Università degli Studi di Macerata

Dipartimento di Istituzioni Economiche e Finanziarie

Similarity in export composition and catching-up

Luca De Benedictis e Lucia Tajoli

Temi di discussione n. 28

Similarity in export composition and catching-up

Luca De Benedictis e Lucia Tajoli

Abstract

In this paper we look at the role of export composition in the growth process, considering how increased similarity in trade structure among countries can induce catching-up in income levels.

We apply our analysis to the Central and Eastern European Countries (CEECs) using the EU as a benchmark. We explicitly consider the sectoral export patterns of the CEECs by comparing them to those of the current members of the EU, focusing on countries' specialization as suppliers for the EU market.

Our main result is that similarity in export composition has a positive, significant and nonlinear impact on catching-up, and seems to be driven by the growth of the main export market more than by other factors. Results are robust to controlling for openness and country-size and for investment, schooling, and the quality of institutions.

Luca De Benedictis, DIEF - University of Macerata - Via Crescimbeni 20, Macerata 62100, Italy. +3907332583235. debene@unimc.it
Lucia Tajoli, Dipartimento di Ingegneria Gestionale, Politecnico di Milano - Via Giuseppe Colombo 40, Milano 20133, Italy. +390223992752. lucia.tajoli@polimi.it

1 Introduction

In this paper we examine the much-debated relationship between trade and economic growth from a specific viewpoint: the role of export structures in bringing about similar income levels across a group of trading countries. A wide range of theoretical approaches - from post-keynesian models of trade and growth to endogenous growth models - suggest that the link between a country's growth rates and its level of openness hinges on the characteristics of the country's trade pattern. But in spite of the suggestions coming from theoretical models, most of the empirical literature limits the analysis to the effect of aggregate openness indicators on growth. Here we try to bridge theoretical propositions and empirical analysis, by explicitly considering trade structure as a determinant of growth. More specifically, we test whether different or similar export compositions affect the catching up process,[1] on the basis that more than openness *per sè* what should matter in moving income levels closer together is a country's export pattern relative to its main partners.

The empirical exercise focuses on the recent EU enlargement to the Central-Eastern European countries (CEECs). This integration process is interesting to examine for a number of reasons. First, the CEECs display strong dynamics both in terms of GDP and changes in trade structures. Since the very early phases of transition, the CEECs opened up significantly to trade, especially toward the EU, changing sharply both the geographic and sectoral orientation of their trade flows. Such a change was not uniform, bringing about different trade structures among the CEECs. Second, being very open economies, any mechanism linking growth and trade is likely to operate fully for the CEECs. Third, those countries experienced also a catching up process toward the EU income levels, even if the distance from the EU in this respect is still very large.

Are the above mentioned phenomena somehow related? Is similarity in export composition affecting convergence in income per capita? These are relevant questions with important policy implications, but to the best of our knowledge they don't have yet a conclusive answer. The empirical evidence

[1]Here we don't consider explicitly income growth rates as we don't apply directly the definition of convergence by Barro and Sala-i-Martin (1995) that economies with lower levels of per capita income tend to grow faster in per capita terms. Instead, we look at relative per capita income levels or differences in income levels, and we name convergence or catching-up the process through which economies with lower per capita income levels close the existing gap. We prefer to follow this approach because for the countries in our sample and on the relatively short time span we consider, the instability in GDP growth rates is too high to give indications about a country's long run growth path.

for the CEECs and the EU suggests that such a correlation indeed exists and it is quite robust (De Benedictis and Tajoli, 2004b). Moving from this result, we also explore the mechanisms that might give rise to it. In the next section we suggest how similarity in trade structures and in income levels may be linked, while the two following sections present the empirical evidence for the EU and the CEECs on export composition and catching-up. Section five concludes.

2 How are export composition and catching-up related?

After a wave of empirical literature on openness and growth which was largely anecdotal and used very simple cross-country estimation techniques, the work developed in the 1990s tried to address some of the shortcomings of the previous literature, establishing the link between trade and growth on firmer grounds. The papers by Dollar (1992), Sachs and Warner (1995), Edwards (1998), Frankel and Romer (1999) are just a sample of the studies finding a positive relation between openness indicators and growth rates amplifying the consensus on the positive effect of trade on growth.

But this more recent wave of literature was heavily disputed too, on the basis that the empirical results were not robust to changes in the time period or group of countries being analyzed. The use of different indicators was criticized, as it implicitly assumes different mechanisms through which trade influences economic performance, without explicitly addressing this important point (Hallak and Levinsohn, 2004). Part of the literature linking trade and growth rates sees openness as inversely related to distortions in the economy, and as an indicator of the correct functioning of the market and price mechanism, leading to suitable investment decisions and therefore to growth (Baldwin, 2004). While this mechanism could be very relevant especially in many less developed countries, the openness indicators may in fact capture a range of different and deeper effects. The main point of the criticism to the use of an array of aggregate openness indicators is the " ... suspect that the relationship is a contingent one, dependent on a host of country and external characteristics" (Rodriguez and Rodrik, 2000) which are not correctly captured by this technique.

A closer look to the theoretical models shows that countries' interdependence affects growth patterns and the nature of catching-up in several fundamental ways. As stressed by the works of Slaughter (1997) and Ventura (1997), trade impacts on growth and convergence paths by affecting

factors' prices, and therefore factors' accumulation. Such an impact depends on a country relative position with respect to its trading partners, and different circumstances may well bring about different dynamic effects. One of these circumstances is a country's specialization and trade structure. In order to link trade structure and convergence, Slaughter (1997) decomposes the tendency toward similar per capita income level into a "factor price effect" and "factor endowment effect", as simple accounting shows that per capita income is a combination of both factor prices and factor quantities. Both the order of magnitude and the sign of such effects are sensitive to trade patterns.

This is where we take off, focusing on the effects of the sectoral composition of exports on catching-up. We move from the analyses of Slaughter (1997) and from the approach of Ben-David and Loewy (1998) explicitly considering how similarity in export sectoral composition can induce convergence in income levels among countries through different channels suggested by the economic theory on growth.

