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Openness and economic growth: A comparative study of alternative trading regimes

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Abstract. While common sense would indicate that trade and growth are positively correlated, it is not clear, both from theoretical and empirical perspectives, whether or not trade is a proximate determinant of economic growth. We try to elucidate the ambiguities in the literature, by studying the nexus between trade share and growth by comparing three different groups of countries: historical EEC, the extreme case of CMEA customs union, and a group of European transitional economies (TEs) (largely now in the EU). Our main finding, by applying static and dynamic panel estimators, is that the coefficient of real openness has the incorrect sign for the former two samples but has the correct sign for the third. The positive link between openness and growth for the last group of countries is robust to changes in the empirical indicator of openness in the growth regressions (inter and intra-industry trade indicators).

JEL Classification: O47; O42; E22.
Keywords: Economic Growth; Transition Economies; Capital Accumulation; Trade Openness; Panel Data.

Résumé. Alors que la corrélation positive entre le commerce et la croissance semblerait aller de soi, il n'est pas établi, tant du point de vue théorique qu'empirique, que le commerce soit un déterminant de la croissance. Cet article tente d'élucider les ambiguités de la litérature, à partir de l'étude des liens entre la part du commerce et la croissance, pour trois groupes différents de pays : la CEE, le cas de l'union douanière au sein du Comecon, ainsi que certains pays européens en transition (ayant pour la plupart rejoint l'UE). Notre principal résultat, obtenu à partir d'estimations en panel statique et dynamique, est que le coefficient d'ouverture réelle n'a pas le signe attendu pour les deux premiers groupes, mais est bien positif pour le troisième. Ce lien positif entre ouverture et croissance pour le dernier groupe de pays est robuste au choix de l'indicateur retenu pour l'ouverture dans les équations de croissance (indicateurs de commerce inter et intra-industries).

Classification *JEL* : O47; O42; E22.
Mots-clefs : Croissance économique ; économies en transition ; accumulation de capital ; ouverture commerciale ; données de panel.

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1. Introduction

The literature on the empirical relationship between growth and international trade is large, and has received a great stimulus with the appearance of models of endogenous growth. In fact, whereas in the neoclassical model it is difficult to find foreign trade and openness among the growth promoting factors, in contrast, in the new growth theories, the works of Grossman and Helpman (1991, 1996) and Aghion and Howitt (1992), offer theoretical support to the prediction that openness may affect long run growth through various channels.

The first, and more prominent, channel operates as a transmission mechanism of technological progress and spillovers that are generated by improvements in knowledge in trade-partner countries. The access through international trade to a large variety of intermediate goods and new final products will affect a country's productivity growth. Second, trade and technological diffusion reduce the redundancy effect of research duplication, and enlarge the size of the market in which the typical firm operates; this raises the monopoly rents allocated to innovators by encouraging research-intensive production that spurs economic growth. Third, a related indirect channel of international trade occurs via competition among firms in outward-oriented countries. These pro-competitive gains from trade might force domestic firms to innovate by encouraging specialization that would have been unprofitable in smaller markets. This last channel is gaining momentum by a large microeconometric literature, in which the hypothesis of learning by exporting is thoroughly investigated (Tybout, 1992, 2003; Mélitz, 2003).[2]

Beyond these linkages, however, the same literature (Grossman & Helpman, 1991; Young, 1991; Galor and Mountford, 2006) emphasises a number of potentially counteracting effects. The most relevant of these effects relates to: (i) misallocation of labour from research to production of final goods, (ii) disincentives to R&D due to imitation in technology, (iii) the possibility of negative spillovers when they are national, rather than international, in scope.

The ambiguities surrounding the theoretical modelling are reflected in a range of empirical results. A substantial empirical wave of research[3] documents a positive association between openness and economic growth. The paper by Harrison (1996) is particularly remarkable. She collected seven indicators of openness and found that with standard econometric technique just one measure out of seven (the black market premium) has a significant impact on growth. When she uses panel fixed-effect techniques three indicators become significant at the conventional 5% level.

2. The shift from macroeconometric studies to studies based on plant or firm level data is discussed in Lopez (2005). Very good surveys on microeconometric evidence of the "learning by exporting hypothesis" are Wagner (2007) and Greenaway and Kneller (2005). This literature documents that there is strong and growing evidence in favour of *self-selection* of more productive firms into export markets and only a few evidence of the *learning-by-exporting hypothesis* (reverse causality).

3. See the works by Harrison (1996); Edwards (1993, 1998); Sachs and Warner (1995, 2001); Frankel and Romer (1999); Miller and Upadhyay (2000); Wacziarg (2001); Irwin and Tervio (2002); Dollar and Kraay (2003); Alcalà and Ciccone (2004).

A second wave of research questions the robustness of the econometric results by suggesting that there is little robust connection across countries between trade and growth. The classical cross-section empirical study by Levine and Renelt (1992), for example, that applies Leamer's extreme bound test, does not offer support for any independent and robust relationship between trade and growth. The authors suggested a two-link chain between trade and growth through investment. Analogously, Sala-i-Martin (1997), by running his two million regressions, does not find a robust correlation between trade and economic growth. Vamvakidis (2002) draws similar conclusions. By looking at the historical data from 1870 to the present, he finds no support for the positive openness-growth link, which appears to be a phenomenon of recent decades.

More recently, an emerging literature, led by Rodriguez and Rodrik (2001), Rodrik *et al.* (2004), Rodriguez (2006) casts serious doubts about the consistency of the trade-growth relationship, which is very sensitive to the countries and time periods selected for comparison, the measures of openness used as well as the way it is instrumented in regression analyses.[4] Rodriguez and Rodrik carried out a systematic critique of previous research findings, among which Sachs and Warner (1995), Edwards (1998) Frankel and Romer (1999), by demonstrating selection biases in the studies reviewed. By correcting for these shortcomings, the claimed positive relationship disappears. The paper of Rodrik *et al.* (2004) constitutes a case in which not only the impact of institutions on growth is more relevant than that of openness, but also the coefficient of the trade/GDP ratio turns to be negative.

In addition, the wave of research that we have categorized as favourable to the openness growth nexus highlights drawbacks in leading published papers. Wacziarg and Welch (2003), for example, have evidenced two problematic aspects of this literature: (i) the vast amount of heterogeneity across country in the regression analysis, (ii) the non-adequacy of a simple dichotomous indicator of openness to discriminate between slow and fast growing countries. In their work, when the openness dummy is substituted by trade shares, the link between trade and growth becomes negative and insignificant.

Empirical growth studies, either those investigating the impact of *trade volume* on growth, or those that have employed different empirical indices for *trade policy orientation*, have not led to a convincing response on the trade-growth relationship. The substantial empirical result is a lack of consensus of the impact of openness on long run growth.

The present work draws from these strands of researches, and further investigates the openness-growth nexus in three groups of countries: historical EEC, the countries in the former CMEA customs union, and a group of transitional economies (TEs). Taking into account econometric criticisms (such as parameter heterogeneity, endogeneity biases, weak instruments) which invalidate results from standard estimators, we focus on panels of a

4. As is well known, most of the existing cross-country growth studies suffer serious problems in terms of endogeneity and measurement errors. The majority of these studies cannot identify the direction of causality between trade and growth because the measurement of openness used may be endogenous and therefore inadequate to identify the effects of trade on economic growth. Is technological progress improving competitiveness and openness or do higher openness promote technological progress? The reverse causality problem involves also to the trade-growth relationship.

relatively homogeneous group of countries that share a common set of relevant coefficients. Apart from the difficulties of isolating trade policy – since it is not the sole, among other macroeconomic policies, that may affect growth – we follow the recent literature that uses real trade share (*real openness*, measured as the US dollar value of imports and exports to GDP in PPP US$[5]), as the best measure of trade orientation, capturing both inward-oriented and export-promoting regimes. To overcome some criticisms in growth empirics, we look at countries in which trade is perceived to have been historically an important factor of growth (EECs), and contrast their performances with the European Eastern counterpart: the CMEA's customs union. Analogously, we look at the same set of countries that, when opened up to international trade after the communist regime, are becoming important exporters.

We would expect that integration between similar countries, as predicted by endogenous growth theories, increases efficiency and enhances the growth rate (Rivera Batiz and Romer, 1991).[6] Casual empiricism shows that this took place for EEC at least until 1990 but not for CMEA[7], whose economies are defined as closed in the Sachs and Warner sense.[8] We believe that an assessment of dissimilarities between the two customs unions, one characterised, in the period under analysis, by exceptional growth and the other by a great diversion of resources, as well as the extension of the analysis to TEs, may highlight the relative contribution of trade on growth.

