculation of trade potentials is the rather problematic question and recent time several papers appeared to discuss such issues. Egger (2000) has made several initial recommendations to overcome shortcomings of the traditional procedures of trade potentials calculation. In this study, we apply to the gravity model, which became the work-horse for the international trade analysis and integration effects assessment. There are at least two alternative procedures to calculate trade potential for Central and Eastern European countries using gravity framework. They are so called in-sample and out-of-sample approaches. Within out-of-sample technique the gravity-type equation for EU-15 bilateral trade sample is estimated:

$$\log(TV_{ijt}) = \phi_0 + \phi_1 \log(Y_{it}) + \phi_2 \log(Y_{jt}) + \phi_3 \log(D_{ij}) + \phi_4 B_{ij} + \varepsilon_{ijt}, \quad (19)$$

where  $TV_{ijt}$  is the bilateral trade volume either exports or imports between country  $i$  and  $j$  in time  $t$ ,  $Y_{it}$  and  $Y_{jt}$  are the GDP in referred countries,  $D_{ij}$  is the distance between capital cities of country  $i$  and  $j$ ,  $B_{ij}$  is an indicator of common border between country  $i$  and  $j$ .  $\varepsilon_{ijt}$  is an error term.

We assume estimated model to describe benchmark trade performance for European transition countries after complete convergence towards European Union. It is natural to think that CEECs' trade performance with EU would become similar to old EU member states due to the process of economic integration. In this aspect, we are mostly interested in the analysis of trade convergence in time dimension. As the result, we obtain deviations between predicted and observed trade flows: bilateral deviations for EU-15 and European transition countries for last 20 years. In literature such deviations are commonly interpreted as un-exhausted trade potentials. Moreover, having values changing in time we could find the evidence for the systematic trade convergence process. Current approach, being highly convenient and widely used, have principal problem when applied. It could not distinguish real deviations from the potentials and residuals attributable to the unobserved variables.

Another way to deal with this issue following in-sample approach is to analyze trade potential of certain transition country with European Union instead of the bilateral trade deviations. In other words we ask: what are the potentials for the trade relations development with EU-15 for Poland, Hungary, etc.? Herein, we estimate the systematic difference in trade performance

for these countries comparing with EU-15 states. To provide following analysis, we include European transition countries in our estimation sample. Then we proceed with estimation of time-variant individual parameters for each transition country.

$$\log(TV_{ijt}) = \phi_0 + \phi_1 \log(Y_{it}) + \phi_2 \log(Y_{jt}) + \phi_3 \log(D_{ij}) + \phi_4 B_{ij} + \delta_{it} ETC_{ij} + u_{ijt}, \quad (20)$$

Estimation sample in this approach includes bilateral trade observations for all country-pairs from EU-15; furthermore we include CEECs, Baltic States and Ukraine's data. Variables are the same as in equation (19) with additional  $ETC_{ij}$  - European transition countries dummies.  $u_{ijt}$  is an error term.

Current approach illustrates better performance in calculations of the systematic deviation from the potentials for European transition countries. Working in this way, we ignore bilateral deviations and analyze general time-varying deviations for each transition country. We say that the certain transition country is characterized by unrealized trade potential with EU-15, if the estimated coefficients  $\delta_{it}$  near corresponding dummies are negative. Furthermore, this country demonstrates the trade convergence to European Union, if  $\delta_{it}$  have been adjusting up to zero over time. Presented findings are the basis for further trade convergence measures development. On the Figure 1 we provide the schematic illustration of applied gravity framework using actual/predicted scatter plot for EU-15 and European transition countries.

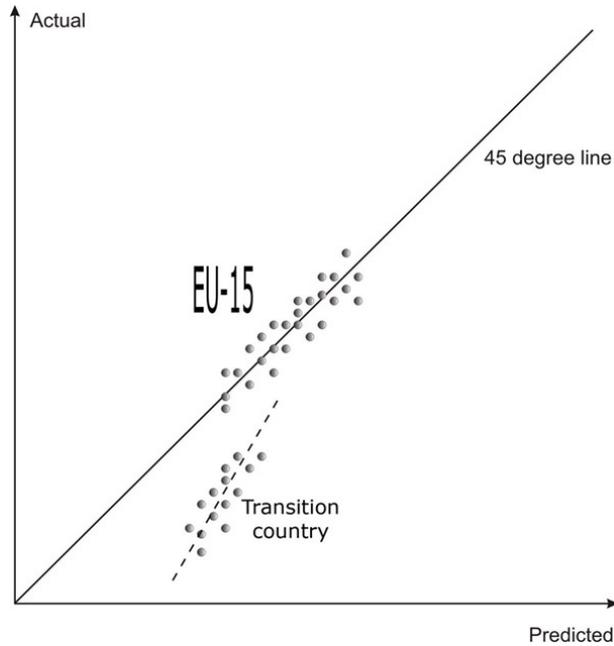


Figure 1: Schematic illustration of the gravity framework

For the purposes of current research, we would interpret 45 degree line as a benchmark to think of the common base for CEECs convergence. We say that CEE country undertrades with EU-15, if we observe the systematic deviations of bilateral trade for this country with EU-15 from 45 degree line. Providing the in-sample estimation (20), we indirectly assume this deviation for the certain year to be constant for the various income levels of the importing country. Nevertheless, our estimation results provide the evidence that CEECs trade relations with high-income countries from European Union are more similar to EU-15 benchmark level than for the low-income countries. On the Figure 1, this effect is illustrated as a smaller deviations from the benchmark level of the bilateral trade for CEE country with high-income country from EU-15 and respectively higher deviation from the benchmark level of bilateral trade for CEE country with low-income country from EU-15.

We step further with the convergence analysis and discuss formal convergence measures. In current paper, we define the convergence measure as the ratio of actual and potential trade flows for the certain transition country with European Union:

$$\mu_{it} = \frac{TV_{it}}{TV_{it}^*} \quad (21)$$

where  $\mu_{it}$  - is the measure of convergence of country  $i$  to EU-15 in time  $t$ ,  $TV_{it}$  and  $TV_{it}^*$  are actual and potential trade flows with EU-15 respectively for country  $i$  in time  $t$ . In fact convergence measures would differ in the way you calculate and aggregate trade potentials for the certain transition country. Based on earlier described procedure of trade potentials calculation, we introduce several trade convergence measures. We expect following properties for the developed indicators:

1. For EU-15 countries sample averaged trade convergence measure is expected to be close to the unity (or 100% convergence). It reflects the normal for the European Union trade patterns due to the established economic integration state.
2. For European transition countries trade convergence indicators should capture actual deviation from the benchmark trade performance. Respective values are in range from zero up to the unity which reflects heterogeneity in convergence dynamics of selected transition countries. Nevertheless we suppose special selected cases of countries' overtrade with EU-15 when convergence measures could exceed unity. In current paper, we say that European transition country "undertrades" with EU-15 if its actual trade volume with EU-15 less

than the trade volume of country from EU-15 of the same size adjusted on distance and common boarder effects.