The first channel links similarity in trade structure and *productivity improvements*, as trade in similar or identical industries allows exploiting different externalities that can positively affect growth rates. Technological and knowledge spillovers are unlikely to affect all sectors evenly (van de Klundert and Smulders, 1996) and are more likely to occur within the same or technologically similar industries. Therefore the scope for international technological spillovers is enhanced if trade structures overlap. Intra-industry trade exploits economies of scale, enhancing productivity, which can accelerate the growth rate along the transition path. Production sharing and processing trade, which are very important phenomena in the EU-CEECs trade relations and give rise to a partial overlap of trade flows, increase the likelihood of spillovers and the access to advanced technology by the CEECs. Similar export patterns can also increase average productivity through increased competition for the firms involved, as suggested by Ben-David and Kimhi (2000). Stronger competition, both at home and abroad, makes the absorption of foreign knowledge and ideas crucial, and allows only the more productive firms to survive. If this is the case, it might not be trade per se that matter, if there is no overlap in specialization. Instead, similar export patterns will increase competition between countries, enhancing the positive competition effects. The effects of increased productivity are directly connected to factors' accumulation. If growth and convergence are driven by factors accumulation and incentives to accumulate depend on returns and prices (Young, 1991; Ventura, 1997), similar trade specialization brings about a similar incentive structure and can enhance catching-up.

The second channel connecting export similarity and convergence en-

hances the *demand-side effects*, somehow along the lines first suggested by Linder (1961) and more recently developed by Markusen (1986). The positive effects of trade on growth rates rely to a large extent on trade volumes to exploit the scale effects built in endogenous growth models (Rivera-Batiz and Romer, 1991). Therefore the positive consequences of trade are more likely to take place if the goods exported by a country are matched by a large and growing demand in its export market. If similarity in trade structures reflects this matching of supply and demand, which enhances the static and dynamic gains from trade, a lagging country can speed up its catching-up process if its trade structure becomes more similar to the one of advanced countries, as this will expand the opportunities offered by trade.

Finally, there is a third channel connecting export similarity and catching-up. The economic literature sees export diversification as a form of *insurance against industry-specific adverse shocks* (Helpman, 1988; Saint Paul, 1992; Kalemli-Ozcan et al., 2003). In this perspective, the catching-up process may come to a temporary or persistent stop because of an adverse sectoral shock. Diversification is more needed where other form of insurance are missing. A country having an export composition similar to the one of its trading partners enjoys a implicit form of insurance being exposed to similar business cycle phases and to shocks, reducing the amount of divergence factors.

In spite of these theoretical suggestions, very few studies explicitly consider the role of trade structure in determining countries' growth and convergence. A difficulty in performing this kind of empirical test is in finding a good representation of the trade structure comparable across countries, and in linking a measure of disaggregated trade flows to aggregate macroeconomic variables. The few existing works consider the role of concentration versus diversification of exports, or exports of agricultural goods and raw materials, to test the risk-exposure-and-growth hypothesis (Lederman and Maloney, 2003). Feenstra and Rose (2000) find a strong relation between what they call advanced export structures and high productivity levels and fast growth rates, having in mind the trade-productivity-growth link. Crespo Cuaresma and Wörz (2004) test whether exports in technology intensive industries have a higher potential for positive externalities, and they find a significant effect in the case of developing countries. Bensidoun et al. (2001) also find that the growth effects of trade depend on the type of products countries are specialized in, and in particular what matters is the adaptation of specialization patterns to the dynamic of international demand. In general, when a trade structure variable is considered, the empirical evidence confirms what the theory suggests, that trade structure - rather, or at least more precisely than trade *per sè* - can affect the catching-up of countries.

3 GDP growth, openness and trade structure dynamics

3.1 Catching-up and transition in the CEECs

Rather than trying to assess whether a particular trade structure promotes growth in general, in this paper we test whether having a similar export composition brings about income similarity within a group of countries. In other words, we assume that a particular trade structure can influence positively or negatively convergence relatively to the group of partner countries taken as a benchmark. Therefore we choose and define carefully the sample of countries we want to examine. Emphasizing similarities and referring to a benchmark specific for the countries selected made up by the main export market allows to refrain from using a sectors' classification that arbitrarily divides exporting sectors in groups with different impacts on growth rates and convergence.

Our sample is made up of the group of countries candidate for EU-membership in the 1990s: Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Slovak Republic, and Slovenia. The process of trade liberalization between these CEECs and the EU was pursued immediately after the collapse of the centralized systems in central Europe and played a key role in the integration process of the area. Even in the very early phases of transition, when experiencing negative GDP growth rates, the CEECs shifted their trade structures to a remarkable extent, unobserved in non-transition economies, both in terms of exporting industries and in terms of trading partners. The CEECs and the EU signed the so-called Europe Agreements in the early 1990s, starting a process of preferential trade liberalization and phasing out of their reciprocal tariffs, so that the EU quickly became the CEECs' main export market. To a large extent, integration though trade flows was achieved well before the formal entry of the CEECs in the European Union in 2004.

For the CEECs, the EU represented a natural target also in terms of standards of living, and income convergence is seen as a goal of the integration process (European Commission, 2004). But not surprisingly the catching-up process of the CEECs in terms of growth and income levels was more difficult and required the transition to be more advanced. It was only since the mid-1990s that the CEECs' economies reverted to positive growth rates and started to converge toward the EU both in terms of productivity and per capita income. Since then, the CEECs' GDP growth rates were on average higher than the EU members' growth rates.

As shown in Table 1, on average the CEECs' GDP per capita is less than half the one of the EU15, but it has been increasing during the observation period. The reported values of the standard deviation indicate a substantial amount of heterogeneity in the group of countries considered. The sample in fact shows more variation across countries rather than over time, confirming very different performances of the CEECs in this respect. If we compare the differences in GDP per capita in the first part of the period to the second half, we observe that within this group the heterogeneity tends to increase rather than decrease. This is due to the fact that the catching-up process was very uneven across countries, as shown in Table 2, where we measure the average percentage change in the gap between each country's GDP per capita and the EU-15 average, all in purchasing power standards. The average annual rate of catch-up shows large differences between countries, not directly correlated with the starting point. Slovenia (one of the CEECs with the highest GDP per capita in 1993) and Estonia (one of the CEECs with the lowest GDP per capita in 1993) both show a relatively high catch-up rate across the entire period. The Czech Republic, who in 1993 attains an income level that is the closest to the EU average among the CEECs, has a low catch-up rate. The performance is also different across time. Bulgaria and Romania, ranking at the bottom of the group in 1993, show a positive trend toward the EU average income only from 1998 onward.