This paper contributes to the current debate by showing that the effects of traditional measures of openness on growth are weakly significant and wrongly signed even in the wider worldwide customs union. Furthermore, using the division into communist and market economies, we can test implicitly the importance of institutional factors (monopoly power by the government, property rights, distortions in resources allocation) on growth. Finally, the unsatisfactory results found for both group of CMEA and EEC' countries led us to calculate a finer measure (at a lower level of disaggregation) of openness by looking at the structure of trade for the TEs. These measures reveal to be positively and robustly associated with growth.

The remainder of the paper proceeds as follows. In section 2, we briefly discuss data, methodological issues and outline model specifications. In section 3, we perform empirical tests of the effects of trade openness on economic growth for the two customs unions and present the results. In section 4 we analyse the composition of trade for a group of transition

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5. PPP adjusted trade share is the preferred measure in the paper by Alacalà and Ciccone (2004) and Dollar and Kraay (2003). Alcalà and Ciccone show that the link with growth is not robust when trade is measured in nominal terms (nominal openness).

6. Among the few empirical papers that test the effects of European integration see Henrekson *et al.* (1997) and Landau (1995).

7. The CMEA (Council for Mutual Economic Assistance) includes Poland, Hungary, Bulgaria, Romania, Czechoslovakia, East Germany, USSR, Mongolia, Vietnam, Cuba, and Yugoslavia. For a detailed assessment of the CMEA trading system see Lavigne (1995), Schrenk (1992), Sheets and Boata (1996).

8. According to Sachs and Warner (1995) an economy is closed if it satisfies one of these five conditions (1) tariffs of 40% or more; (2) quotas of 40% or more; (3) black market premium higher or equal to 20%; (4) country with a state monopoly in export; (5) a country with a socialist economic system. As Harrison and Hanson (1999) state, of all the five factors described by Sachs and Warner in defining their trade measure, only the socialist system dummy variable is negatively and significantly correlated with growth.

and accession countries (TEs) and perform regressions of different measures *of inter and intra-industry trade,* at different level of disaggregation, on growth rates. We conclude the paper, in section 5, with a summary and a brief discussion of the main findings.

2. Hypothesis, data and methodology

The hypothesis that we test is that the growth potential of openness in the EEC countries should be positive and more robust than that in the CMEA countries. The reason why we expect such a result has been extensively explained in the introduction, and relates to the growth increase experimented in the countries that enter the free trade agreement that constituted the European Economic Community.

To test our hypothesis we use time series data taken mainly from the Penn World Tables, version 6.1. A detailed description of these data can be found in the APPENDIX 2, as well as in Heston, Summers and Aten (HS&A, 2002). The sample includes data for countries of the former European Community and CMEA. In the last section, we extend the investigation to a group of transition economies formed by former CMEA. The data set for CMEA covers the period 1960-1990, but is unbalanced since data for some countries started in 1970.[9] The EEC sample and time series, starting in 1950, are historically updated by the inclusion of countries in the year in which they joined the community.[10] The same period of analysis is used for both samples in order to make a meaningful comparison of the results. The data set for the countries in the transition process (TEs) covers the period 1990-2000.

As is well-known in the empirical growth literature, the most commonly used econometric method has been *cross section* estimation of the Barro and Sala-i-Martin (1995) style. This approach uses a single regression and average-values of the variables and growth rates for each country for the entire period. It also assumes that the production function parameters and levels of technologies are the same across countries. Even if its simple implementation is appealing, cross-section method fails to capture the dynamic aspects of growth. The many criticisms raised have brought many researchers to use dynamic panel techniques that account for *country idiosyncratic effects*, and offer the possibility of obtaining consistent parameter estimates even in the presence of measurement errors and endogeneity of regressors. The approach of dynamic panel estimators has been recently extended to growth datasets.

In this work, we apply panel estimators by using pooled data at annual frequency. To overcome the problem of cyclical fluctuations as causes of variations in growth rates, we also perform panel regressions based on averages of non-overlapping five-year periods. Clearly, in both cases (annual and quinquennial data) the effect of openness that we estimate reflects transitional dynamics rather than steady state growth.

9. The other three countries of CMEA, not in the European area, such as Vietnam, Cuba and Mongolia, have been excluded.

10. For example, data for the UK, Ireland and Denmark are included beginning in 1973. The data set for the first panel covers the period 1950-1990. We dropped Luxembourg, which even if it joined the EEC from the beginning is a strong outlier for its high degree of openness.

Our model is substantially an augmented growth equation, relating growth to trade openness similar to that used by many analysts (i.e. Greenaway *et al.*, 2002; Dollar and Kraay, 2002). New growth theory regressions commonly search for additional determinants of growth beyond the basic factors of production. Following the theoretical considerations made at the outset, openness should affect *per capita* growth and can be included as an explanatory factor in the regression:

$$y_{i,t} - y_{i,t-1} = \beta_0 y_{i,t-1} + \beta'_1 X_{i,t} + \beta_2 OPEN_{i,t} + \mu_t + \eta_i + u_{i,t} \qquad (1)$$

where the subscript i and t represents country and time period respectively, y is the log of real GDP *per capita*, X is a set of control variables expressed in logs, and $OPEN$ is the log of real trade/GDP ratio, which is our measure of openness. In the equation above η_i is the country specific intercept, such as unobserved factors (i.e., differences in initial level of productivity) that influence the country growth rate, μ represents an unobserved period effect and u_{it} is the disturbance term. As it is standard in the literature, the dependent variable is the rate of real *per capita* GDP growth. This equation models growth in a dynamic context since it includes the lag of GDP level as an explanatory variable.

The set of control variables X takes into account their importance as proximate growth determinants and the possibility that they can influence the trade-growth nexus. Among them, we consider the investment rate (as a proxy for physical capital), a measure of human capital, and the population growth rate. The first two variables should be interpreted as potential channels through which openness influences growth, since technological progress is typically embodied in equipments while human capital measures the capability of the labour force to absorb the new technologies transferred by trade.

A first problem with this specification is the presence of unobserved country-specific effects. If the individual effects represent omitted variables, it is likely that these country-specific effects are correlated with the other regressors, as well as with both growth and trade volume. A second concern is the endogeneity of openness and other explanatory variables. Trade and growth appear to be related and causation should go in both directions. Therefore, we need to control for jointly endogeneity and reverse causation. The third problem is that the presence of the lagged dependent variable $y_{i,t-1}$ induces a correlation between the error term and the lagged dependent variable and the classical static panel models such as Pooled OLS and within group estimators are likely to produce inconsistent estimations.

Among the various econometric techniques proposed to overcome these problems is the Arellano and Bond (1991) approach (DIFF-GMM estimator) which has been applied to growth regressions by many analysts (Islam, 1995; Dollar and Kraay, 2003; Amable, 2000; Bond *et al.*, 2001, among others). The canonical dynamic fixed effect model is[11]:

$$y_{i,t} - y_{i,t-1} = \beta_0 y_{i,t-1} + \beta'_1 X_{i,t} + \varepsilon_{i,t} \qquad (2)$$

11. See Bond, Hoeffler and Temple (2001).

$$\varepsilon_{i,t} = \eta_i + u_i$$
$$E[\eta_i] = E[u_{i,t}] = E[\eta_i u_{i,t}] = 0 \qquad \text{for } i = 1,\dots,N \text{ and } t = 2,\dots,T$$

Equation (2) can be expressed equivalently as:

$$y_{i,t} = \beta^*_0 y_{i,t-1} + \beta'_1 X_{i,t} + \varepsilon_{i,t} \qquad \text{for } i = 1,\dots,N \text{ and } t = 2,\dots,T \tag{3}$$

where $\beta^*_0 = \beta_0 + 1$. Since $y_{i,t-1}$ is endogenous to the fixed effects in the error term, to avoid dynamic panel bias it is necessary to transform the data to remove the fixed effects and their potential correlation with lagged income variable.[12] Equation (3) rewritten in first differences is:

$$y_{i,t} - y_{i,t-1} = \beta^*_0 (y_{i,t-1} - y_{t-2}) + \beta'_1 (X_{i,t} - X_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1})$$
$$\text{for } i = 1,\dots,N \text{ and } t = 3,\dots,T \tag{4}$$

The GMM estimator gains efficiency by exploiting all the linear moment restrictions that derive from the assumption of no serial correlation in the errors. The following moment conditions are assumed to hold:

$$E(\varepsilon_{i,t} - \varepsilon_{i,s}) = 0 \quad \text{for } s \neq t$$
$$E[y_{i,t-s}(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0$$
$$\text{for } s \geq 2;\ t = 3,\dots,T$$
$$E[X_{i,t-s}(\varepsilon_{i,t} - \varepsilon_{i,t-1})] = 0$$
$$\text{for } s \geq 2;\ t = 3,\dots,T$$

The estimator uses all available lagged values of the dependent variables as well as lagged value of other regressors, dated t−2, as instruments for the equation in first differences. The GMM(DIF) approach of equation (4) may lead to a downward bias in the coefficients when the time-periods are too short with respect to the number of countries and when data are persistent. This occurs because the lagged level of the variables is weakly correlated with subsequent first-differences and instruments are weak.[13] This is not the case in this work because we know that the estimator improves, as T gets larger, then the Arellano & Bond (1991) estimator should yield efficient estimates. For some group of countries, in which the number of observations and time periods are small (especially when five-year averages are computed), we pool all the countries (CMEA and EEC) in a unique sample to test for the openness-growth nexus.