3. The indicators of trade convergence should be estimated over time to capture the dynamic process.

In current research we propose following trade convergence measures which fit in discussed properties set. The first one is the **systematic trade distance**. To obtain this measure we estimate gravity-type equation (20). Herein we estimate gravity model for EU-15 countries' bilateral trade flows and include into the sample transition country with time specific dummy. As the estimation result we obtain the vector of estimates ( $\delta$ ) near these dummy variables which we treat as systematic trade distance measures. For each European transition country we obtain the estimates of trade distance according to the data availability, i.e. Czech Republic for years 1993-2004, for Hungary - 1984-2004, etc.

$$\mu_{it} = e^{\delta_{it}} \quad (22)$$

The alternative measure we propose in current framework is the **income weighted trade distance**. Following this approach, we also apply the estimation for EU-15 bilateral trade sample and include transition country into the sample. The equation to be estimated in this case looks like:

$$\log(TV_{ijt}) = \phi_0 + \phi_1 \log(Y_{it}) + \phi_2 \log(Y_{jt}) + \phi_3 \log(D_{ij}) + ETC_{ij}(\alpha_{it} + \beta_{it} \log(Y_{jt})) + \varepsilon_{ijt} \quad (23)$$

Herein we obtain two estimates  $\hat{\alpha}_{it}$  and  $\hat{\beta}_{it}$  for each observed year for all transition countries in the sample. Then we proceed with income weighting procedure. As the weights we use GDP indicators of EU-15 countries. We follow the intuition that trade relations with richest countries from EU-15 could be initially more important for transition countries.

$$\delta_{it} = \frac{\sum_{j \in EU15} [\hat{\alpha}_{it} + \hat{\beta}_{it} \log(Y_{jt})] \log(Y_{jt})}{\sum_{j \in EU15} \log(Y_{jt})} \quad (24)$$

The income-weighted trade convergence measure would be equal to  $\mu_{it} = e^{\delta_{it}}$ .

Next we proceed with a schematic illustration of trade convergence process. For this purpose provide the combined diagram actual/predicted bilateral trade scatter plots for considered time period. As before, the 45 degree line is the benchmark level of the EU-15 trade

performance. Hereinafter, we treat this 45 degree line as the benchmark level for convergence analysis. If the actual/predicted dots lie on this line, it means that the actual bilateral trade equals to the trade volume predicted by the gravity benchmark model. Staring with an initial period, all dots for transition countries' trade with EU were under the 45 degree line. It means that all European transition countries exhibited the systematic undertrade with EU-15 in this period. During periods, we could observe that actual/predicted cloud for EU-15 moves up-right along the 45 degree line. It reflects the trade growth between these countries explained by the gravity model (growth of trade due economic growth in these countries). At the same time, the actual/predicted cloud for European transition countries lies on a line below the 45 degree line and reflects the systematic undertrade with EU-15 for the analyzed transition countries. Furthermore, actual/predicted cloud of transition countries moves up-right along the systematic deviation line, and this fact is also explained by economic growth in these countries and their trade partners in European Union. We say, the transition country exhibits the convergence to

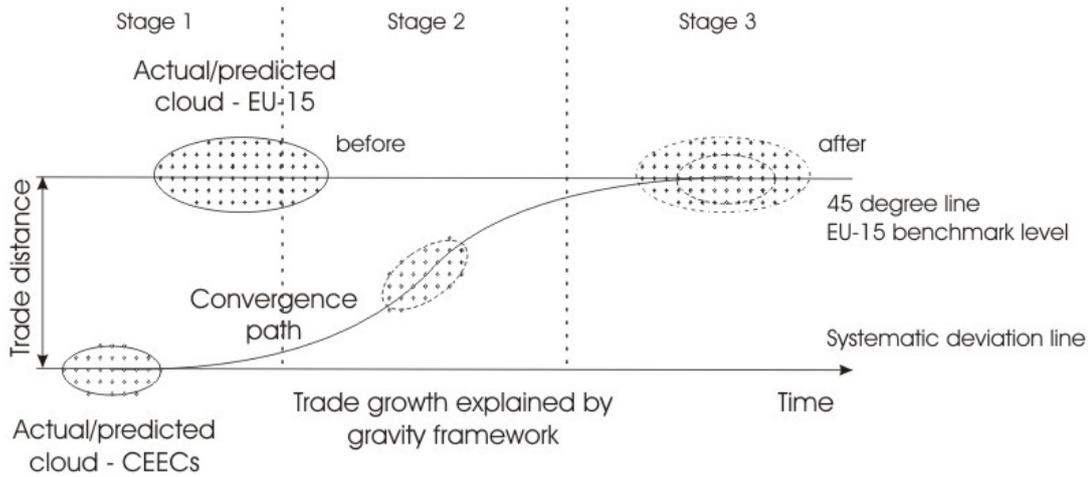


Figure 2: Mechanics of trade convergence

EU-15, if the systematic deviation line goes up to the 45 degree line with time. But in real world, trade convergence towards EU-15 appears to be more complex. Starting with the certain period, the actual/predicted cloud for transition rotates to the left round the systematic deviation line (see Figure 2). Current rotation reflect the fact that trade convergence process begins with the more close trade relations with the richest countries of EU-15. Then, the actual/predicted cloud for CEECs countries moves up to the 45 degree line and, finally, rotates to the right round the systematic deviation line. Intuitively, it reflects that transition countries established more close

trade relations with other countries from EU-15, following the trade experience of EU richest countries. The trade convergence process concludes in case when actual/predicted trade dots of the selected transition country gets to the 45 degree line. Note, this state could not always be stable. Trade performance of transition countries could deviate from the benchmark level due to various policy and demand shocks.

### 3.4 Decomposition of trade convergence

Previously we have discussed empirical framework for analysis of trade convergence in European transition economies towards EU-15 level. However, did the European transition economies become similar to EU-15 in terms of trade composition? In what follows we provide empirical methodology for analysis of trade convergence across two trade components: extensive and intensive margins. While trade growth on extensive margin implies increase in number of traded goods, trade growth on intensive margin relates to increase in trade volume per one product variety. In this respect, we develop empirical methodology to decompose the trade volumes convergence on extensive and intensive trade margin. We describe two alternative methods to provide decomposition of trade convergence.

**N-PQ decomposition.** For the current procedure, we use the gravity framework to explain the components of cross-country trade flows, and explore convergence of trade components to EU-15 level. Moreover, taking into account that trade flows volume is given as product of price, quantity, and variety components, we calculate the inputs of corresponding components in the whole trade convergence process. In what follows we describe trade convergence decomposition in more detail.

The basic trade decomposition utilized in consequent discussion measures intensive margin as number of SITC4 product categories ( $N_{ijt}$ ), and intensive margin as product of trade flows unit value ( $P_{ijt}$ ) and average quantity across product categories ( $Q_{ijt}$ ). That is,

$$P_{ijt} = \frac{\sum_{k \in \Omega_{ijt}} p_{ijt}^k q_{ijt}^k}{\sum_{k \in \Omega_{ijt}} q_{ijt}^k} \quad (25)$$

$$Q_{ijt} = \frac{\sum_{k \in \Omega_{ijt}} q_{ijt}^k}{N_{ijt}} \quad (26)$$

where  $p_{ijt}^k$  and  $q_{ijt}^k$  are the price and quantity of trade flows between country  $i$  and  $j$  in time  $t$  in  $k$ -th product category respectively. Note, that resulting trade flows decomposition satisfies the

condition that trade flows' volume equals product of price, quantity, and variety:

$$TV_{ijt} = N_{ijt} \times P_{ijt} \times Q_{ijt} \quad (27)$$

In previous section we developed measures for trade convergence process of CEECs towards EU-15. However, as we stated earlier, it is practically more important to investigate how this "aggregate" convergence goes across different trade components, and what weight has convergence of certain trade component in the trade convergence. For this purpose we use the gravity set of regressors (GDP's of exporting and importing countries, distance, common boarder dummy) and time-varying dummies for transition countries to capture convergence within trade components.