Table 1: Distribution of GDP per capita relative to the EU15 (EU15=100)

	1993-2002			1993-1997			1998-2002		
	μ	σ	Min-Max	μ	σ	Min-Max	μ	σ	Min-Max
Overall	40.4	13.3	23.1-69.0	39.0	12.9	23.5-64.9	41.8	13.6	23.1-69.0
Between		13.6	25.5-63.9		13.4	26.5-62.5		14.1	24.3-66.9
Within		2.6	34.6-46.4		1.6	36.0-42.3		1.5	39.1-45.1
tot. obs.	100			50			50		
i	10			10			10		
t	10			5			5		

These differences reflect a number of factors, such as the macroeconomic policies followed in the transition period, different investment (both domestic and foreign) rates, different rates of technological catching-up, affected by the country's skill endowment and absorption capacity. But the different growth rates might also reflect differences in the industrial structure and in the weight of sectors having different dynamics in productivity.

As far as openness, with few exceptions, the CEECs are classified as open economies since 1990-92. In their updating of the Sachs and Warner (1995)

Table 2: Average annual catch-up rate for the CEECs (%)

	GDP per capita (EU15=100)		Average annual catch-up rate for the CEECs(%)		
	1993	2002	1993-2002	1993-1997	1998-2002
Bulgaria	27.9	26.4	0.21	1.18	-0.77
Czech Rep.	60.8	61.9	-0.31	-1.27	0.65
Estonia	30.6	40.1	-1.61	-1.64	-1.58
Hungary	44.7	53.4	-1.70	-0.47	-2.93
Latvia	26.6	34.8	-0.61	0.47	-1.69
Lithuania	33.2	39.1	0.08	1.80	-1.64
Poland	34.6	41.7	-1.36	-2.28	-0.44
Romania	25.8	26.5	-0.17	-0.25	-0.09
Slovakia	37.7	47.1	-2.03	-2.55	-1.50
Slovenia	58.2	69.0	-3.45	-3.87	-3.03

Notes: A negative catch-up rate indicates that the income gap between a country and the EU average is falling while a posive rate means that this gap is widening. The catch-up rate is calculated as $[(g_{it} - g_{et}) - (g_{i(t-1)} - g_{e(t-1)})/(g_{i(t-1)} - g_{e(t-1)})] * 100$ where g_{it} is the level of GDP per capita in PPS for country i at time t and g_{et} is the average value for EU15. See also European Commission (2004), ch.2.

openness indicator, Wacziarg and Welch (2003) classify only Estonia and Romania as closed economies. This classification does not follow uniquely from the CEECs' tariff levels, which are differentiated, going from an average of 17.37% for Bulgaria to 1.12% for Estonia. Considering other openness indicators, such as the import and export flows over GDP, all the CEECs appear to be very open to trade, with the smallest economies being naturally the most open. However, for these countries, the comparable aggregate openness indicators hide large differences in export composition.

3.2 Defining similarity in trade structures

The existing literature shows that the CEECs trade patterns changed quite dramatically since the early phases of transition: the CEECs' export structure has moved in different directions, with some countries quickly upgrading their specialization, while other countries still lagging behind (Landesmann, 2003). Normally, evidence on changes in trade structures is presented through a large number of indicators and presenting an array of sectoral specialization indices, but it is not straightforward to find a suitable description of such complex changes with a measure that can be used in empirical exercises. Following De Benedictis and Tajoli (2004a), we give evidence of such a dynamic process relying on an index of similarity in export composition for the ten CEECs considered.

We examine the evolution of trade similarity over time – from 1993 to 2002 - measuring the distance of a country's export composition from a given benchmark, using sectors' export shares toward the EU15 internal market. We define a *self-similarity* index (how the export composition of a EU member-to-be has changed with respect to the beginning of the transition process) and *EU-similarity* index (if and how the export composition of a EU member-to-be has changed with respect to the EU export composition), using the Bray-Curtis distance index:[2]

$$d_{xy} = \frac{\sum_i |x_i - y_i|}{\sum_i (x_i + y_i)}. \tag{1}$$

[2]The Bray-Curtis semimetric - largely used in the natural sciences - is a bounded measure, $0 \leq d_{xy} \leq 1$; it has the advantage of not increasing in the number of sectors considered, n; of being invariant to proportional sub-classifications of the n sectors considered; it is not subject to the *double-zeros paradox*; it lessens the effect of the largest differences since difference in high sectoral export shares contribute the same as difference between small sectoral export shares; and is appropriate in presence of skewed distributions. See De Benedictis and Tajoli (2004a) for a deeper description of the index, and also Finger and Krenin (1979).

where x and y are two different countries identified by n sectoral export shares (the value of exports in sector i over the value of total exports toward the EU15 market), given by x_i and y_i. In defining EU-similarity, country x is a CEEC and y is the EU benchmark; in defining self-similarity, country x is a CEEC considered at any subsequent time period and y is always the initial year considered, 1993.

Table 3: Export composition of the CEECs

	Self-similarity index (1993 = 1)	EU-similarity index (EU15 =1)		Relevance of EU market (% of total exports)		Share of high-tech goods over total exports to EU (%)	
	2002	1993	2002	1997	2002	1993	2002
Bulgaria	0.76	0.52	0.43	48.00	59.62	5.42	4.87
Czech Rep.	0.66	0.65	0.68	58.60	67.67	8.81	17.79
Estonia	0.47	0.30	0.41	58.11	81.51	0.67	24.98
Hungary	0.56	0.61	0.64	69.38	69.24	12.11	30.28
Latvia	0.40	0.23	0.28	86.92	80.65	0.67	7.54
Lithuania	0.48	0.26	0.35	38.57	49.12	0.50	2.24
Poland	0.67	0.52	0.69	62.66	64.98	5.64	13.09
Romania	0.75	0.36	0.42	59.57	71.07	3.30	10.26
Slovakia	0.54	0.48	0.61	46.88	63.79	4.03	13.27
Slovenia	0.75	0.61	0.68	63.25	62.39	12.80	16.87

The self-similarity and EU-similarity indices are presented in table 3. In both the similarity dimensions examined, the differences across countries are remarkable. Once again, the CEECs appear as an heterogeneous group, and this is true also in terms of export structure, as already observed in Table 2 with respect to their catching-up rate. The three Baltic republics represent a group on their own, as their export composition has changed the most since 1993. These countries in 1993 were very different from the EU both in terms of exports and of income per capita. They show very little or no convergence toward the EU in terms of exports, and very different performances in terms of catching-up. Romania and Bulgaria are the countries whose export composition changed the least in the past decade, and following a very irregular path (De Benedictis and Tajoli, 2004b). Bulgaria also shows divergence in its export composition with respect to the EU, and Romania shows some convergence only in the last few years. The remaining five countries overall changed their export composition in the EU direction, even if to quite different extents. Poland is the country who converged the most toward the EU export composition and it is now the most similar country in this respect. Hungary instead followed a very irregular path, like Slovakia, even if

the two countries had different starting points both in terms of export composition and income. For this converging group, convergence in the export composition seems to slow down in the last observations. Summing up, there is no generalized trend in the changes observed in the export composition, confirming that the CEECs followed different paths in restructuring their economies, just like they recorded different macroeconomic performances.