12. Though the fixed effects have been eliminated, the lagged dependent variable is still endogenous, since $y_{i,t-1}$ is correlated with the error terms $\varepsilon_{i,t-1}$. Likewise any predetermined variable in *X* that is not strictly exogenous becomes potentially endogenous given the correlation with $\varepsilon_{i,t-1}$. However, differently from mean-deviation transform deeper lags of the regressors are now available as instruments (see Roodman, 2006).

13. See Blundell and Bond (1998) for further details on the finite sample bias of GMM (DIF).

3. Results for CMEA and EEC's samples

3.1. The CMEA sample

The TABLE 1 shows CMEA's summary statistics while correlations of the variables are reported in the appendix.

Table 1 - CMEA summary statistics

Variables	Obs.	Mean	Std. Dev.	Minimum	Maximum
Growth rate of real *per capita* GDP ($\Delta \ln y_t$)	186	0.0348679	0.0489497	–0.1693671	0.1872678
Real GDP *per capita* ($\ln y_t$)	194	8.146158	0.6563822	6.066108	9.252921
Investment/GDP ($\ln(I/GDP)$)	194	3.428393	0.2003489	2.76001	3.839452
Openness ($\ln OPEN$)	194	3.64322	0.7234507	1.644805	4.817779
Population growth rate ($\Delta \ln POP$)	193	0.0112934	0.218564	–1.304984	2.554233
Average years of schooling ($\ln AVERSCH$)	194	2.048292	0.1935649	1.574847	2.353278
Share of public expenditure/GDP ($\ln GOV$)	194	2.511865	0.6390218	1.252763	3.529297

The conditioning set of our specification contains the growth rate of population (*GPOP*), the natural log of real investment ratio *I/GDP* and human capital. We use the variable *AVERSCH* as the stock measure in Barro and Lee (2000), which denotes the average years of schooling in the population of 25 years and above and controls for the level of human capital in the country. The rationale for each variable's inclusion is known from growth theories. We include, as stressed by Rodrik (1998), also the natural log of real consumption government spending in *GDP* (*GOV*) to enhance the effect of trade on growth.

Following the methodological discussion above, we present the results of our analysis. Regressions for CMEA are reported first and those for the EEC follow. For each group and data, we will report results using pooled OLS[14], Within-Group estimates with fixed effects, and results of the first-differenced GMM estimator.

Column one of TABLE 2 reports pooled OLS as a benchmark. The result expected for CMEA is a weak insignificant statistical relationship between openness and growth and a positive and robust relationship with the investment share. The estimated coefficient of (ln) real investment

14. We estimate pooled panel regression which assumes time and cross section invariant intercepts and coefficients. This means that we assume a common level of technology for all countries.

to GDP is positive and statistically significant at 1% level. We also performed regressions with the various measures of human capital used in the literature, and we find that neither of these measures is positively correlated with growth. All of them, even when they have been interacted with investment or openness, exhibit a negative sign and often are not statistically significant. All the regressions include time effects (not reported) that are assumed to pick up any omitted shock that affects trade and growth in all countries simultaneously. The inclusions of the time dummies decrease the robustness of the openness coefficient, which in their absence is negative and significant at 15 per cent level. In the OLS specification, the time dummies indicate that international conditions for growth have deteriorated over the period 1980-1985 while positive effects are reported for previous periods.

An equation like that in Column (1), although routinely used in growth empirics, suffers from many drawbacks since it assumes homogeneity and does not control for fixed effects and endogeneity of regressors. To alleviate dynamic mis-specification, we use fixed effects to estimate regressions in Column (2). It allows us to incorporate the influence of country-specific technology level in the regression. It is worth noting that simple Within-Group estimations with fixed effects, but without correcting for endogeneity, are very much in accord with the OLS estimates, especially when there is not much heterogeneity across countries. Openness still shows a negative and insignificant coefficient and the investment ratio holds its statistical significance at 1%. The period dummies significant in (2), are relative to the periods 1980-1985 (–0.0418079, *t*-statistics = –2.47).

The problem with their inclusion is that they outperform other indicators and make openness less significant. The major problem with the fixed effect estimator is that autocorrelation and persistence in the data are likely to produce inconsistent estimates of the coefficients. Since the GMM framework, by addressing both problems of endogeneity and autocorrelation with lagged income, offers consistent estimates, regression (3) is estimated with this method. The instrument used consists of previous observations of the explanatory and lagged-dependent variables. However, even when we correct for endogeneity and run our first step GMM (DIF) estimation the results are confirmed and the negative coefficient of openness has little explanatory power. In the last regression, the point estimates of openness and the investment shares lie above the corresponding within-group estimates. Even if this is an element for consistency, we test the overall validity of the instruments conducting the Sargan test of the over-identifying restrictions, which accepts the null of instrument validity. For consistent estimates with differencing data, the Arellano and Bond test requires the absence of second order serial correlation, and the p value reported confirms the acceptance of the hypothesis.[15]

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15. We follow Arellano and Bond by using first step estimator for inference on coefficients. The standard errors reported after the one-step estimator is the Arellano and Bond robust estimator. The Windmeijer corrections are available only for GMM two-step estimator. The second step estimator consists in constructing a consistent estimate of the variance-covariance matrix of the moment conditions with the residuals obtained in the first step. Asymtotically the second step is superior in terms of efficiency but not in terms of the values of the coefficients. Given that our cross-sectional dimension is small relative to the number of instruments the two steps performed poorly in our regressions. Blundell and Bond (1998) states that simulations show that the one step estimator has been found more reliable than the more efficient two step estimator and that "the loss in precision is unlikely to be large" (p. 9).

Table 2 - Annual data cross-country growth regression (1960-1989)

CMEA sample
Dependent variable: $\Delta \ln y_t$

Variables	Pooled OLS[a]	Within group-(fixed effects)[a]	GMM(DIFF) (one step) (openness and investment endogenous)
	(1)	(2)	(3)
$\Delta \ln y_{t-1}$			0.09495
			(1.35)
$\Delta \ln y_{t-2}$			0.01944
			(0.26)
$\ln y_{t-1}$	$-6.86e^{-06}$	$-6.16e^{-06}$	
	–(2.73)***	(–1.07)	
$\ln (I/Y)$	0.09533	0.08851	0.16175
	(3.82)***	(3.40)***	(4.96)***
ln *OPEN*	–0.00751	0.0019188	–0.02126
	(–1.35)	(–0.10)	(–0.81)
ln *AVERSCH*	–0.04662	–0.09946	–0.01257
	(–1.73)*	(–1.87)**	(–0.94)
Δln *POP*	–2.848581	0.7085221	2.52930
	(–2.60)***	(0.41)	(1.33)
ln *GOV*	–0.000151	–0.0461445	–0.4136
	(– 0.28)	(–1.80)*	(–8,08)***
Constant	– 0.12018	0.0798929	
	(–1.19)	(0.48)	
Period dummies[a]	YES	YES	YES
Observations	186	186	162
R^2	0.23	0.27	
Arellano-Bond AR(1)[b]			[0.00]
Arellano-Bond AR(2)[c]			[0.18]
Sargan test[d] $\chi^2 = (154.62)$ p value in brackets			[0.25]

Notes: ***, **, * denote coefficients significantly different from zero at the p = 1%, 5% and 10% levels respectively. t statistics in parentheses are robust and clustered by countries.