The first step is separate estimation of gravity-type regressions for trade components, similar to (20):

$$\log(N_{ijt}) = \mathbf{X}_{ijt} \vec{\beta}^N + \delta_{it}^N ETC_{ij} + \varepsilon_{ijt}^N \quad (28)$$

$$\log(PQ_{ijt}) = \mathbf{X}_{ijt} \vec{\beta}^{PQ} + \delta_{it}^{PQ} ETC_{ij} + \varepsilon_{ijt}^{PQ} \quad (29)$$

where  $\mathbf{X}_{ijt}$  is the vector of gravity explanatory variables. As before, we treat coefficients near dummy variable as systematic distance between trade components of a transition country and EU-15 benchmark level. Moreover, as far as trade volume equals to the product of extensive and intensive margins, systematic trade distance breaks into the sum of trade components systematic distances:

$$\delta_{it} = \delta_{it}^{EM} + \delta_{it}^{IM} \quad (30)$$

The corresponding systematic trade distance measure of convergence could be calculated as exponential function of systematic trade distance. Hence, systematic trade distance measure of convergence is product of respective trade components convergence measures.

**EM-IM decomposition following Hummels and Klenow.** The alternative point is the decomposition of trade convergence on Hummels-Klenow Intensive (IM) and Extensive (EM) margins. For this purpose Hummels-Klenow (2005) methodology of trade decomposition is adopted. Their approach draws heavily on Feenstra (1994) framework of import price indexes construction that controls for changes in the set of importing product varieties and product quality. Hummels and Klenow extend this approach to compare cross-country composition of trade flows on extensive and intensive margins. Following this idea, they introduce variety, price and quantity measures of bilateral trade flows relative to certain "reference" country's trade

flows. The constructed trade components satisfy the condition that product of respective trade components equals to the ratio of the analyzed country's bilateral trade flows to the trade flows of the "reference" country with the same trading partner.

Let's now formulate their decomposition methodology more precisely. The corresponding variety component is Hummels-Klenow *Extensive Margin* (EM):

$$EM_{ij}^r = \frac{\sum_{k \in \Omega_i} p_{rj}^k q_{rj}^k}{\sum_{k \in \Omega} p_{rj}^k q_{rj}^k} \quad (31)$$

where  $i$  and  $j$  stand for exporter and importer countries, respectively;  $p_{rj}^k q_{rj}^k$  is value of reference country's ( $r$ ) exports to  $j$  in product category  $k$ ;  $\Omega_i$  stands for the set of categories available to country  $i$ ; and  $\Omega$  is the set of product categories available for the reference country, so that  $\Omega_i \subset \Omega$ . Note that if the reference country exported the same value in each commodity group, the Hummels-Klenow extensive margin would equal to the ratio of country  $i$ 's number of export categories relative to the number of categories in reference country. Thus, the Hummels-Klenow extensive margin (for exports) weights the numbers of exported product categories by their relevance in exports of the reference country.

For the next step, Hummels and Klenow define *Intensive Margin* of a country  $i$  to be the measure of trade flows between countries  $i$  and  $j$  relative to trade flows between reference country and country  $j$  in a common set of goods (which is  $\Omega_i$ ):

$$IM_{ij}^r = \frac{\sum_{k \in \Omega_i} p_{ij}^k q_{ij}^k}{\sum_{k \in \Omega_i} p_{rj}^k q_{rj}^k} \quad (32)$$

Note that the intensive margin is defined so as the ratio of trade flows between countries  $i$  and  $j$  to the trade flows between reference country  $r$  and country  $j$  equals to the product of extensive and intensive margins. In current study we select EU-15 economy as the reference country for the further analysis.

Above mentioned issues are concerned with general decomposition of trade flows on extensive and intensive margin. However further we are interested in decomposition of trade convergence. We propose the following procedure of trade decomposition. The convergence measure for trade volumes breaks into convergence measure for extensive margin and intensive margin:

$$\frac{TV_{it}}{TV_t^{EU}} : \frac{TV_{it}^*}{TV_t^{EU}} = \mu_{it} = EM_{it} \times \frac{IM_{it}}{IM_{it}^*} \quad EM_{it}^* = 1, \quad (33)$$

where  $TV_{it}$  and  $TV_{it}^*$  are actual and potential trade flows with EU-15 respectively for country  $i$  in time  $t$ .  $TV_t^{EU}$  are the intra-EU trade flows in different time periods. In current decomposition we assume 100% level<sup>13</sup> of extensive margin ( $EM_{it}^*$ ) as potential for transition country trade variety. Consequently, using this common potential for all transition countries, we could calculate potential for intensive margin ( $IM_{it}^*$ ) dividing potential of trade volume by intra EU-15 trade volume.

## 4 Estimation results

In this section we document empirical evidence on the patterns of trade convergence in European transition economies. Following our empirical methodology, we estimate gravity equation not only for the trade volumes, but also for the trade components: extensive and intensive margin. We include in the sample two groups of country pairs: two EU-15 countries and countries from CEECs and EU-15. Then we run pooled OLS estimation of gravity equations with individual time effects for each transition country.

In Table 2 we present results of econometric estimation, with skipped transition countries' time effects. We report estimation results for the two gravity specifications: (1) with basic gravity regressors: logarithm of exporter's ( $lgdpe$ ) and importer's GDP ( $lgdpi$ ), logarithm of distance between capital cities of the trading partners ( $ld$ ) and indicator of common border between countries ( $cb$ ); and (2) with additional generalized gravity regressors of populations for exporter ( $lpopex$ ) and importer ( $lpopi$ ). Standard errors are reported in parentheses.

The signs of estimated coefficients are consistent with our theoretical framework. In particular, economic sizes (GDP) of trading partners positively influence both extensive and intensive margins, whereas distance between capital cities influences negatively both trade components<sup>14</sup>. Note that the sum of estimated coefficients in equations for extensive and intensive margins equals to the corresponding coefficient in the trade value equation.

However, our major interest lies in estimated time effects for transition economies. These time effects indicate systematic deviations from the "normal" level of trade predicted by gravity model. In the context of trade convergence analysis, we consider estimated time effects as "systematic trade distance" convergence measure. On the following figures we illustrate the

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<sup>13</sup>If extensive margin achieves 100% level for a certain transition country, it means that this country trades in the same product set, as European Union does.

<sup>14</sup>Distance between capital cities proxies variable trade costs.

|           | Trade Value          |                      | Extensive Margin     |                      | Intensive Margin     |                      |
|-----------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|           | (1)                  | (2)                  | (1)                  | (2)                  | (1)                  | (2)                  |
| lgdpe     | 0.733<br>(0.009)***  | 0.868<br>(0.021)***  | 0.342<br>(0.005)***  | 0.443<br>(0.012)***  | 0.391<br>(0.007)***  | 0.426<br>(0.016)***  |
| lgdpi     | 0.774<br>(0.009)***  | 0.420<br>(0.021)***  | 0.201<br>(0.005)***  | -0.045<br>(0.012)*** | 0.572<br>(0.006)***  | 0.464<br>(0.016)***  |
| ld        | -0.717<br>(0.022)*** | -0.121<br>(0.023)*** | -0.417<br>(0.013)*** | -0.093<br>(0.013)*** | -0.300<br>(0.016)*** | -0.028<br>(0.017)*** |
| lpope     |                      | 0.431<br>(0.023)***  |                      | 0.299<br>(0.013)***  |                      | 0.133<br>(0.017)*    |
| lpopi     |                      | -0.784<br>(0.021)*** |                      | -0.462<br>(0.012)*** |                      | -0.322<br>(0.016)*** |
| cb        | 0.721<br>(0.033)***  | 0.639<br>(0.033)***  | 0.052<br>(0.020)***  | -0.002<br>(0.019)    | 0.669<br>(0.024)***  | 0.641<br>(0.024)***  |
| constant  | 7.380<br>(0.234)***  | 5.462<br>(0.281)***  | 1.955<br>(0.138)***  | 0.683<br>(0.162)***  | 5.426<br>(0.168)***  | 4.779<br>(0.209)***  |
| obs. num. | 3822                 | 3822                 | 3822                 | 3822                 | 3822                 | 3822                 |
| R-Squared | 0.863                | 0.875                | 0.722                | 0.754                | 0.835                | 0.837                |

Table 2: Estimation of gravity-type equations

trade convergence of transition countries on the actual/predicted scatter plot.