The observation of the data on relative GDP per capita of the CEECs (table 1 and 2) together with the changes in export structure (table 3) is suggestive of a possible relationship between converging trade structures and catching-up: on average the countries whose exports' paths are less convergent toward the EU are also the countries lagging behind in terms of incomes. The existence of such relationship can be properly explored and should be tested empirically, to test its robustness and the possibility of observing a spurious relation affected by other factors, and to infer a possible direction of causality.

4 Econometric results

4.1 The relationship between export composition and catching-up

The basic expression of the regression we estimate for the ten CEECs over the period 1993-2002 to test the role of similarity in export composition in the catching-up process is the following:

$$\ln GDP_{jt} = \alpha + \beta \ln EUSIM_{jt} + \mathbf{X}_{jt}\gamma + u_{jt}. \tag{2}$$

where GDP_{jt} is per capita GDP measured in purchasing power standards in percentage of the average EU income per capita. This variable - taking values between 0 and 1 - measures directly the existing gap in per capita incomes between the CEECs and the EU at time t and an increase in its value indicates that the gap is narrowing. $EUSIM_{jt}$, which is our main variable of interest, is the Bray-Curtis index measuring the similarity between the CEECs and the EU export composition, and an increase in this index indicates that the trade structures are becoming more similar. If our hypothesis that similarities in export composition can foster the catching up process through the different channels discussed in section 2, the estimate of the β coefficient should be positive and significant.

$\mathbf{X}_{jt}$ is a vector of control variables, which include variables associated to the catching-up process in the theoretical and empirical literature. In particular, we use as regressors the variable $SELFSIM_{jt}$, the Bray-Curtis

index of self-similarity, which should capture the extent of the changes in the CEECs' export composition with respect to their export composition in 1993, the earliest year of transition included in the dataset. Larger changes in the export composition are measured by a lower value of the self-similarity index. The variable $OPEN_{jt}$ measures the trade (Exports+Imports) share of GDP, in purchasing power standards. The other covariates influencing catching-up included are investment, measured by gross capital formation; the level of schooling in 1993; and a proxy for the quality of institutions, measured using the 1999 EBRD transition index (EBRD, 2004). Finally u_{jt} is an i.i.d. error term. All variables are measured in natural logs in order to facilitate comparisons of partial effects. Specific information on the the data sources is contained in the Appendix.

Regression results are reported in table 4. Our first regressions only considers the correlation between $EUSIM$ and GDP. The estimates confirm the positive sign of the correlation between catching-up and increase similarity in EU-CEECs trade structure. The EU-similarity coefficient is significant at the 99% level and this variable alone explains almost 60% of the variance of the dependent variable. Certainly the reduction of the difference in income levels depends on a number of different factors not captured by the EU-similarity variable. Notwithstanding, these first results are encouraging in indicating that the trade structure might not be irrelevant in affecting the catching-up process.

The coefficients of $EUSIM$ in the within- and between- estimates (columns 2 and 3 of table 4) confirm the observed countries' heterogeneity, and suggest the use of countries' effects in the regression. In column 4 of the table we report the estimates of a pooled least squares regression where we introduced the other control variables also to capture some of these differences across countries. The sign and the significance of the variables in our control group are as expected. The share of investments over GDP, the percentage of population with secondary education in 1993 and the proxy of the quality of institutions are all positively associated with higher rate of convergence, and in our regression they indeed appear positive and significant, and they improve the fit of the regression. Also openness is positively and significantly associated with the catching-up process, especially in small countries. The openness variable interacted with population (measuring the size of the country) displays a negative sign, suggesting non surprisingly that openness has a diminished effect in large economies. The $SELFSIM$ coefficient, capturing the extent of the change in export composition is statistically insignificant once controlling for the degree of openness. The non-significance of the self-similarity variable while EU-similarity maintains its own corroborates the conjecture that it is not a change in the export composition *per sè* to matter

Table 4: Pooled data regressions: dependent variable is country's per capita GDP relative to EU's per capita GDP

	LS (1)	Within (2)	Between (3)	LS (4)	Within (5)	Random effects (6)
Intercept	4.18 ***	3.98 ***	4.19 ***	2.88 ***	2.92 ***	1.55 *
	(0.04)	(0.05)	(0.17)	(0.43)	(0.21)	(1.11)
EU-similarity	**0.73** ***	**0.46** ***	**0.75** ***	**0.66** ***	**0.36** ***	**0.33** ***
	(0.06)	**(0.07)**	**(0.21)**	**(0.06)**	**(0.08)**	**(0.07)**
self-similarity				0.02	-0.04	-0.06
				(0.07)	(0.04)	(0.04)
gross capital formation				0.36 ***	0.19 ***	0.19 ***
				(0.07)	(0.04)	(0.05)
schooling				0.22 **		0.29
				(0.08)		(0.39)
institutions				0.65 **		1.41 *
				(0.22)		(0.92)
openness				0.09 *	1.14 **	0.24 *
				(0.04)	(0.35)	(0.14)
openness×population				-0.02 ***	-0.12 **	-0.02 *
				(0.005)	(0.04)	(0.01)
obs.	100	100	100	100	100	100
σ_e	0.20	0.062		0.139	0.050	0.050
σ_u		0.227			0.584	0.231
R^2_{adj}	0.587	0.587	0.587	0.822	0.999	0.999
F	139.3 ***	37.71 ***	12.38 (1,8) **	60.74 ***	22.21 (5,85)	
$Hausman\chi^2$						16.68 **

Notes: Standard errors in parentheses. All variables are in natural *logs*.

Signif. codes: 0.000 '***'; 0.001 '**'; 0.01 '*'; 0.05 '∘' .

for convergence, but that the direction of change is what matters most.

In equation (5) we introduced countries' fixed effects and dropping the other time-invariant variables to check for unobserved countries' characteristics in our panel. As a consequence all time-invariant variables - such as schooling and the quality of institutions - were dropped from the regression. The use of countries' fixed effects significantly improves our goodness of fit, and the result of a Hausman test of this last specification against the use of random effects gives support to this choice. Also in the fixed effects specification the EU-similarity variable is strongly significant in explaining the catching-up.