In the dynamic specification (3) of GMM-DIFF the variables $\ln I/Y$ and ln *OPEN* are treated as endogenous. Instruments used are all the lags of the specification and 2 further lags of the endogenous variables. Remind that the equation estimated with first difference GMM with respect to the other specifications reported is as follows:

$$\Delta y_{i,t} = \beta_0 + \beta_1 \Delta \ln y_{i,t-1} + \beta_2 \Delta \ln I/y_{i,t} + \beta_3 \Delta \ln OPEN_{i,t} + \beta_4 \Delta \ln POP_{i,t} + \beta_5 \Delta \ln AVERSCH + \beta_5 \Delta \ln GOV + \Delta \varepsilon_{i,t}$$

[a] Period dummies not reported.

[b] The null hypothesis is that the errors in the first differenced regressions do not exhibit first order serial correlation.

[c] The null hypothesis is that the errors in the first differenced regressions do not exhibit second order serial correlation (in square brackets are reported the p value of the test).

[d] The null hypothesis is that the instruments are valid and are not correlated with the residuals. In brackets are reported the p values. All models are estimated using Intercooled STATA 10.

3.2. The EEC sample

We follow the modelling strategy of the previous section and repeat the analysis for the EEC sample. We start by presenting summary statistics in TABLE 3. Correlations among variables are provided in the APPENDIX 2.

Table 3 - CEE summary statistics

Variables	Obs	Mean	Std. Dev.	Minimum	Maximum
Growth rate of real *per capita* GDP ($\Delta \ln y_t$)	260	0.0298784	0.0256404	–0.0477061	0.1183677
Real GDP *per capita* ($\ln y_t$)	268	9.004606	0.3795522	7.916808	9.590693
Investment/GDP ($\ln (I/GDP)$)	268	3.21201	0.1746142	2.653242	3.575151
Openness ($\ln OPEN$)	268	4.022396	0.5294869	2.92047	5.052736
Population growth rate ($\Delta \ln POP$)	267	–0.001944	2440565	–2.968431	1.43206
Average years of schooling ($\ln AVERSCH$)	268	1.916466	0.266224	1.252763	2.416806
Share of public expenditure/GDP ($\ln GOV$)	268	2.684978	0.1890611	2.24071	3.157

The variables used are the same of CMEA's sample. As before, we list our findings in TABLE 4. We report in Column (1) OLS results, the within group fixed-effect estimator in Column (2) and in the last column the dynamic GMM (DIFF) estimator. The time series dimension of this sample is very large (40 annual observations for each country) and by considering that EEC data are of high quality according to Heston *et al.* (2002), we expect to find more robust and reliable results.

Investment seems to be strongly correlated with growth for the EEC as well: a 1% increase in the investment/GDP raises the growth rate from 0.04 to 0.06 percentage points. The impact seems not very large, but data has not been transformed and the growth rate has not been multiplied by 100 as occurs generally in the literature. The impact of trade openness is very surprising to us given our view of a strong growth effect of European integration on growth rate. With OLS, the impact of openness is not statistically significant. Including time dummies reduces the size of the estimated coefficient and its statistical significance.

With either pooled OLS or other panel estimation techniques, we find no evidence of a positive correlation between trade and growth acceleration for EEC. Instead, contrary to in the OLS specification, openness bears a negative and significant coefficient when we correct for fixed effects and for endogeneity. In regression (3) the openness variable and the investment ratio are simultaneously treated as endogenous.

Table 4 - Annual data cross-country growth regressions (1950-1990)

EEC sample
Dependent variable: $\Delta \ln y_t$

Variables	Pooled OLS	WG fixed effects	GMM (DIFF) (ln *I/Y*, ln *OPEN* endogenous)[a]
	(1)	(2)	(3)
$\Delta \ln y_{t-1}$			0.07137
			(1.30)
$\Delta \ln y_{t-2}$			–0.19592
			(–3.61)***
$\ln y_{t-1}$	–0.0124413	0.01750	0.01952
	(–2.51)***	(1.18)	(1.14)
ln (*I*/*Y*)	0.04245	0.05494	0.05999
	(3.86)***	(2.41)**	(4.10)***
ln *OPEN*	–0.00329	–0.03507	–0.03156
	(–0.80)	(–2.69)***	(–1.87)**
ln *AVERSCH*	0.00321	–0.05188	–0.09660
	(0.32)	(–1.44)	(–3.31)***
Δln *POP*	–0.39761	–1.01955	–1.2566
	(–0.85)	(–1.85)*	(–2.00)**
ln *GOV*	–0.00452	–0.01928	–0.05880
	(–0.46)	(–0.46)	(–2.80)***
Constant	0.03065	–0.00537	no constant
	(0.46)	(–0.02)	
Time dummies	YES	YES	YES
Observations	260	260	236
R^2	0.34	0.35	
Arellano-Bond AR(1)			[0.00]
Arellano-Bond AR(2)			[0.50]
Sargan test $\chi^2 = (224)$ p value in brackets			[0.33]

Notes: ***, **, * denote coefficients significantly different from zero at 1%, 5% and 10% respectively; robust *t* statistics clustered by countries are in parentheses.

[a] Regression 3 applies GMM(DIFF) in which the variables $\ln Open/Y_t$ and I/Y_t are considered simultaneously endogenous. Instruments used are all the lags of the variables in the specification included time dummies and further 2 lags of the two variables.

There are several ways to check for these unexpected results. The first is to search for alternative proxies for openness. In some studies, the growth rates of exports or imports taken singularly have been used. We performed regressions with both measures in nominal terms and the results were not significant. Obviously, negative coefficients were obtained when the levels of both variables were included in the same regression. Variables in nominal terms may determine positive effects on growth simply because the data are not adjusted for the inflation rate. In such a case changes in the value of openness may be due to price changes without variations in trade quantities.[16] Furthermore, multivariate Dickey-Fuller tests of the variables included in the regressions showed that openness has a unit root and becomes stationary after first differencing, while the same property does not occur for the other measures of trade reported in HS&A (2002). Therefore, openness in real terms, which takes into account both dimensions of access to foreign market trade, is our preferred measure of trade intensity.

Concerning the other regressors, the results are consistent with the previous empirical literature. Also for EEC the coefficient of the measure of human capital is negative. Attempts to include other educational variables have not been satisfactory. The negative coefficient of secondary education and average years of schooling on growth still remains a puzzle in the empirics of growth (see Wolff, 2000). The only difference with the inclusion of the secondary education measure (Barro and Lee, 2000) is that it increases R^2 by 5 or 6 percentage points.

In all the specifications time dummies have been included. They are very significant for growth in the periods from 55-75 with the greatest effect in the period 60-65, in which the time dummy coefficient is 0.03073 with a *t*-statistic equal to 4.54. In subsequent periods the time dummies have little explanatory power for growth over time. In the case of the EEC the result is at odds since we would expect that productivity would be enhanced by economic integration between countries with high standard of technologies, homogeneity in institutions, macroeconomic policy and market structures. Our results suggest, instead, that integration of European country has affected growth through increased investment, which maintains its sign and robustness in all the specifications. The dynamic panel estimation (regression 3) shows that the lagged difference values of the variable are statistically less significant. This might detect further cyclical effects (not captured by time dummies) and therefore a weak effect on the long-run growth rates. Hence, we think that the method that averages observations over five years should be preferred to assess long-run relationships.

3.3. Five-year estimations

Since the five-year samples are too small to be used in a panel framework we pool all the countries in a unique sample and perform our estimates. We use time dummies and a dummy for EEC membership in our regressions. Table 5 reports the results.

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16. For a discussion of potential drawback of nominal openness compared to real openness see Alcalà and Ciccone (2004).