The small square dots refer to the EU-15 bilateral trade flows observations. The EU-15 actual/predicted cloud is centered around the 45 degree line. To provide the comparative analysis, we also illustrate the Poland's and Hungary's observations of the same figure (see Figures 3-4). The big square dots are the Poland's observation, the round dots are the Hungary's trade observations. Starting with the year of 1984, we could observe the systematic deviation between CEECs and EU-15 trade performance. Speaking in gravity framework terms, in 1984 Poland and Hungary undertraded with EU-15 countries.

The next period we illustrate is the year 1992. We can observe the rotation of Hungary's and Poland's actual/predicted clouds (see Figure 3). Economic intuition behind this fact is enhancing the trade relations with the rich countries of European Union. On Figures 3-4, the trade convergence is illustrated as the vertical adjustment of CEECs actual/predicted clouds up

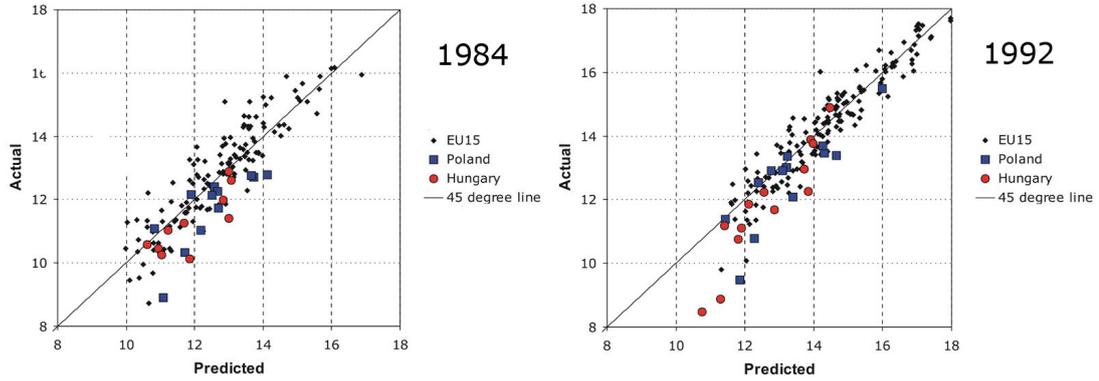


Figure 3: Trade patterns of transition countries in 1984 and 1992

to 45-degree line of EU-15 benchmark trade level.

We find clear empirical evidence on the systematic process of trade convergence in CEECs. At the same time, convergence in trade volume can be compared with substantial changes in trade composition, that occurred in CEECs since the beginning of market transition. Following this logic, we consider trade convergence across two trade components: extensive and intensive margins.

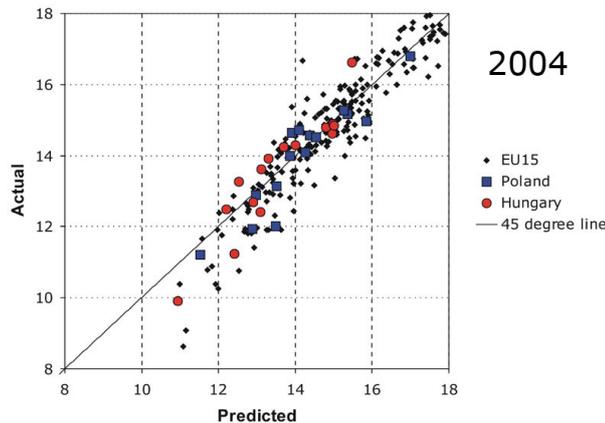


Figure 4: Trade patterns of transition countries in 2004

Firstly, we use Hummels-Klenow measures of extensive and intensive margin to illustrate changes in trade components of transition economies relative to EU-15 level. The Figure 5 reveals how Hummels-Klenow extensive margin for selected CEE countries evolved during the period 1984-2004. In the period of planned economy, CEECs exports variety was quite low comparing with EU-15 countries. The process of market transition led to significant changes in trade structure and growth of extensive margin. Following the wave of economic and trade

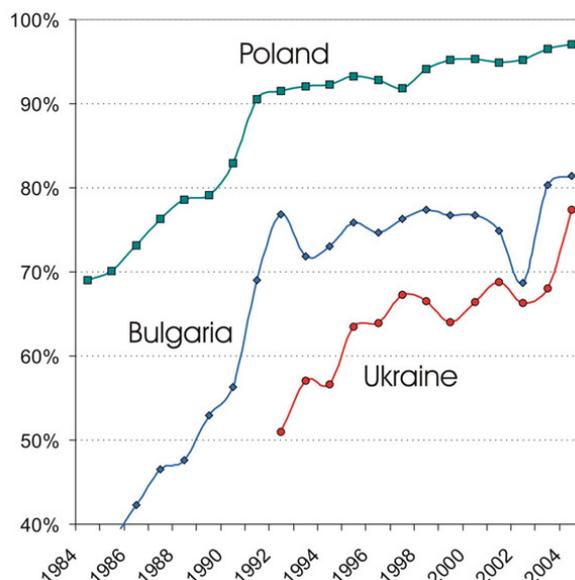


Figure 5: Trade decomposition: Extensive Margin

liberalization CEECs began to enter Western European markets with new product varieties. Correspondingly, by the year 1992 the extensive margin of exports rose up to 92% of EU-15 level for Poland and up to 78% of EU-15 for Bulgaria.

At the same time, the intensive margin of CEECs exports to EU-15 countries substantially declined over the period 1984-1992. Decreasing intensive margin reflects less "intensive" exports to EU-15, that means less exports per one product category comparing with intra-EU-15 trade. The reason is that large number of new product varieties was exported at lower quantities and values relative to intra-EU-15 exports than the "old" export varieties. From the Figure 6 we can see that by the year 1992 the intensive margin was stabilized in various CEECs and then start rising. Basically, in 1992-2004 the CEECs exports to EU-15 showed high growth performance due to the rise of intensive margin. At the same time, the extensive margin accounted for relatively low value of additional exports. We also reveal important heterogeneity among the transition economies considering the changes in trade composition relative to EU-15 countries. Hungary, Poland and Czech Republic, being among "the most advanced" CEECs economies, have clearly outperformed other CEECs in terms of extensive margin relative to EU-15<sup>15</sup>. At the same time, these countries experienced the fastest growth of intensive margin during the period 1991-2004 among all the CEECs.

<sup>15</sup>In 2004 the extensive margin of exports for Poland and Czech Republic was 97% and for Hungary 95% (relative to EU-15).