Regression (5) has been checked for non-normally distributed errors, collinearity, and heteroskedasticity: the regression always passed the tests.[3] Again, the index of EU similarity - even changing specifications and control variables - is always positive and significant.

4.2 Nonlinearity

As in De Benedictis and Tajoli (2004b), we tested the possible nonlinear effect of $EUSIM$ on the dependent variable without imposing any particular constraint on the data in terms of specific nonlinear functional form. Instead of using a tree-regression approach as in Durlauf and Johnson (1995), we used an additive semiparametric regression, as in Liu and Stengos (1999). The semiparametric fixed-effects panel estimate has the great advantage of allowing some standard inference.

The resulting regression equation is:

$$\ln GDP_{jt} = \alpha_j + g(\ln EUSIM_{jt}) + \mathbf{X}_{jt}\gamma + u_{jt}. \tag{3}$$

The only difference with respect to regression (5) is that the variable $EUSIM$ does not enter the equation linearly. $g(\ln EUSIM)$ is an unknown function that take the form of a *smoothing spline* (Hastie and Tibshirani, 1999). The smooth term is modeled using polynomial regression splines,[4] and the semiparametric regression is estimated through a back-fitting procedure (Yatchew, 2003; Hastie and Tibshirani, 1999).

[3] We also addressed the problem of simultaneity between openness and income levels (Frenkel and Romer, 1999) instrumenting $OPEN$ via a one period or two periods lag. No major changes in the coefficients or in their significance has been noticed. Since there is a strong presumption of a serial correlation in openness we also used the first difference of the variable as an instrument. In this case the magnitude of the coefficients changes, but the sign and the significance remain stable.

[4] *Splines* are piece-wise polynomial functions that fit together at 'knots' (Hastie and Tibshirani, 1999, p.22); for cubic splines – as in our case - the first and second derivatives are also continuous at the knots.

Table 5: Interactions with EU-similarity

	GAM (7)	GAM (8)	GAM (9)	GAM (10)	Within (10 bis)	GAM (11)	GAM (12)
EU-similarity	see figure 1	see figure 2 (a)	see figure 2 (b)	see figure 2 (c)	1.69 **	see figure 2 (d)	see figure 3
	(31.89) ♮	(31.43) ♮	(9.12) ♮	(13.65) ♮	(0.58)	(11.60) ♮	(5.31)♮
self-similarity	-0.06	-0.06	-0.04	-0.05	-0.03	-0.18 **	-0.16 **
	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.05)
gross capital formation	0.16 ***	0.16 ***	0.19 ***	0.17 ***	0.20 ***	0.13 **	0.15 ***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
openness	1.45 ***	1.48 ***	1.09 *	1.48 ***	1.37 ***	1.06 *	0.83 ∘
	(0.36)	(0.41)	(0.45)	(0.36)	(0.35)	(0.41)	(0.49)
openness×population	-0.16 ***	-0.15 ***	-0.12 **	-0.16 ***	-0.15 ***	-0.12 **	-0.10 *
	(0.04)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)	(0.05)
EU-similarity×hightech		0.003					0.001
		(0.002)					(0.02)
EU-similarity×opt			0.08 ***				0.05 *
			(0.02)				(0.02)
EU-similarity×bank				-0.29	-1.14 *		0.16
				(0.62)	0.49		(0.69)
EU-similarity×EU-growth						0.06 ***	0.05 **
						(0.02)	(0.02)
Country fixed-effects	yes	yes	yes	yes	yes	yes	yes
obs.	100	100	100	100	100	90	90
R^2_{adj}	0.977	0.977	0.98	0.977	0.999	0.983	0.999
$GCV\,score$	0.002	0.002	0.002	0.003		0.002	0.002

Notes: Standard errors in parentheses. All variables are in natural *logs*.

♮ indicates the approximate significance of smooth terms in terms of χ^2-value.

Signif. codes: 0 '***'; 0.001 '**'; 0.01 '*'; 0.05 '∘' .

The coefficients of the covariates in the first column of table 6 are remarkably similar to the one of regression (5), apart from the direct and indirect effect of openness on catching-up. As far as the partial effect of $EUSIM$, the result of the semiparametric regression is plotted in figure 1 together with $2\sigma^e$ reference bands. The spikes at the base of the plot represent the frequency of observations. The evidence of a nonlinear effect is significant and robust, indicating the existence of a multiple regime. Moving from the left edge of the covariate space, catching-up rapidly increases, flattening down at a second stage, ad rising again at high levels of EU-similarity. Similarity in export composition seems to be more effective only after a certain threshold is reached. It doesn't matter to move "a little bit" toward the EU export composition, what seems to matter for catching-up is to be sufficiently similar (around 0.45 ($e^{-0.8}$) in terms of EU-similarity).

The second main result of our analysis is therefore that not only similarity in trade structure always matter to reduce the income gap, but that as similarity becomes higher the effect on income convergence is magnified. A multiple regime exists among the CEECs catching-up over the EU's per capita GDP, and being similar to the sectoral export composition of EU countries as suppliers for the EU market seems to be the discriminatory factor separating countries that are catching-up from the ones that are falling behind.

4.3 The interaction between export composition similarity and growth mechanisms

Having found robust evidence on the role of similarity in trade structures in closing the income gap for the CEECs, we now turn to the mechanisms underlying this effect. As discussed in section 2 of the paper, there are at least three quite different channels through which similarity in export composition might affect the process of catching-up: by enhancing the scope of technological spillovers; thanks to the matching of export supply and demand; and because of the insurance provided by similar export structures. In the last part of our empirical exercise, we introduce in the regression additional controls related to these mechanisms, interacting them with the EU-similarity variable. The significance of a specific interaction term indicates which channel enhances the role of similarity in export composition. The presence of non-linearity in the coefficient of EU-similarity suggests that interaction terms should capture these effects, giving also some indications about the channels that play a significant role.