Table 5 - Five-year[a] panel regression (1950-1990)

CMEA+EEC' sample
Dependent variable: $\Delta \ln y_t$

Variables	Pooled OLS $\Delta \ln y_t$ $\Delta \ln y_{i,t}$ (1)	WG-fixed effect (2)	GMM (DIF)[b] (Ln OPEN endogenous) (3)
$\Delta \ln y_{t-1}$			0.13701
			(1.24)
$\Delta \ln y_{t-2}$			
$\ln y_{t-1}$	0.00186	–0.055984	– 0.06207
	(0.27)	(–2.41)**	(–2.32)**
ln (*I*/*Y*)	0.02698	0.04368	0.04836
	(2.40)**	(1.89)*	(1.98)**
ln *OPEN*	0.00314	0.02090	0. 00472
	(0.84)	(1.07)	(0.25)
ln *AVERSCH*	–0.01173	0.01984	–0.00071
	(–1.03)	(0.70)	(–0.01)
$\Delta \ln POP$	0.00165	–0.44552	–0.39913
	(0.46)	(–2.97***)	(–1.87)**
$\Delta \ln GOV$	–0.00891	–0.02455	0.01430
	(–2.94)***	(–0.74)	(0.36)
EEC membership	–0.00241		
	(–0.28)		
Time dummies	YES		YES
Constant	–0.18739	0.35691	no constant
	(–1.71)*	(1.33)	
Observations	89	74	57
R^2	0.48	0.46	
Arellano-Bond AR(1)[c]			(0.06)
Arellano-Bond AR(2)[c]			(0.96)
Sargan test $\chi^2 = 32.07$ (27) p value in brackets			(0.22)

Notes: ***, **, * denote coefficients significantly different from zero at 1%, 5% and 10% respectively. *t* statistics in parentheses are clustered by countries. The p-value of the serial correlation tests are in square brackets.

[a] The five year averages regression has the form: $\Delta_5 y_{i,t} = \alpha_1 \Delta_5 y_{i,t} - y_{i,t-5} + \alpha_2 \Delta_5 x_{i,t} + \Delta_5 \varepsilon_{i,t}$
where: $\Delta_5 y_{i,t} = y_{i,t} - y_{i,t-5}$ and $\Delta_5 x_{i,t}$ denotes the average value over five years of the regressors.

[b] ln *OPEN* is treated as a potentially endogenous variable in GMM (DIFF). The instrument set contains observations on all the variables in the equation-dated *t*–2 and further lags dated *t*–3 and *t*–4 as well as time dummies.

[c] AR(1) and AR(2) are tests for first order and second order serial correlation in the first differenced residuals under the null of no serial correlation.

The overall finding is that either with annual data or five-year averages, whatever the econometric technique used, the investment in physical capital is the most robust determinant of growth. Concerning trade openness, when we pool both samples and average data over five years, Openness becomes correctly signed but not statistically significant. Even when we correct for endogeneity the coefficient still remains insignificant. Time dummies are significant and for the time period 1955-60 and 1960-65 display a positive and robust coefficient (not reported). Experiments of interacting the trade variable with both investment and human capital did not yield coefficients that were rightly signed and significant across a variety of specifications. The only significant case of robustness is when we interact trade with the EEC dummy. The regressions are reported in the APPENDIX 2.

We checked the sensitivity of the results with respect to changes in the conditioning set (different measures of human capital), and estimation methods (fixed effects with instrumental variables) but the coefficients maintain their sign and statistical insignificance, whatever the number of lags or the choice of predetermined-endogenous right-hand variables that enter in the regression. Hence, the openness variable does not seem to be a strong determinant of long run growth. The GRAPH A2.1 in the APPENDIX 2 helps us to get some further insights on the link between trade and openness. After the period analysed (1950-1990), the EEC countries have implemented important steps towards a single market. This increase in economic integration was not accompanied by an evident increase in the growth rates in the old EEC countries.

4. Openness, trade structure and growth in transitional economies

The transition to market of former CMEAs has been associated with dramatic changes in their foreign trade. Imports and exports have been strongly affected by processes of geographical reorientation (especially towards the EU) and sectoral restructuring. In this section we try to evaluate the relationship between openness and growth for a group of TEs[17] in the period 1990-2000.

Following Amable (2000), in addition to the openness measure, we consider as explanatory variables some indices of sectoral composition of trade flows, such as inter-industry index and dissimilarity index, in order to better qualify the link between trade and growth.[18] The use of such trade structure indicators seems to us particularly appropriate for countries showing relevant changes in the composition of their trade flows. In particular, such indices should indicate whether inter- or intra-specialisation promotes growth in accordance with different models of trade integration.

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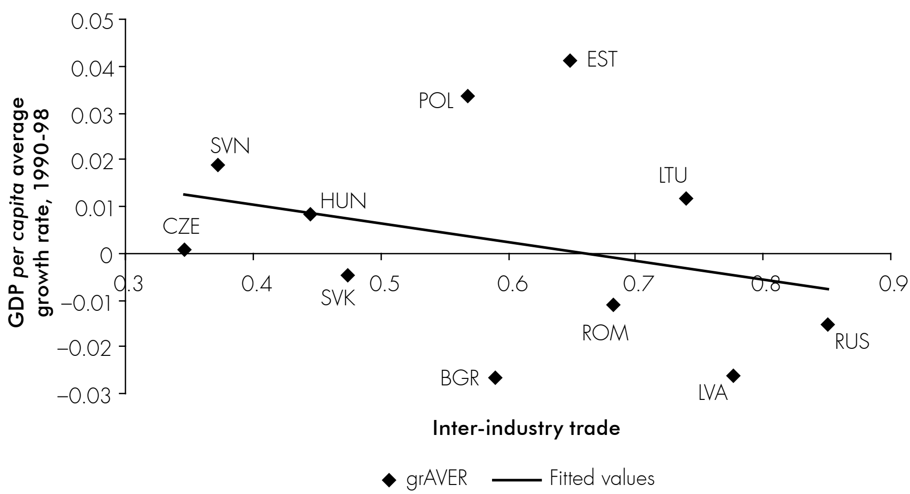
17. We have considered 11 transitional economies: Hungary, Czech Republic, Slovakia, Poland, Bulgaria, Russia, Romania, Slovenia, Latvia, Estonia, Lithuania.

18. Details on the construction of all trade indices used are in the APPENDIX 2.

We complement inter-industry and dissimilarity measures with intra-industry indices calculated at 8-digit level of disaggregation (at product level). Such indices allow the separation of the share of trade flows differentiated by quality (vertical intra-industry trade) from the share of trade flows differentiated by product attributes (horizontal intra-industry trade). This further qualification is significant in order to disclose dynamic comparative advantage operating inside both intra-industry (in the form of vertical intra-industry trade) and inter-industry trade flows. If the vertical component is the dominant part in intra-industry trade, then trade is better explained according to traditional arguments based on factor proportions and differences in technology rather than by factors based on the standard imperfect competition theories. Hence, we complement inter (intra)-industry indices calculated at 3-digit level with indices of vertical and horizontal intra-industry trade calculated at 8-digit level. For a better understanding of this point, compare GRAPH 1 and GRAPH 2.

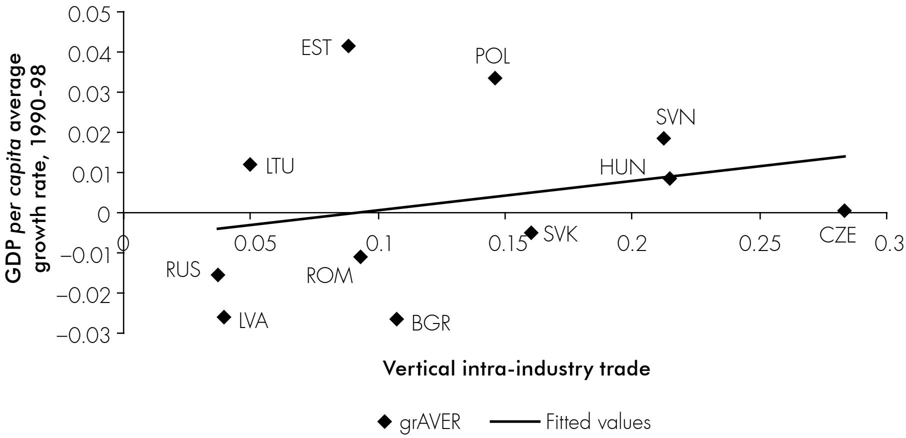
GRAPH 1 displays a negative relationship between inter-industry trade and growth for the TEs in the period 1990-98: less inter-industry trade (more intra-industry trade) is associated with more growth. If we limited our observation to the GRAPH 1, in which inter (intra)-industry trade index has been calculated at the 3-digit level, we would conclude that intra-industry specialisation promotes growth and that the standard theory based on comparative advantages does not offer a good prediction.

Graph 1 - Inter-industry trade and growth



Nevertheless, if we look at GRAPH 2, in which trade index has been calculated at product level (8-digit), we can observe that vertical intra-industry trade is positively associated with growth. In this case, we cannot dismiss the traditional explanation based on comparative advantages because vertical intra-industry is theoretically founded on a dynamics of specialisation based on factor proportion (for example, different qualities incorporate different skill intensities).