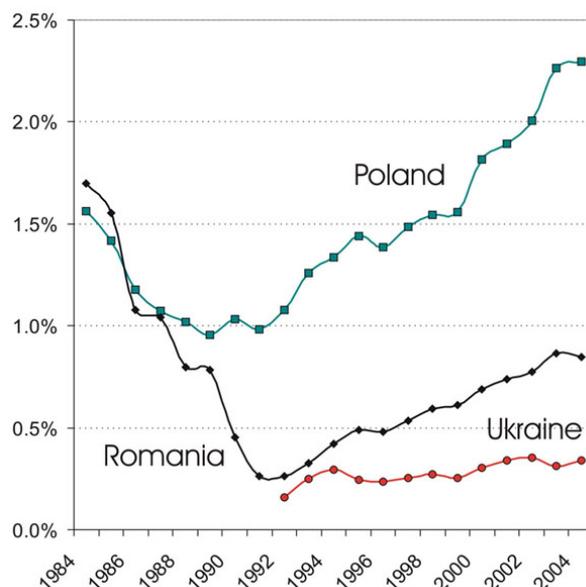


Figure 6: Trade decomposition: Intensive Margin

Considering the documented empirical evidence, the important question is which of the economic fundamentals lay behind trade convergence and changes in trade composition in European transition economies. Answering this question we use our extension of Helpman-Melitz-Rubinstein (2005) and Chaney (2006) models, which allows both extensive and intensive margins depend on economic sizes of trading partners, fixed and variable trade cost and aggregate productivity of firms. Importantly, other things being equal, in this model decreasing fixed cost of exporting leads to opposite movements of trade margins: while extensive margin grows, intensive margin declines.

In order to test the predictions of the theoretical model with empirical evidence, we estimate gravity-type regressions for both extensive and intensive trade margins with individual time effects for transition economies<sup>16</sup>. This procedure allows eliminating the influence of GDP growth in trading countries on trade components. In the result, estimated individual time effects reflect the convergence process of extensive and intensive trade margins due to unobserved variables: trade costs and aggregate productivity.

We obtain the resulting decomposition of trade convergence on extensive and intensive margin for 9 transition economies: Poland, Hungary, Czech Republic, Slovak Republic, Estonia, Latvia, Lithuania, Ukraine (See Appendices 4-6). For those countries, where we are able to

<sup>16</sup>See Table 2 above

track trade convergence from the year 1984 to 1992 (Poland and Hungary), we observe sharp increase in extensive margin indicator, whereas intensive margin declines<sup>17</sup>. At the same time, we could not explain the observed patterns, if we don't assume decrease in fixed cost of trade. This fact directly stems from the properties of the theoretical model.

Moreover, in the proposed theoretical framework we provide interpretation of empirical results and uncover the mechanics of trade convergence in European transition countries. In the beginning of market transition, fixed cost of trade with European Union decreases. Consequently, threshold level of productivity for exporting declines, and new firms begin to enter EU market with new product varieties. In turn, this leads to rising variety of trade. At the same time, intensive margin drops as far as new exporting firms are less productive than "old" exporters. In the second phase of trade convergence, intensive margin demonstrates fast growth, while extensive margin grows at much lower pace. Basing on the theoretical model, we assume that exogenous rise of aggregate firms' productivity could be the important factor of the substantial increase in intensive margin. The new exporting firms benefit from rising productivity and increase quantities and values of exports.

At the same time our empirical methodology allows to construct measures of trade convergence not only of trade volumes, but also of extensive and intensive trade margins. These measures indicate, to what extent certain transition economy succeeded in "normalization" of trade relations with European Union<sup>18</sup>. On the other hand, calculated indicators allow to make inference about the input of each trade component into the convergence in trade volumes. This evidence could be important for policy-makers in transition economies.

Our empirical findings confirm that patterns of trade convergence are different for the analyzed transition countries (see Appendices 4-6). Considering our estimation results, in the sample of CEECs the best performance was shown by Hungary with almost achieved convergence on trade volume. At the same time, while Hungary outperformed other transition countries on intensive margin convergence, Czech Republic demonstrated the highest convergence achieved on extensive margin. In 2004 Poland and Czech Republic, following Hungary, were the closest to the benchmark level of EU-15 trade performance. Slovakia's convergence path was similar to Hungarian one, still with lower degree of achieved convergence level. At the same time, Slovenia did not converge at all neither by exports nor by imports.

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<sup>17</sup>These results could be compared with results of Hummels-Klenow decomposition.

<sup>18</sup>Each constructed measure of trade convergence is scaled so that 1 means "normal" level of EU-15 countries.

In the sample of Former Soviet Union countries, Estonia demonstrated the best trade convergence performance. Starting with late 90's Latvia and Lithuania demonstrate simultaneous increase in extensive margin and decrease in intensive margin indicator. This pattern signals about diminishing fixed trade cost in these countries. Comparing to CEECs and the Baltic states, Ukraine possesses the lowest rank in terms of achieved trade convergence towards European Union. According to our calculations, Ukraine was over 3 times undertraded with EU-15 countries. Moreover, we revealed that convergence on exports is not balanced with convergence on imports for such countries as Latvia, Lithuania, Estonia, Slovenia and Poland. For these countries we report higher level of imports convergence comparing with exports one.

## 5 Conclusions

The paper investigates the patterns of trade convergence in European transition countries. Unlike the vast literature on trade potentials of CEECs, we consider convergence of two trade components: extensive and intensive margins. While the first part of trade convergence relates to extension of trade categories' set, the second part controls for trade intensification per one product category. We explore how trade convergence goes across extensive and intensive margins and discuss economic fundamentals of observed patterns.

Our theoretical framework extends models of Helpman, Melitz and Rubinstein (2005) and Chaney (2006), allowing both extensive and intensive margins of trade be influenced by economic sizes of trading partners, fixed and variable trade cost and firms' productivity. Proposed theoretical model is helpful for explaining mechanics of the trade convergence process in European transition countries. Our empirical findings suggest that in the first years after the beginning of market transition, extensive margin of trade sharply increased. Simultaneously, intensive margin of trade considerably declined. Later on, intensive margin begins to grow, while growth of extensive margin slows down.

Eliminating the influence of economic growth on extensive and intensive margins, we explain observed empirical patterns of trade convergence with initial reduction of fixed cost of trade. As motivated from the presented theoretical model, initial reduction of fixed trade cost leads to appearance of new exporters and consequent rise of the trade variety. At the same time, average productivity of exporting firms decreases, because new exporters are less productive than old exporters. Consequently, intensive margin of trade declines.

The empirical findings of the paper confirm the significant heterogeneity of trade convergence patterns among various transition countries. Our results indicate, that such advanced CEE countries as Hungary, Poland and Czech Republic exhibited the best performance in terms of trade convergence. The polar case is Ukraine that still underperforms in normalization of trade pattern with EU-15. The special case is Slovenia that has almost not converged.

Finally, our project provides deeper understanding of trade convergence process in European transition countries. Results of trade convergence decomposition on extensive and intensive margins can be used as efficiency indicators for economic policies of transition countries. At the same time, performed analysis of trade convergence process in advanced CEE countries could provide useful insights to the policy making for new EU candidate countries.

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## Appendix 1. Mathematical proofs.