We use different variables as proxies to represent the different mecha-

Figure 1: Marginal effect of EU-similarity on convergence

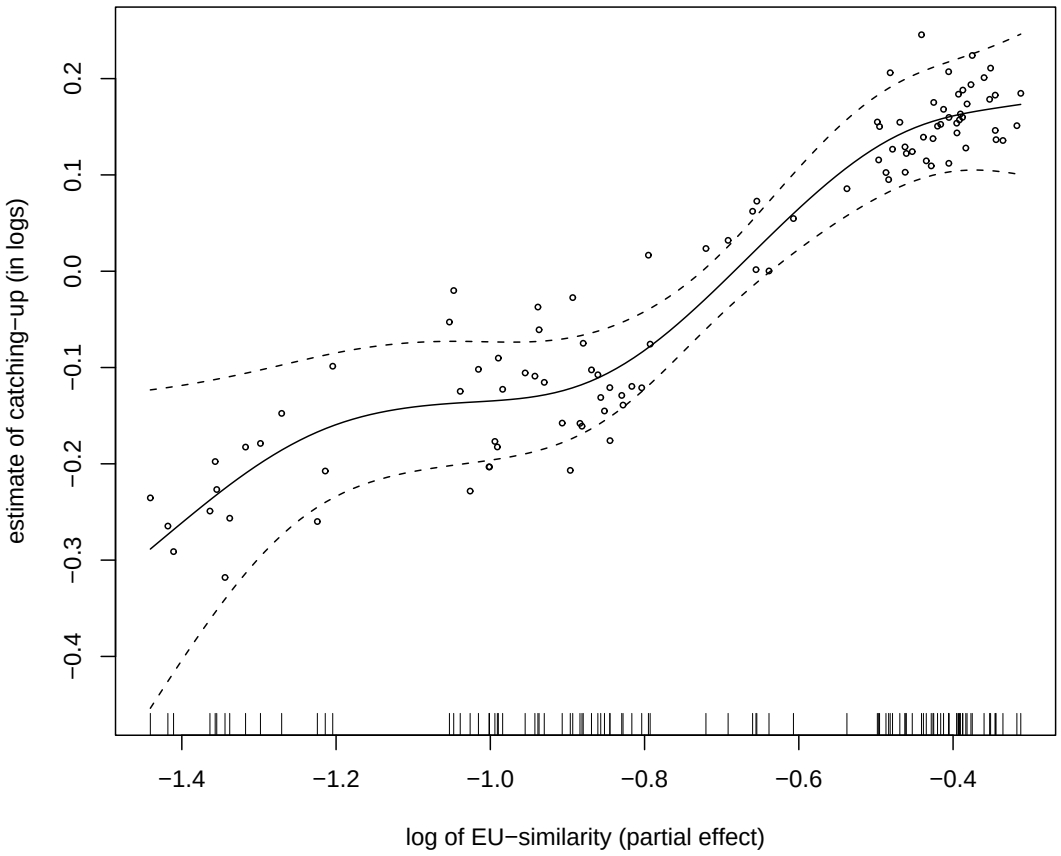


Table 6: Correlation matrix

	$\ln GDP_{jt}$	$\ln EUSIM_{jt}$	$EU-GROWTH_t$	$HIGHTECH_{jt}$	OPT_{jt}	$BANK_j$
$\ln GDP_{jt}$	1.0000					
$\ln EUSIM_{jt}$	0.7662	1.0000				
$EU-GROWTH_t$	0.0016	0.0646	1.0000			
$HIGHTECH_{jt}$	0.6007	0.5976	0.1465	1.0000		
OPT_{jt}	-0.4682	-0.2017	-0.0820	-0.3729	1.0000	
$BANK_j$	0.4893	0.3268	-0.0000	0.6463	-0.2351	1.0000

nisms. If the export composition similar to the EU matters for the catching-up of a country because this allows for more knowledge and technological spillovers through trade, we expect the weight of the sectors where such spillovers are stronger to play a positive role. Therefore, we use the share of the high-tech goods (computers, electrical machinery, aerospace, pharmaceuticals and precision tools) over total exports of each country to capture this effect. Another important channel for spillovers which also tends to make export patterns more similar is outward processing trade (OPT). Through OPT, goods belonging to the same merchadise group are exported by a country to be processed abroad and then re-exported by the processing country, therefore appearing in the export vector of both. The processing of intermediate foreign goods coming from the EU15, extensively undertaken in the CEECs, is an important vehicle of technology transfer. If similarity in exports indicates the capacity to adapt to foreign demand, a dynamic demand in the main export market should enhance the catching-up process. As a proxy for the dynamics of demand in the EU market, we use the EU-15 GDP growth rate. Finally, to capture the importance of similarity in export composition as an insurance mechanism, we introduce a proxy of the availability of other forms of insurance, measured by an index of development of the financial markets or of the banking sector.

As shown in table 6, our proxies are weakly positively correlated with relative GDP per capita and with the EU similarity index, with the exception of OPT, displaying a negative correlation. In table 7 we report the results of the regressions using one by one each of these control variables interacted with the EU-similarity index. It is worth noticing that our main result still holds using these interactions terms: the coefficient of the EU-similarity variable is once more significant and positive. The comparison of the different interaction terms shows that a similar export composition matters for catching-up especially when it allows exploiting the growth of demand in the export market and when OPT (a deeper form of integration) takes place. The role of EU-similarity is not driven by the growing weight of high-tech sectors, as the non-significance of the interaction term between the high-tech share in exports and EU-similarity shows.

Only when all the interaction terms are introduced simultaneously in the last regression, the EU similarity index totally looses its significance. Our interpretation of this result is that our hypothesis about which are the main channels through which a similar export composition affects the catching-up process is confirmed.