Graph 2 - Vertical intra-industry trade and growth



Tables 6 and 7 describe results for the sample of TEs in the period 1990-2000. In particular, table 6 reports regression results when trade indices at the 3-digit level are considered as regressors, while table 7 shows results when trade indices at the 8-digit level are included.

In Column (1) of table 6, the coefficient associated with openness is positive and significant. This finding contrasts previous results relative to CMEAs and supports the idea of a positive influence of trade flows on growth when market mechanisms are set in motion. Columns (2), (3) and (4) of table 6 show regression results when alternative measures of trade integration are considered. In Column (2), the inter-industry index is considered (INTER). This index has been measured as the complement to one of the Grubel-Lloyd intra-industry trade indices calculated at the 3-digit level. The finding is that a negative and significant relationship emerges between inter-industry trade and growth (at 1% level). However, as mentioned before, it is important to investigate the type of intra-industry specialisation before inferring conclusions about the model in action. In Column (3), following Amable (2000), we consider as a regressor the dissimilarity index of exports. This index measures at what extent the export composition by sector of a transitional economy diverges from the export composition by sector of EU (value 1 indicates complete divergence while value 0 indicates complete convergence). The coefficient associated with DISS(X) is negative and significant (at 1% level), implying that a larger similarity to EU export composition should stimulate the growth of TEs. In Column (4), we use the import dissimilarity index. The coefficient associated with DISS(M) is negative and significant (at 1% level). This should imply that a convergence towards the EU structure of demand for final goods and input requirements promotes the growth of TEs. By looking at the other explanatory variables, now only government expenditure is significant (at 5% and 10% level).[19]

19. No measure of human capital has been included in regressions for TEs because of lack of homogeneous data for all countries of the sample.

Table 6 - Trade and growth in transitional economies: Annual data cross-country growth regression (1990-2000)

Dependent variable: $\Delta \ln y_t$
Trade indices at 3-digit level of disaggregation

Variables	Fixed effects (1)	Fixed effects (2)	Fixed effects (3)	Fixed effects (4)
$\Delta \ln y_{t-1}$	–0.000035	–0.000054	–0.000054	–0.000051
	(–4.70) ***	(–5.48) ***	(–5.14) ***	(–4.98) ***
$\ln(I/Y)$	0.037150	0.020584	0.032696	0.042020
	(1.43)	(0.78)	(1.18)	(1.55)
$\Delta \ln POP$	0.478926	–0.238094	1.554115	–0.103827
	(0.27)	(–0.15)	(0.91)	(–0.06)
$\ln GOV$	0.055679	0.065109	0.096125	0.097259
	(1.67) *	(1.65) *	(2.33) **	(2.37) **
$\ln OPEN$	0.095305			
	(3.22) ***			
INTER		–0.695305		
		(–5.07) ***		
DISS(X)			–0.790875	
			(–4.07) ***	
DISS(M)				–0.970698
				(–4.21) ***
Constant	–0.232192	0.597909	0.510253	0.342850
	(–2.83) ***	(3.41) ***	(2.74) ***	(2.17) **
Observations	103	75	75	75
R^2	0.3172	0.5084	0.4486	0.4569

Notes: *** denotes significance at 1% level, ** at 5% level, * at 10% level; *t* statistics in brackets.

In the TABLE 7, the coefficients of intra-industry trade indices are significant in all specifications. In Column (5), the Grubel-Lloyd intra-industry trade index, calculated at 8-digit level (GL), is positively associated with growth (at a 1% level of significance). In Column (6) and (7) we can observe that both components of intra-industry trade – horizontal and vertical – are positively related to growth (coefficients associated with GLH and GLV variables are significant at a 1% level). When we split the vertical intra-industry trade index in up-market (GLV^+) and down-market (GLV^-) components, both of them display positive and significant coefficients (Columns 8 and 9).[20]

20. However in the case of TEs a relevant part of GLV^+ consists of outward processing trade from EU firms. Said, differently, higher unit values of exported goods by TEs would not signal only higher quality but also the simple fact that some goods are temporarily imported in TEs for processing and then re-exported to the EU.

Table 7 - Trade and growth in transitional economies:
Annual data cross-country growth regression (1990-2000)

Dependent variable: $\Delta \ln y_t$
Trade indices at 8-digit level of disaggregation

Variables	Fixed effects (5)	Fixed effects (6)	Fixed effects (7)	Fixed effects (8)	Fixed effects (9)
$\Delta \ln y_{t-1}$	–0.000068	–0.000065	–0.0000713	–0.0000613	–0.0000779
	(–5.50) ***	(–4.59) ***	(–5.80) ***	(–4.37) ***	(–6.11) ***
$\ln(I/Y)$	0.014334	0.029621	0.018482	–0.000553	0.0547569
	(0.42)	(0.77)	(0.56)	(–0.01)	(1.66) *
$\Delta \ln POP$	0.613984	0.710684	0.477563	0.811810	0.174109
	(0.37)	(0.38)	(0.30)	(0.45)	(0.11)
$\ln GOV$	0.096669	0.094996	0.093527	0.109062	0.075802
	(2.00) **	(1.73)*	(1.97)**	(2.01)**	(1.56)
GL	1.052904				
	(4.90) ***				
GLH		1.977393			
		(2.82) ***			
GLV			1.466721		
			(5.19) ***		
GLV^+				2.334576	
				(3.25) ***	
GLV^-					1.945672
					(4.83) ***
Constant	0.052943	0.103460	0.046086	0.092167	0.055653
	(0.32)	(0.55)	(0.28)	(0.50)	(0.33)
Observations	64	64	64	64	64
R^2	0.57	0.45	0.59	0.47	0.57

Notes: *** denotes significance at 1% level, ** at 5% level, * at 10% level; *t* statistics in parentheses.

In general, findings by using trade indices calculated at product level (8-digit) show that both types of product differentiation dynamics, horizontal and vertical, have a positive influence on growth. In such a case investment becomes insignificant. A likely explanation is that trade indices, which signal product quality, should be better complemented by measures of human capital rather than physical capital.

5. Conclusions

This paper has reconsidered the issue of whether trade openness spurs economic growth. We have compared three different groups of counties: historical EEC, the countries of former CMEA customs union and a group of Transitional economies (TEs). In doing so, we have avoided the shortcomings of mixing countries with very different characteristics and institutions and purged the dominance effect of institutional quality when these indicators are included in a growth regression with openness to trade (Rodrik *et al.*, 2004).

Our main findings confirm that in planned economies the impact of the summary measure of real openness by using HS&A (2002) ratio is negative. Surprisingly, however, the pattern of results is qualitatively similar for both the two customs unions. Trade openness has a negative and statistical significant impact also on the growth rate of the EEC group.

The finding of a negative correlation for the two major samples studied raises doubts about the importance of this variable on long run growth performance. We started our work with the expectation that openness should be influential for EEC but not for CMEA and realised that the growth effects of openness are not considerably different in both samples. This result is found using panel data techniques at annual frequency. It is known that conventional trade theory associates international trade with a reallocation of resources within the national borders. This reallocation generates efficiency gains that increase the *level* of GDP, but there are some who doubt whether these level effects are temporary or permanent. Whereas there is a strong consensus on a level effect of openness, the same degree of consensus does not emerge for the growth effects of international trade.

Also the literature that tested for the growth effects of European integration is not able to achieve a firm conclusion. Landau (1995) tested if common market has made a significant contribution to the economic growth of the EEC countries in the context of OECD and found that the dummy for the common market is insignificant. When it is interacted with time it becomes negative but still insignificant. The paper by Henrekson *et al.* (1997) found a positive correlation of EEC membership with growth when they include in their regression the real exchange rate distortion but this positive association disappears when the level of openness is used. Vanhouldt (1999) did not find permanent effects of European integration and Badinger (2001) who tested for permanent and temporary growth effects of European integration rejects the hypothesis of long run effects. However, these studies differ from ours in their integration variables but the results of no growth effects support our findings.

When we pooled EEC and CMEA in a unique sample and averaged observations over five-years, trade openness becomes correctly signed but does not have any statistical significance. Therefore, our finding does not support a robust and positive relationship between trade and growth. What we find, in accordance to Levine and Renelt (1992) and Baldwin and Seghezza (1996) results, is that there should be an indirect channel that goes from trade to investment and then growth. Also Wacziarg and Welch (2008) document how liberalization in the period 1950-98 has fostered growth through its effect on physical capital accumulation.