**Proposition 1.** Under assumption (A1):  $\frac{V_{ij}(\phi)}{U_{ij}(\phi)\phi^{\sigma-1}}$  is monotonically decreasing in  $\phi$ , the following result holds: *If an ideal price index of importing country does not change, then intensive margin of exports is positively related to GDP growth in importing country.*

**Proof.** From (18), (13), (12) and (9) we obtain:

$$\begin{aligned}\frac{\partial \ln IM_{ij}}{\partial Y_j} &= \frac{1}{Y_j} + \frac{1}{V_{ij}} \times \frac{\partial V_{ij}}{\partial Y_j} - \frac{1}{U_{ij}} \times \frac{\partial U_{ij}}{\partial Y_j} = \\ &= \frac{1}{Y_j} - \frac{1}{V_{ij}} \times \tilde{\phi}_{ij}^{\sigma-1} g(\tilde{\phi}_{ij}) \times \frac{\partial \tilde{\phi}_{ij}}{\partial Y_j} + \frac{1}{U_{ij}} \times g(\tilde{\phi}_{ij}) \times \frac{\partial \tilde{\phi}_{ij}}{\partial Y_j} = \\ &= \frac{1}{Y_j} + \left( \frac{1}{U_{ij}} - \frac{\tilde{\phi}_{ij}^{\sigma-1}}{V_{ij}} \right) \times g(\tilde{\phi}_{ij}) \times \frac{\partial \tilde{\phi}_{ij}}{\partial Y_j}.\end{aligned}$$

From (9) we have that  $\frac{\partial \tilde{\phi}_{ij}}{\partial Y_j} = -\frac{\tilde{\phi}_{ij}}{(\sigma-1)Y_j}$ . Therefore,

$$\frac{\partial \ln IM_{ij}}{\partial Y_j} = \frac{\tilde{\phi}_{ij}}{(\sigma-1)Y_j} \times \left( \frac{\sigma-1}{\tilde{\phi}_{ij}} - \left( \frac{1}{U_{ij}} - \frac{\tilde{\phi}_{ij}^{\sigma-1}}{V_{ij}} \right) \times g(\tilde{\phi}_{ij}) \right)$$

Let us denote

$$f(\phi) = \frac{\sigma-1}{\phi} - \left( \frac{1}{U_{ij}(\phi)} - \frac{\phi^{\sigma-1}}{V_{ij}(\phi)} \right) \times g(\phi)$$

Then,

$$\begin{aligned}f(\phi) &= \frac{\sigma-1}{\phi} \left( \frac{\partial V_{ij}/\partial \phi}{V_{ij}} - \frac{\partial U_{ij}/\partial \phi}{U_{ij}} \right) = \\ &= \frac{U_{ij}}{V_{ij}} \times \left( \frac{\sigma-1}{\phi} \times \frac{V_{ij}}{U_{ij}} - \frac{\partial V_{ij}/U_{ij}}{\partial \phi} \right) = \\ &= -\frac{U_{ij}}{V_{ij}} \times \frac{\partial \left( \frac{V_{ij}}{U_{ij}\phi^{\sigma-1}} \right)}{\partial \phi}\end{aligned}$$

As far as  $\partial \left( \frac{V_{ij}}{U_{ij}\phi^{\sigma-1}} \right) / \partial \phi < 0$  by assumption (A1), we obtain that  $\frac{\partial \ln IM_{ij}}{\partial Y_j} > 0$ . This actually means that intensive margin of exports is positively related to GDP growth in importing country. ■

**Proposition 2.** Under assumption (A2):  $V_{ij}(\phi)/U_{ij}(\phi)\phi^{\frac{(\sigma-1)^2}{\sigma}}$  is monotonically increasing in  $\phi$ , the following result holds: *If an ideal price index of importing country does not change and wages in exporting country are positively related to GDP growth, then intensive margin of exports is positively related to GDP growth in exporting country.*

**Proof.** As in proof of Proposition 1, from (18), (13), (12) and (9) we have:

$$\begin{aligned}\frac{\partial \ln IM_{ij}}{\partial Y_i} &= \frac{(1-\sigma)}{w_i} \times \frac{\partial w_i}{\partial Y_i} + \frac{1}{V_{ij}} \times \frac{\partial V_{ij}}{\partial Y_i} - \frac{1}{U_{ij}} \times \frac{\partial U_{ij}}{\partial Y_i} = \\ &= \frac{1}{w_i} \times \frac{\partial w_i}{\partial Y_i} \times \tilde{\phi}_{ij} \times \left( -\frac{\sigma-1}{\tilde{\phi}_{ij}} + \left( \frac{1}{U_{ij}} - \frac{\tilde{\phi}_{ij}^{\sigma-1}}{V_{ij}} \right) \times g(\tilde{\phi}_{ij}) \times \left( \frac{\sigma}{\sigma-1} \right) \right)\end{aligned}$$

Then, following the same computations as in proof of Proposition 1, we obtain that

$$\frac{\partial \ln IM_{ij}}{\partial Y_i} = \frac{1}{w_i} \times \frac{\partial w_i}{\partial Y_i} \times \tilde{\phi}_{ij} \times \frac{U_{ij}}{V_{ij}} \times \frac{\partial \left( \frac{V_{ij}}{U_{ij} \tilde{\phi}_{ij}^{\frac{(\sigma-1)^2}{\sigma}}} \right)}{\partial \tilde{\phi}_{ij}}$$

Hence, we directly obtain that  $\frac{\partial \ln IM_{ij}}{\partial Y_i} > 0$ , i.e. intensive margin of exports is positively related to GDP growth in exporting country. ■

**Proposition 3.** *If an ideal price index of importing country does not change, then intensive margin of exports is positively related to growth of fixed cost of exporting.*

**Proof.** This directly stems from (9) and (18). If fixed cost of exporting rises, threshold level of productivity for exporting also rises. Hence, average productivity of exporting firms and intensive margin of exports rise, too. And vice versa, if fixed cost of exporting declines, intensive margin of exports also declines. ■

**Proposition 4.** *Under assumption (A1), If an ideal price index of importing country does not change, then intensive margin of exports is negatively related to growth of variable trade cost.*

**Proof.** Following the same computations as in previous proofs, we obtain that

$$\frac{\partial \ln IM_{ij}}{\partial \ln \tau_{ij}} = -\tilde{\phi}_{ij} \times \left( \frac{\sigma-1}{\tilde{\phi}_{ij}} - \left( \frac{1}{U_{ij}} - \frac{\tilde{\phi}_{ij}^{\sigma-1}}{V_{ij}} \right) \times g(\tilde{\phi}_{ij}) \right)$$

Hence, using the assumption (A1) we get  $\frac{\partial \ln IM_{ij}}{\partial \ln \tau_{ij}} < 0$ . ■

**Proposition 5.** *If an ideal price index of importing country does not change, then extensive margin of exports is positively related to GDP growth of importing country.*

**Proof.** This directly stems from the fact, that threshold level of productivity for exporting (9) is inversely related to GDP of importing country. Therefore, if GDP of importing country grows, then threshold level of productivity for exporting declines, and grows part of exporting firms  $U_{ij}$ . Finally, this leads to growth of extensive margin. ■

**Proposition 6.** Under assumption (A3) that

$$\frac{\partial \ln w_i}{\partial \ln Y_i} < \frac{1}{1 + \frac{\sigma}{\sigma-1} \times \frac{\tilde{\phi}_{ij}g(\tilde{\phi}_{ij})}{1-G(\tilde{\phi}_{ij})}}$$

If an ideal price index of importing country does not change, then extensive margin of exports is positively related to GDP growth of exporting country.

**Proof.** From (9), (12), (17) we have that

$$\frac{\partial \ln EM_{ij}}{\partial \ln Y_i} = 1 - \frac{\partial \ln w_i}{\partial \ln Y_i} \times \left( 1 - \frac{\sigma}{\sigma-1} \times \frac{\partial \ln U_{ij}}{\partial \ln \tilde{\phi}_{ij}} \right).$$

Since  $\frac{\partial \ln U_{ij}}{\partial \ln \tilde{\phi}_{ij}} = -\frac{\tilde{\phi}_{ij}g(\tilde{\phi}_{ij})}{1-G(\tilde{\phi}_{ij})}$  and (A3) holds, we directly obtain that  $\frac{\partial \ln EM_{ij}}{\partial \ln Y_i} > 0$ . ■

**Proposition 7.** If an ideal price index of importing country does not change, then extensive margin of exports is negatively related to fixed cost of exporting.