Figure 2: Marginal effect of EU-similarity on convergence

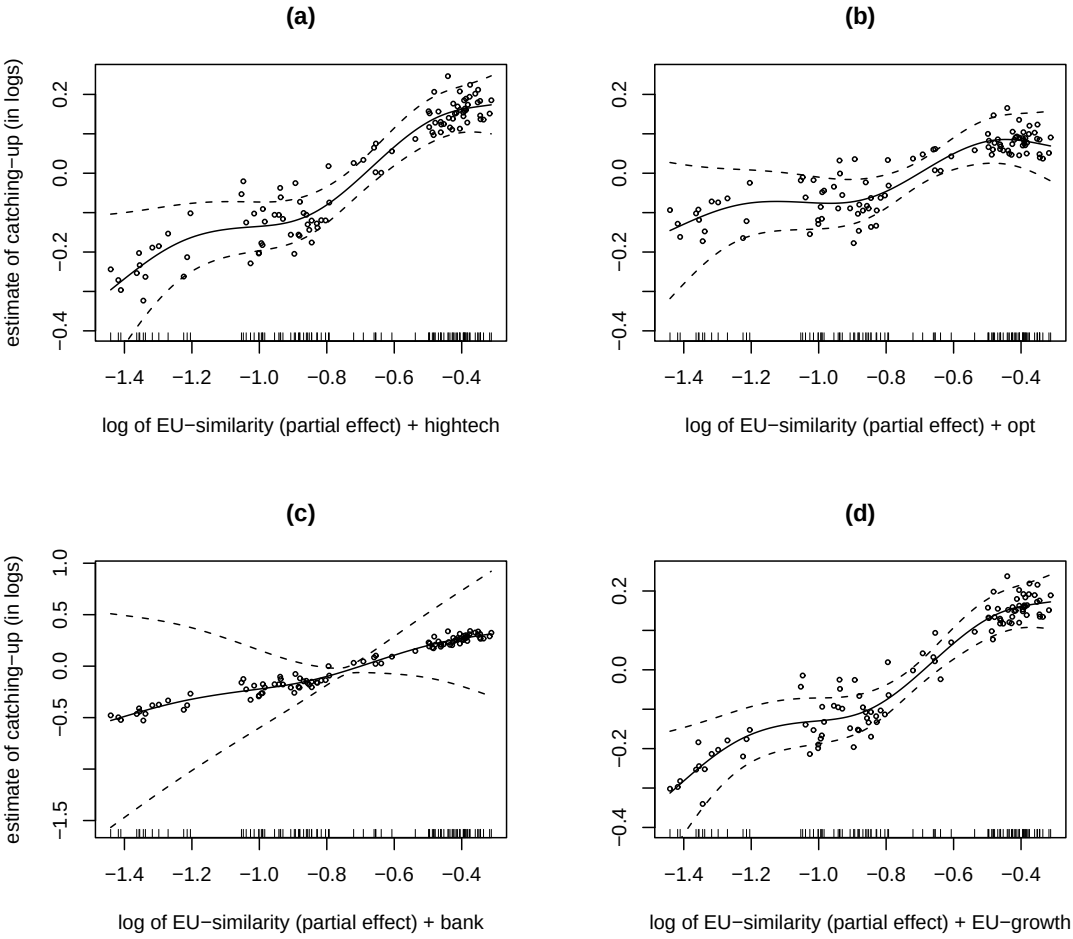
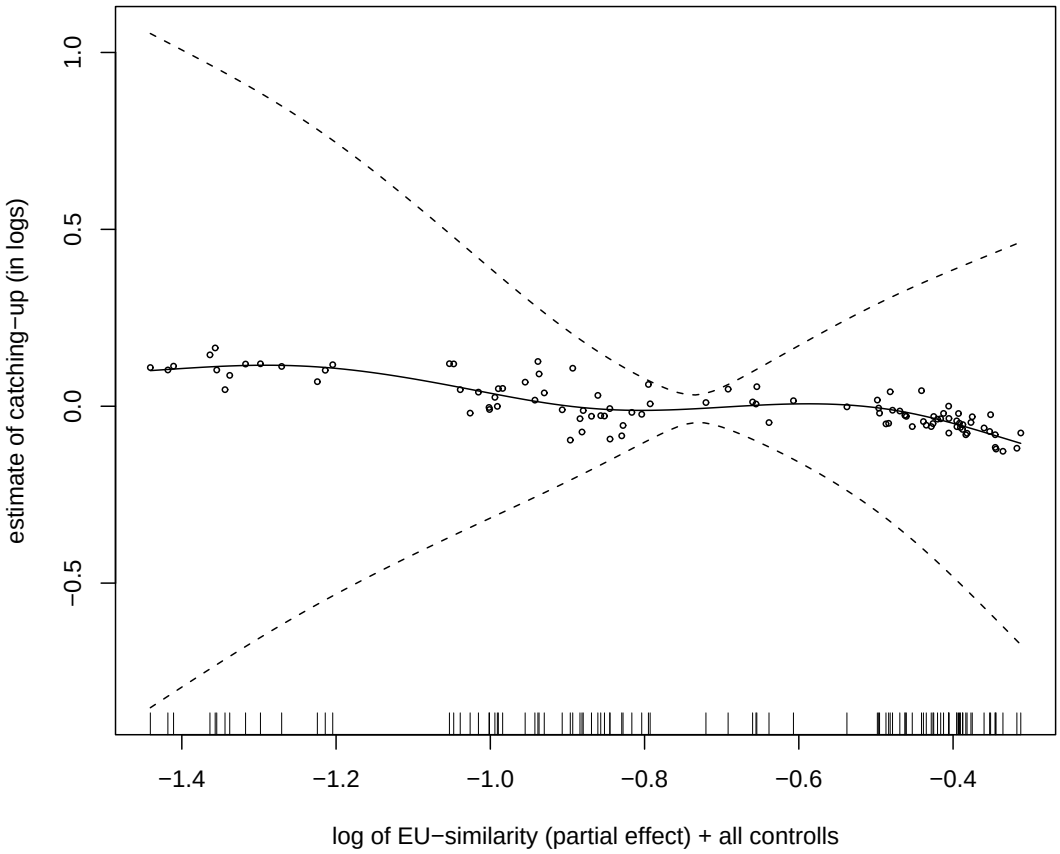


Figure 3: Marginal effect of EU-similarity on convergence



5 Conclusions

Both empirical evidence and theoretical models suggest that the relationship between trade and growth might be a contingent one, depending on a host of specific circumstances. Trade models indicate that different models of specialization have diversified effects on factors' prices and therefore factors' accumulation, suggesting that one of the specific circumstances affecting the trade and growth relationship might indeed be the patter of trade. In this paper we test this hypothesis for the case of the CEECs and the EU.

The CEECs have been converging toward the EU income levels during the 1990s at different speeds. The EU is also the main trade partner of these countries, and their export flows toward the EU market have been increasing, but these flows too displayed different characteristics. Our empirical analysis shows that a measure of export composition similarity between the CEECs and the EU is positively and significantly associated with the convergence process of these countries in terms of income: the CEECs whose export composition is closer to the EU enjoyed a faster catching-up process. Results also show that this impact is nonlinear, yet it is robust controlling for investment, schooling, and the quality of institutions. Theoretical analyses suggest distinct reasons behind this result, but the proper mechanism driving the observed link needs to be further explored. The use of variables that proxy the possible different mechanisms indicates that matching the demand of the main export market plays an important role.