Parallel to this conclusion, however, we need to emphasise another finding of our analysis. In fact, in the third sample examined, the TEs, the time-period is too short to infer long run effects of trade on growth. Motivated by the fact that the integration measure in our regression is *correctly signed,* we have constructed for this sub-sample indices of inter-industry and intra-industry trade. Openness and intra-industry trade indices seem to be significant determinants of their growth transitional path. However, when we split the vertical intra-industry trade index in up-market (GLV^{+}) and down-market (GLV^{-}) components, the latter displays a more significant coefficient.

Should we infer from this last finding that trade does spur growth particularly at the beginning of the process of opening-up to international integration, and then this effect declines? Since the empirical analysis revealed that openness enhance growth only for TEs, it is plausible to argue that countries with a lower initial stock of knowledge are able to imitate faster than those with a higher initial stock of knowledge. Transition countries that are not at the frontier of technological progress will gain more in terms of productivity growth from international transfer of technology through trade than their Western counterparts. If this is true, we can argue that perhaps the results for EEC are not completely at odds if we look at European historical growth experience. Since the '70 there has been slower growth in the EEC (only partly due to oil shocks) and the completion of the internal market has not opened yet the growth opportunities predicted by official Reports (Cecchini Report, 1988) and by some scholars (Baldwin, 1989, 1992).

An equally likely and plausible explanation is that the standard measures of openness adopted are not sufficient to capture the process of economic integration across countries. Aside from trade, important determinants of openness may include outward FDI, human capital mobility, scientific publications, patenting etc... We believe that, rather than traditional definitions, a more comprehensive measure of openness can do a better job in detecting growth impact, hopefully along the lines applied to the TEs sample in this paper.

R. C. & G. C.[21]

21. The authors would like to thank two anonymous referees and the Editor, professor Eric Strobl, for their helpful and valuable comments and suggestions. The usual disclaimer applies.

Appendix 1
Alternative specifications

We performed in this work different regressions to detect some type of significance on the connection between the openness and growth. It is evident that openness is not free from methodological problems and we have tried many variable interactions with the hope of finding some medium-long run effect. The regressions below show a further effort to analysing the robustness of the link. The experiment is done with the complete sample of EEC and CMEA countries with data averaged over five years. We include in the regression equation the interaction between the dummy of EEC membership and openness and the results are reported below.

As is shown in TABLE A1.1, the only substantive regressor is the EEC dummy interacted with Openness (together with population growth and time dummies). Moreover, even with this interaction, the OPEN variable by itself does not become more significant. More interesting is that the coefficient of the investment rate is significant only in the OLS specification and then its significance disappears. In all the specifications in the text the ln*I/Y* has always conserved its sign and robustness. For this reason we really doubt about the information of this interaction term to provide the total impact of openness and EEC membership on growth. In the specification (3) with GMM-DIF the interaction terms has a low significance (13%) and none of the variables show any significance, except the time dummies and the initial period real GDP *per capita*.

Table A1.1 - Five-year (a) panel regression (1950-1990)

CMEA+EEC' sample
Dependent variable: $\Delta \ln y_t$

Variables	Pooled OLS $\Delta \ln y_t$ $\Delta \ln y_{i,t}$ (1)	WG-fixed effect (2)	GMM (DIF) (3)
$\Delta \ln y_{t-1}$			0.11770
			(0.54)
$\Delta \ln y_{t-2}$			–0.1472945
			(–0.66)
$\ln y_{t-1}$	–0.00763	–0.1138228	–0.1024296
	(–0.787)	(–2.84)***	(–1.95) **
$\ln (I/Y)$	0.04179	–0.004673	0.0046135
	(2.84) ***	(–0.01)	(0.09)
$\ln OPEN$	–0.00634	0.0171931	0.0088925
	(–1.18)	(0.96)	(0.35)
$\ln AVERSCH$	–0.003214	0.01984	–0.0218607
	(–1.55)	(0.70)	(–0.30)
$\Delta \ln POP$	–0.41696	–0.0438954	–0.0432853
	(–2.44)**	(–0.28)	(–0.13)
$\ln GOV$	–0.00285	–0.027501	–0.0309652
	(–0.44)	(–1.09)	(–0.55)
EEC membership	–0.07282		
	(–1.66)*		
EEC*$\ln OPEN$	0.02007	0.059987	0.059082
	(1.85)*	(2.43)**	(1.48)
Time dummies	YES		YES
Constant	0.07343	0.35691	0.9994658
	(1.06)	(1.33)	(2.30)***
Observations	74	74	43
R^2	0.48	0.71	
Arellano-Bond AR(1)			[0.009]
Arellano-Bond AR(2)			[0.37]
Sargan test $\chi^2 = 16.22$ (17) p value in brackets			[0.51]

Notes: (a) The five year averages regression has the form: $\Delta_5 y_{i,t} = \alpha_1 \Delta_5 y_{i,t} - y_{i,t-5} + \alpha_2 \Delta_5 x_{i,t} + \Delta_5 \varepsilon_{i,t}$ where: $\Delta_5 y_{i,t} = y_{i,t} - y_{i,t-5}$ and $\Delta_5 x_{i,t}$ denotes the average value over five years of the regressors.

Instruments for differenced equation.
GMM-type: L(2/.).growth per capita. Standard: D.lagrgdpch D.li LD.li L2D.li D.lopen LD.lopen L2D.lopen D.lg LD.lg L2D.lg D.laver LD.laver L2D.laver D.gpop, D.dummy3 D.dummy4 D.dummy5 D.dummy6 D.dummy7 D.ceeopen.

Appendix 2
Data sources and definitions

Samples

We use three samples. The first one is composed by the following EEC countries: Belgium, France, West Germany, Italy, and Netherlands (data are included from 1950) United Kingdom, Ireland and Denmark (data are included from 1970).

The second sample is formed by historically planned economies (CMEAs) which includes: Czechoslovakia, Poland, Hungary, Bulgaria, Romania, East Germany (DDR), USSR and Yugoslavia. In earlier version of PWT only 3 of these countries were included in the data set (Hungary, Poland and Yugoslavia). All the countries participated in the 1996 benchmark comparisons carried out through the OECD and have been treated individually by Heston *et al.* (2002). Estimates of components of GDP and related variables for these countries are subject to some measurement errors. To signal the relative reliability of the estimates, HS&A, whose data set is used extensively in this work, have assigned to the data quality of these countries a rating scale between B and C against a rating scale of A which is assigned to all the countries in the EEC panel (see HS&A, 2002; Penn World Table 6.1, Data Appendix, Table A, p. 13.)

The third sample is formed by ex-CMEA and accession countries: Hungary, Czech Republic, Slovakia, Poland, Bulgaria, Russia, Romania, Slovenia, Latvia, Estonia, and Lithuania.

Data sources

Data for the main variables listed above are from Heston, Summers and Aten (2002), Penn World Tables, version 6.1.

Data for human capital (PRIM, SECON, and AVERAGE) are taken from Barro and Lee (1993) and updated from Barro and Lee (2000). PRIM (LP in Barro and Lee, 2000) is the percentage of primary school attained in the total population. SECON is the "percentage of secondary school attained" in the total population (LS in Barro and Lee, 2000) and AVERAGE is the average schooling years in the total population (PYR in Barro and Lee, 2000).

Trade data for the TEs are taken from the EUROSTAT COMEXT database. From this database, we have considered 135 3-digit sectors classified according to NACE-CLIO and 13724 8-digit products classified according Combined Nomenclature.

List of variables

POP: population is from the World Bank World Development Indicators 2001 and United Nations Development centre for sources prior to 1960.

RGDP*xx*: real GDP *per capita* (1995 international prices) for 19*xx* (RGDPCH in HS&A, 2002).

INV*xx*: investment share in RGDP (KI in HS&A, 2002).

OPEN*xx* (KOPEN in HS&A, 2002) is the ratio of export plus imports in exchange rate US$ relative to GDP in PPP (US$ PPP/GDP). Remind that our measure of openness is termed "real openness". All previous studies have typically used the measure of nominal openness available in previous versions of Penn World Table data set.

GOV *xx:* Government share relative to RGDP (KG in HS&A, 2002).