**Proof.** As in proof of Proposition 5, threshold level of productivity for exporting positively depends on fixed cost of exporting, and Extensive margin of exports is negatively related to the threshold productivity. ■

**Proposition 8.** If an ideal price index of importing country does not change, then extensive margin of exports is negatively related to variable trade cost.

**Proof.** As in Propositions 5, 7, rising variable trade cost leads to growth of threshold productivity level, and consequently to decline in Extensive margin. Vice versa, diminishing variable trade cost results in growth of Extensive margin. ■

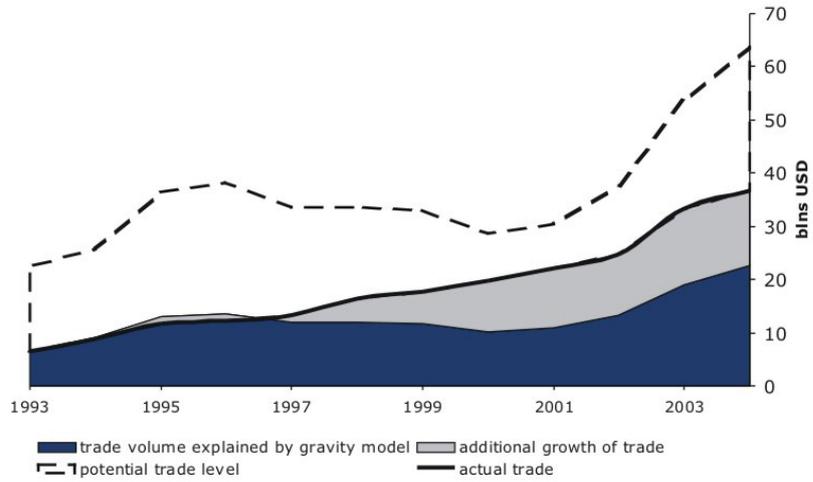
## Appendix 2. Trade flows decomposition.

| Country         |    | 1984  | 1988  | 1990  | 1994  | 1998  | 2000  | 2004  |
|-----------------|----|-------|-------|-------|-------|-------|-------|-------|
| Czech Republic  | EM |       |       |       | 0.941 | 0.955 | 0.958 | 0.968 |
|                 | IM |       |       |       | 0.010 | 0.014 | 0.016 | 0.019 |
|                 | TV |       |       |       | 0.009 | 0.013 | 0.016 | 0.019 |
| Estonia         | EM |       |       |       | 0.516 | 0.690 | 0.739 | 0.788 |
|                 | IM |       |       |       | 0.001 | 0.002 | 0.003 | 0.002 |
|                 | TV |       |       |       | 0.001 | 0.002 | 0.002 | 0.002 |
| Hungary         | EM | 0.657 | 0.738 | 0.845 | 0.921 | 0.943 | 0.925 | 0.948 |
|                 | IM | 0.009 | 0.007 | 0.006 | 0.008 | 0.014 | 0.017 | 0.018 |
|                 | TV | 0.006 | 0.005 | 0.005 | 0.007 | 0.013 | 0.016 | 0.017 |
| Latvia          | EM |       |       |       | 0.433 | 0.588 | 0.620 | 0.674 |
|                 | IM |       |       |       | 0.003 | 0.002 | 0.002 | 0.002 |
|                 | TV |       |       |       | 0.001 | 0.001 | 0.002 | 0.001 |
| Lithuania       | EM |       |       |       | 0.481 | 0.592 | 0.632 | 0.746 |
|                 | IM |       |       |       | 0.002 | 0.002 | 0.003 | 0.002 |
|                 | TV |       |       |       | 0.001 | 0.001 | 0.002 | 0.002 |
| Poland          | EM | 0.691 | 0.786 | 0.829 | 0.923 | 0.941 | 0.953 | 0.970 |
|                 | IM | 0.016 | 0.010 | 0.010 | 0.013 | 0.015 | 0.018 | 0.023 |
|                 | TV | 0.011 | 0.008 | 0.009 | 0.012 | 0.015 | 0.017 | 0.022 |
| Slovak Republic | EM |       |       |       | 0.805 | 0.851 | 0.868 | 0.918 |
|                 | IM |       |       |       | 0.003 | 0.006 | 0.006 | 0.008 |
|                 | TV |       |       |       | 0.003 | 0.005 | 0.005 | 0.008 |
| Slovenia        | EM |       |       |       | 0.840 | 0.886 | 0.858 | 0.888 |
|                 | IM |       |       |       | 0.005 | 0.005 | 0.005 | 0.005 |
|                 | TV |       |       |       | 0.005 | 0.005 | 0.004 | 0.004 |
| Ukraine         | EM |       |       |       | 0.566 | 0.665 | 0.664 | 0.774 |
|                 | IM |       |       |       | 0.003 | 0.003 | 0.003 | 0.003 |
|                 | TV |       |       |       | 0.002 | 0.002 | 0.002 | 0.003 |
| Bulgaria        | EM | 0.385 | 0.476 | 0.563 | 0.731 | 0.774 | 0.767 | 0.814 |
|                 | IM | 0.004 | 0.002 | 0.002 | 0.002 | 0.003 | 0.003 | 0.003 |
|                 | TV | 0.002 | 0.001 | 0.001 | 0.002 | 0.002 | 0.002 | 0.003 |
| Romania         | EM | 0.545 | 0.617 | 0.570 | 0.760 | 0.789 | 0.820 | 0.863 |
|                 | IM | 0.017 | 0.008 | 0.005 | 0.004 | 0.006 | 0.007 | 0.008 |
|                 | TV | 0.009 | 0.005 | 0.003 | 0.003 | 0.005 | 0.006 | 0.007 |

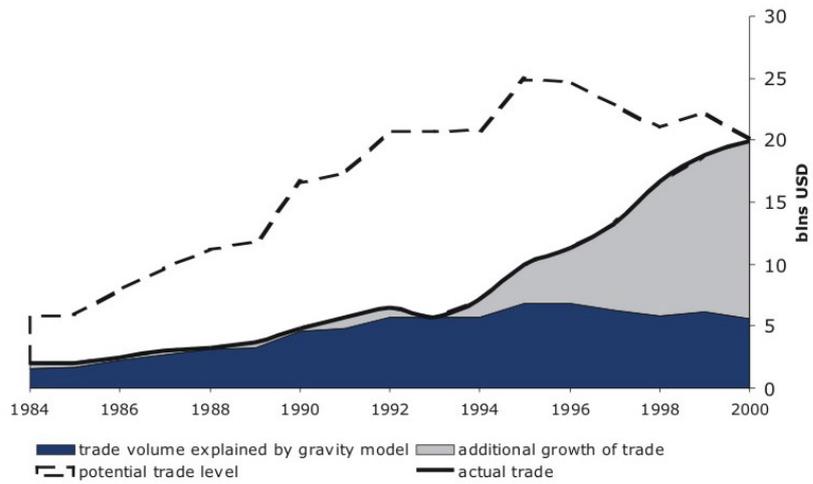
Trade decomposition for European transition countries was provided following Hummels and Klenow (2005) procedure. Herein we use EU-15 as a reference country for further decomposition.

Appendix 3. Trade growth and convergence in European transition countries.