How economic integration affects convergence and catching up between countries is a very sensitive issue. In the EU, income convergence is one of the main challenges, as wide gaps in income levels and living standards among members can put on strain the whole process of European integration. This could be true also in other circumstances of integration between countries at different stage of development. Further research could therefore also consider whether these results for the CEECs and the EU can be generalized.

References

Alesina A., E. Spolaore and R. Wacziarg, (2004), "Trade, Growth and the Size of Countries", in P. Aghion and S. Durlauf (eds), *Handbook of Economic Growth*, North Holland, forthcoming.

Baldwin R. E. (2004), "Openness and growth: what is the empirical relationship?", in R.E. Baldwin and A. Winters (eds), *Challenges to globalization*, NBER conference report, University of Chicago Press, Chicago.

Barro R. and X. Sala-i-Martin, (1995), *Economic Growth*, MIT Press.

Ben-David D. and A. Kimhi, (2000), "Trade and the rate of income convergence", *NBER WP* n. 7642.

Ben-David D. and M.B. Loewy, (1998) "Free trade, growth and convergence", *Journal of Economic Growth*, vol. 3(2).

Bensidoun I., G. Gaulier and D. Unal-Kesenci, (2001) "The nature of specialization matters for growth: an empirical investigation", *CEPII Working Paper* 2001-13.

Crespo Cuaresma J. and J. Wörz, (2004) "On Export Composition and Growth", *Weltwirtschaftliches Archiv*, forthcoming.

De Benedictis L. and L. Tajoli, (2004a) "Economic Integration, Similarity and Convergence in the EU and CEECs Trade Structures", *SSRN working papers*, 28 February, http://ssrn.com/abstract=412241. A previous version of the paper circulated under the same title as a *Michigan Comparative & Interdisciplinary Paper on European Integration*, 04-004.

De Benedictis L. and L. Tajoli, (2004b) "Openness, Similarity in Trade Structures and Income Convergence", paper presented at the annual conference of the European Trade Study Group in Nottingham, 10 September, http://www.dep.polimi.it/people/68/trade-structures-and- convergence.pdf.

Dollar D. (1992), "Outward-oriented developing economies really do grow more rapidly: evidence from 95 LDCs, 1976-1985", *Economic development and cultural change*, 40, 523-544.

Durlauf S.N. and P.A. Johnson, (1995), "Multiple regimes and Cross-Country Growth Behaviour", *Economic Journal*, vol.108, pp.383-398.

EBRD (2000), *EBRD Transition Report 2000: Employment, skills, and transition.*

Edwards S., (1998), "Openness, productivity and growth: what do we really know?", *Economic Journal*, vol.108, pp.383-398.

European Commission (2004), *The EU Economy 2004 Review*, European Economy n.6, Brussels.

Feenstra R.C. and A.K. Rose (2000), "Putting things in order: patterns of trade dynamics and growth", *The Review of Economics and Statis-*

tics, 82(3), 369-382.

Frankel J. and Romer D. (1999), "Does trade cause growth?", *American Economic Review*, vol.89, 379-399.

Hallak J.C. and J. Levinsohn (2004), "Fooling ourselves: evaluating the globalization and growth debate", *NBER Working paper*, 10244.

Hastie T.J. and Tibshirani R.J. (1999), *Generalized Additive Models*, Chapman and Hall.

Helpman E. (1988), "Trade patterns under uncertainty with country specific shocks", *Econometrica*, 56(3), 645-659.

Jaccard J. and R. Turrisi (2003), *Interaction Effects in Multiple regression*, 2nd edition, Thousand Oaks, CA: Sage.

Kalemli-Ozcan S., B.E. Sorensen, and O. Yosha (2003), "Risk sharing and industrial specialization: regional and international evidence", *American Economic Review*, 93(3), 903-918.

Landesmann M. A., (2003), "Structural features of economic integration in an enlarged Europe: patterns of catching-up and industrial specialization", *European Commission Economic paper*, 181.

Lederman D. and W. F. Maloney (2003), "Trade structure and growth", *World Bank Policy Research Working Paper* 3025.

Linder S. (1961), *An essay on trade and trasformation*, Uppsala, Almqvist and Wiksells.

Liu Z. and T. Stengos (1999), "Non-linearities in Cross-country Growth Regressions: A Semiparametric Approach", *Journal of Applied Econometrics*, 14, 527-538.

Markusen J.R. (1986), "Explaining the volume of trade: an eclectic approach", *American Economic Review*, 76(5), 1002-1011.

Rivera-Batiz L.A. and P. Romer (1991), "Economic integration and endogenous growth", *Quarterly Journal of Economics*, 106, 531-555.

Rodriguez F. and D. Rodrik (2000), "Trade policy and economic growth: a skeptic's guide to the cross-national evidence", in B.Gernanke and K. Rogoff, eds., *NBER Macroeconomics Annual*, 2000, Cambridge, MIT Press.

Sachs J. and A. Warner (1995), "Economic reform and the process of global integration", *Brookings Papers on Economic Activity*, 1, pp. 1-118.

Saint-Paul G. (1992), "Technological choice, financial markets and economic development", *European Economic Review*, 36, 763-781.

Slaughter M.J. (1997) "Per capita income convergence and the role of international trade", *American Economic Review*, 87(2).

Ventura J. (1997), "Growth and interdependence", *Quarterly Journal of Economics*, 107, 57-84.

van de Klundert T., S. Smulders (1996), "North-South knowledge spillovers and competition: convergence versus divergence", *Journal of Development Economics*, 50(2), 213-395.

Wacziarg R. and K.H. Welch, (2003), "Trade liberalization and growth: new evidence", *NBER Working Paper*, 10152, December.

Young A., (1991), "Learning by doing and the dynamic effects of international trade", *Quarterly Journal of Economics*, 106.

Appendix

Data sources

Export composition is calculated using data from Eurostat, Comext database on Intra and extra EU trade, adopting the Combined Nomenclature classification.

Openness is calculated as exports+imports/GDP using data from Eurostat, Statistics in Focus, or alternatively is the openness dummy from Sachs and Warner (1995) updated by Wacziarg and Welch (2003).

Income gap between the CEECs and the EU is calculated as the ratio between the CEEC GDP per capita and the average EU-15 GDP per capita both in PPS, taken from Eurostat, Statistics in Focus, Economy and Finance.

Gross capital formation is taken from Eurostat, Statistics in Focus,.

Population is taken from Eurostat, Statistics in Focus.

Schooling refers to the percentage of population with secondary education in 1993 (or initial available year) and it is taken from ILO Laborsta database.

The *Transition index* is taken from the EBRD, Transition report 2000.