Simple correlations

Table A2.1 - Bivariate CMEA sample correlations between growth and its determinants

	GROWTH	ln Y_t	ln (*I/GDP*)	ln *OPEN*	ln *GOV*	ln *AVERSCH*	*GPOP*
GROWTH	1.000						
ln Y_t	–0.197*	1.000					
	(0.0069)						
ln (*I/GDP*)	0.2709*	0.2809*	1.0000				
	(0.0002)	(0.0001)					
ln *OPEN*	–0.1586*	0.2060*	–0.3057*	1.0000			
	(0.0306)	(0.0040)	(0.0000)				
ln *GOV*	–0.1552*	0.3211*	–0.2439*	0.1053	1.0000		
	(0.0344)	(0.0000)	(0.0006)	(0.1438)			
ln *AVERSCH*	–0.2169*	0.6230*	0.1347	0.0380	0.1271	1.0000	
	(0.0029)	(0.0000)	(0.0611)	(0.5992)	(0.0775)		
Population	0.1398	–0.0873	0.0477	–0.2108*	–0.1000	–0.0562	1.0000
growth	(0.0571)	(0.2274)	(0.5097)	(0.0032)	(0.1664)	(0.4378)	

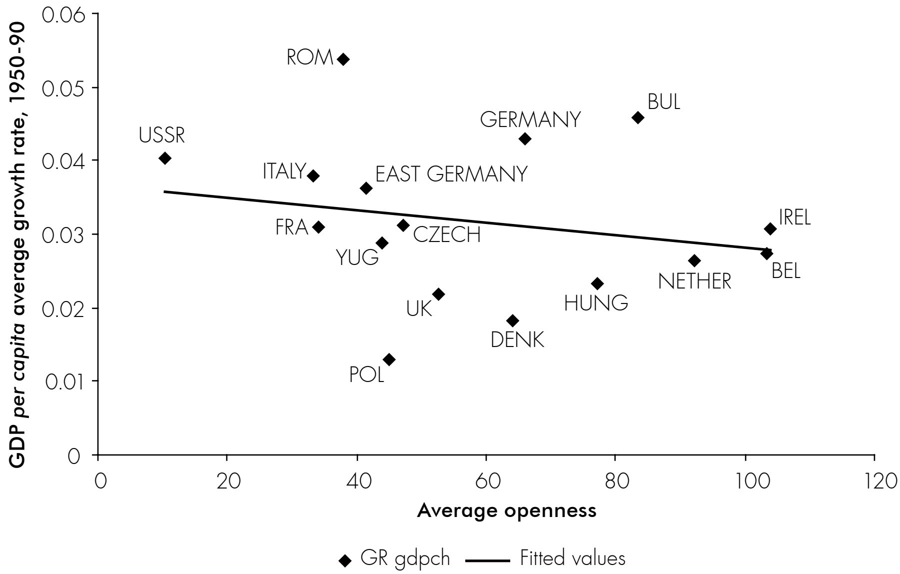
Note: The significance probability of the correlations under the null hypothesis that the statistic is zero is shown in parenthesis. * significant at 5% level.

Table A2.2 - Bivariate EEC sample correlations between growth and its determinants

	GROWTH	ln Y_t	ln (*I/GDP*)	ln *OPEN*	ln *GOV*	ln *AVERSCH*	*GPOP*
GROWTH	1.000						
ln Y_t	–0.2944*	1.000					
	(0.0000)						
ln (*I/GDP*)	0.3787*	0.2312*	1.0000				
	(0.0000)	(0.0001)					
ln *OPEN*	–0.2534*	0.3618*	–0.3573*	1.0000			
	(0.0000)	(0.0000)	(0.0000)				
ln *GOV*	–0.1026	0.0047	–0.2208*	–0.2560*	1.0000		
	(0.0003)	(0.9388)	(0.0987)	(0.0000)			
ln *AVERSCH*	–0.2369*	0.6479*	–0.2758*	0.5565*	0.0874	1.0000	
	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.1537)		
Population	0.2074*	0.0722	–0.0456	–0.0774	0.0485	0.0422	1.0000
growth	(0.0008)	(0.2395)	(0.4581)	(0.2072)	(0.4300)	(0.4924)	

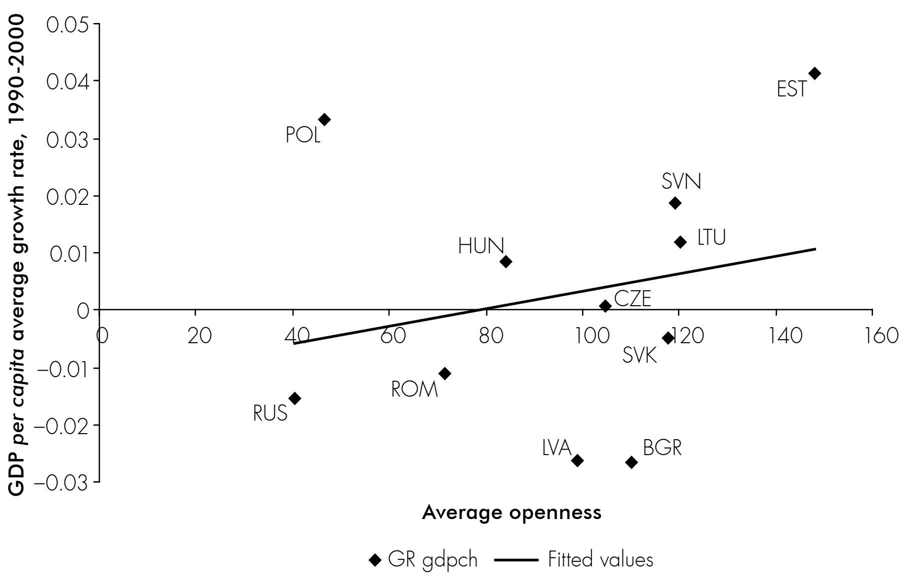
Note: The significance probability of the correlations under the null hypothesis that the statistic is zero is shown in parenthesis. * significant at 5% level.

Graph A2.1 - Openness and growth (1950-1990)



Source: Heston *et al.*, 2002.

Graph A2.2 - Openness and growth in TEs (1990-2000)



Trade indices

INTER: inter-industry trade index calculated as 1 – GL index,

$$GL_j = 1 - \frac{\sum_i |X_i - M_i|}{\sum_i (X_i + M_i)} = \frac{\sum_i (X_i + M_i) - \sum_i |X_i - M_i|}{\sum_i (X_i + M_i)}$$

where j = country, i = 3-digit industry, X = exports, M = imports.

$DISS(X)_J$ = export dissimilarity index $= 1/2 \sum \left| \frac{X_{ij}}{X_j} - \frac{X_{ieu}}{X_{eu}} \right|$, where eu = EU.

$DISS(M)_j$ = import dissimilarity index $= 1/2 \sum \left| \frac{M_{ij}}{M_j} - \frac{M_{ieu}}{M_{eu}} \right|$

GLH_j = horizontal intra-industry trade index = $\frac{\sum_{p \in H} (X_p + M_p) - \sum_{p \in H} |X_p - M_p|}{\sum_p (X_p + M_p)}$

where p = 8-digit product, UV_p are the unit values of exports (x) and imports (m), $\alpha = 0.15$ and the summation $p \in H$ in the numerator is over those 8-digit commodities for which

$$1 - \alpha \le \frac{UV_p^x}{UV_p^m} \le 1 + \alpha$$

GLV_j = vertical intra-industry trade index = $\frac{\sum_{p \in V} (X_p + M_p) - \sum_{p \in V} |X_p - M_p|}{\sum_p (X_p + M_p)}$

where the summation $p \in H$ is over those 8-digit commodities for which:

$$\frac{UV_p^x}{UV_p^m} \le 1 - \alpha \quad \text{or} \quad \frac{UV_p^x}{UV_p^m} \ge 1 + \alpha$$

GLV_j^+ = up-market vertical intra-industry trade index =

$$\frac{\sum_{p \in U} (X_p + M_p) - \sum_{p \in U} |X_p - M_p|}{\sum_p (X_p + M_p)}$$

where the summation $p \in U$ is over those 8-digit commodities for which $\frac{UV_p^x}{UV_p^m} \ge 1 + \alpha$

GLV_j = down-market vertical intra-industry trade index =

$$\frac{\sum_{p \in D} (X_p + M_p) - \sum_{p \in D} |X_p - M_p|}{\sum_p (X_p + M_p)}$$

where the summation $p \in D$ is over those 8-digit commodities for which $\frac{UV_p^x}{UV_p^m} \le 1 - \alpha$

Since the sets V and H are mutually exclusive and exhaustive and since the sets U and D are mutually exclusive and exhaustive of V, it follows immediately that:

$GL_{j_{(8\text{-}digit)}} = GLH + GVL^+ + GLV$

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