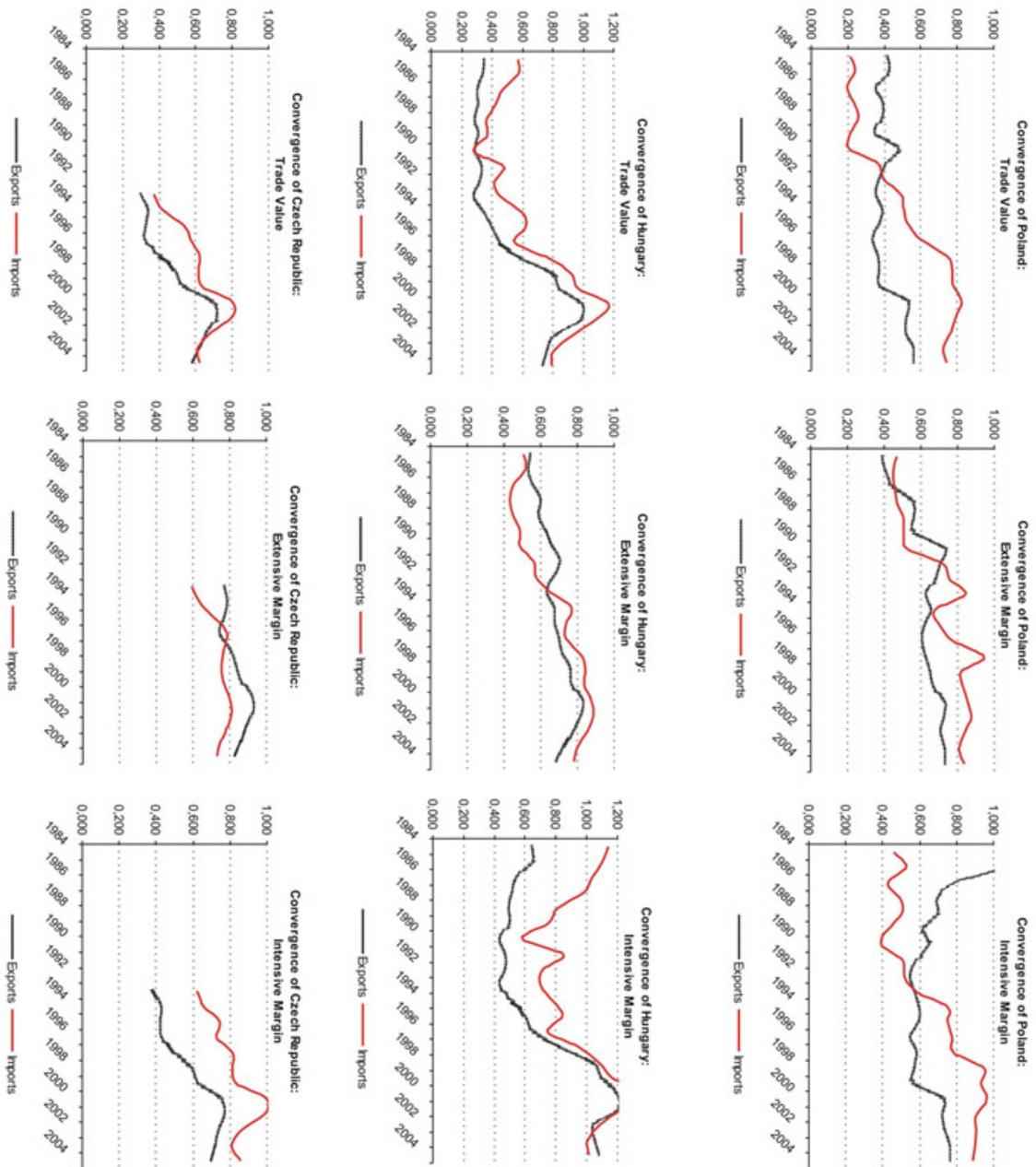
Czech Republic



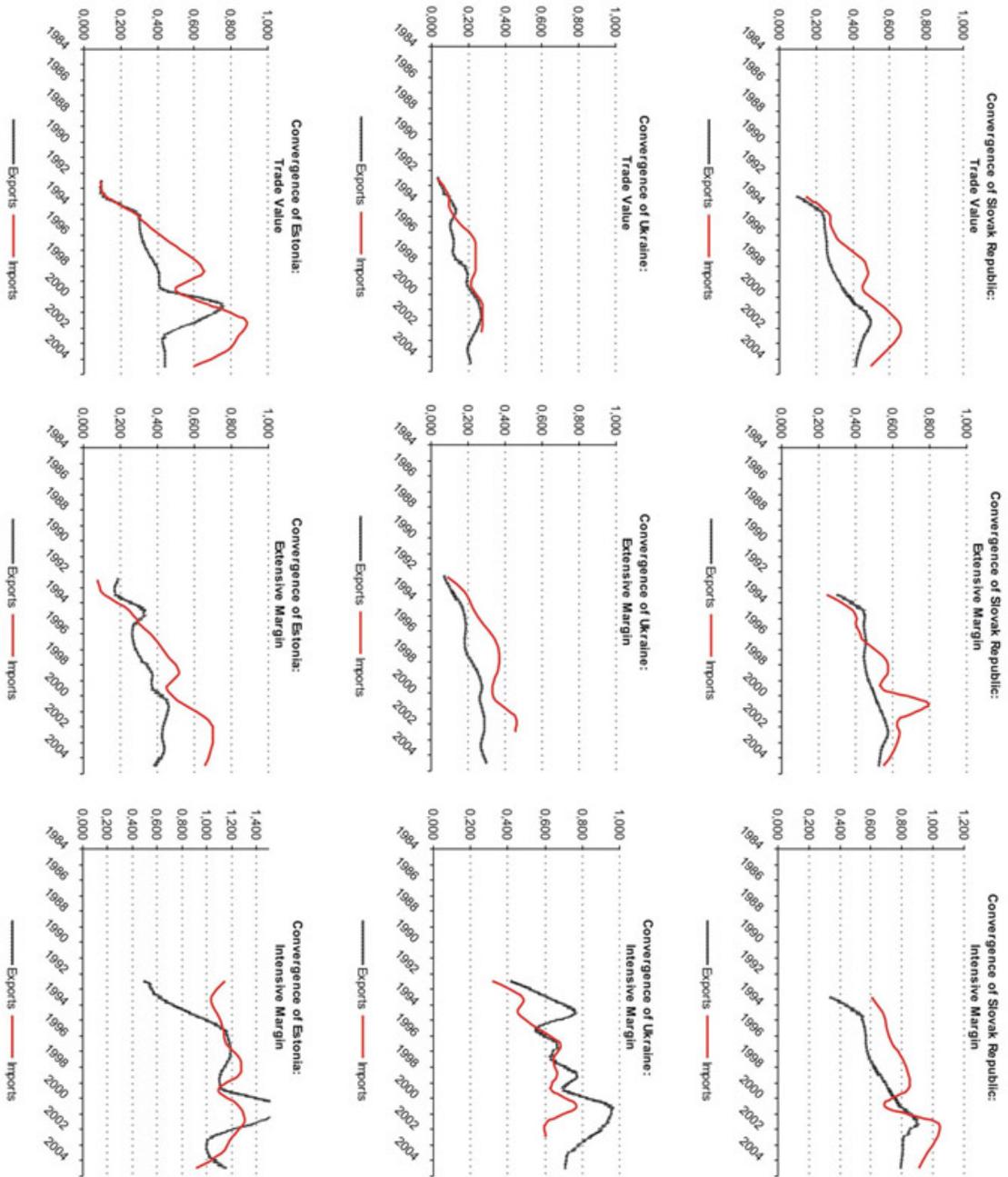
Hungary



## Appendix 4. Trade convergence of Poland, Hungary and Czech Republic.



Appendix 5. Trade convergence of Slovak Republic, Ukraine and Estonia.



## Appendix 6. Trade convergence of Latvia, Lithuania and Slovenia.

