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The relationship between economic growth and selected macroeconomic indicators in a group of Central and East European countries: a panel data approach

Abstract

The paper investigates the relationship between economic growth and various macroeconomic indicators using panel data set of a selected group of 9 Central and East European Countries over 1995-2003. The choice of appropriate econometric model for each growth regression in relation to specific indicator is made based on the results of specification tests that include Hausman, Lagrange Multiplier and F tests. The main findings are as follows: Both the level of inflation rate and its volatility negatively affect economic growth:

- the share of domestic investment in GDP has positive impact on growth rate of GDP;
- 'openness' when measured as the ratio of the sum of exports and imports to GDP positively affects economic growth;
- the ratio of the stock of external debt to GDP exerts a negative impact on economic growth;
- the ratio of budget balance to GDP is likely to positively affect growth rate of GDP.

Keywords: economic growth, inflation, openness, investment, external debt, budget balance.
JEL Classification: F34, E24, E31.

Introduction

Neo-classical growth theory as formulated by Solow (1957) postulates that in the long run two critical factors determining growth rate of an economy are exogenously given respective rates of growth of total factor productivity and population. However, in the medium term the rate of accumulation of physical capital and therefore the savings rate are likely to influence the growth rate of the economy (Froyen, 1998). For a long time economists have associated the "level of total factor productivity" with the "level of technology" which has become an endogenous variable determined by the model's variables in the path breaking work of new generation economists such as Romer (1990, 1992) and Mankiw, N.G. et al. (1995). On the other hand Harberger (1998) prefers to call "growth in total factor productivity" the "real cost reductions" and points out that besides "technological progress", major factors that can generate reductions in "real cost of production" are:

- lowering inflation;
- eliminating price controls or interventions in credit markets;
- eliminating the costs imposed on an economy by ill-conceived regulations and bureaucratic hurdles;
- trade liberalization in the form of removal of tariffs, quotas and other kinds of protective measures;
- privatization that enables real cost reductions;
- a sound legal and institutional framework in which individuals are protected against arbitrary incursions on their property and other economic rights.

Actually all these various forms of "real cost reductions" that result from factors other than technological progress can be considered as source of growth in "efficiency" with which firms use the existing resources together with a given level of technology. Weil (2005) suggests that the level of total factor productivity in neo-classical production function is given by the product of the "level of technology" and the "level of efficiency".

There is a body of literature, which suggests that the degree of "openness" of economy (which is positively related to trade liberalization that Harberger lists as one of the sources of total factor productivity growth) can positively affect the long-run growth rate of an economy (Romer, 1986, 1992; Grossman and Helpman, 1991; Barro and Sala-i-Martin, 1995). The main argument behind this hypothesis is that producing relatively larger share of domestic output for global export markets and increased availability of imports in domestic markets will expose domestic firms to increased competitive pressures forcing them to innovate and/or adopt new technologies at a faster rate and use their resources more efficiently so as to lower their cost of production. In addition to pressure of competition, producing larger amount of output for global markets will allow the domestic firms to take advantage of 'economies of scale', which would enable them to further reduce their unit cost of production. Similarly 'lower inflation' allows for reductions in 'real cost of production' simply because, as Harberger (1998) points out, it enables economic agents to perceive the actual prices correctly so that they make rational investment decisions. And this, in turn, implies relatively more efficient use of resources leading to growth in total factor productivity and therefore higher rate of output growth. Some of the empirical literature that produced evidence for a negative relationship between inflation rate and economic growth include Fischer (1993), Briault (1995), Barro (1991, 1996), Kormendi and Meguire (1985) and Guerrero (2003). Some others have suggested that it's not the level of inflation but rather its volatility that has negative impact on long-run growth rate of an economy (Al-Marhubi, 1998; Judson and Orphanides, 1996). On the other hand, Barro (1995) reported that inflation volatility has no impact on long-run growth. And findings of Sarel (1996), Bruno and Easterly (1995) and Ghosh and Phillips (1998) have suggested that the nature of the effect of the level of inflation on economic growth could depend on the sample of the countries and/or the time period chosen for study.

The literature on economic growth have pointed out that accumulation of stock of external debt as well as fiscal deficits could exert adverse effects on economic growth through their impact on investment rate and therefore the rate of accumulation of physical capital. Intuitively higher government saving rate (measured as the percentage of budget surplus in GDP (Gross Domestic Product)) is likely to affect economic growth positively through two channels: (1) countries which have higher government saving rates also tend to have greater overall savings and investment, and therefore grow faster; and (2) higher government saving indicates sound overall macroeconomic management, which lowers risks for investors and increases investment leading to higher rate of economic growth (Fischer, 1993; Barro, 1991; and Sachs and Warner, 1996; Hernandez, 2004). On the other hand, the arguments about the possible negative impact of "accumulation of stock of external debt" on economic growth have been usually formulated in the context of "debt overhang" hypothesis which arises in a situation in which debtor country benefits very little from the return to any additional investment because of debt-service obligations, and in case there is some likelihood that in the future, debt will be larger than the country's repayment ability, expected debt-service costs will discourage further domestic and foreign investment (Krugman, 1988, Sachs, 1989). Patillo et al. (2004) using large panel data set of 61 developing countries over the period 1969-98 have shown that increased "external indebtedness" negatively affected economic growth through its adverse effects on physical capital accumulation and total factor productivity growth. Their results are supported by the findings of Schaclarek (2004), Deshpande (1997), Sawada (1994), and Rockerbie (1994). However it is worth to note that Chowdhury (1994) have found no evidence for "debt overhang" in a panel data study of a selected group of Asian economies for the period 1970-1988. Corden (1989) is among others who have pointed out the adverse effects of accumulation of stock of external debt either on government's willingness to undertake painful reforms as trade liberalization and fiscal adjustments or on riskiness of investment environment.

In light of the points raised above we now present the main focus of this paper: the purpose of our work is to investigate both the qualitative and quantitative nature of the effects of each one of the selected macroeconomic factors, most of which were discussed above on economic growth of a selected group of Central and East European Countries (CEEC) some of which are now members of European Union, over a period (1995-2003) prior to their entry in EU in 2004 and 2007. Literature on cross-country differences on economic growth of "transition economies" in post-communist era have suggested that the main determinants of economic growth have been structural reforms, macroeconomic stability and decreased role of government in economic activity (De Melo et al., 1997; Havrylyshyn et al. 1998, 2000; Fischer, 2000; and Sahay, 2000; Garibaldi et al., 2002; Chubrik, 2005). Given this we emphasize that our goal is neither to find the best possible model nor to identify the most important determinants of economic growth for our selected group of CEEC. Our goal is limited to investigate whether or not the level of inflation rate, the volatility of inflation rate, the share of domestic investment in GDP, trade openness (as measured in two alternative ways by the respective shares of exports and the sum of exports and imports in GDP) and the respective ratios of the stock of external debt and budget balance to GDP have individually exerted statistically significant effects on growth rate of GDP.

As Chubrik (2005), Garibaldi et al. (2002), Kormendi and Meguire (1985), and Deshpande (1997) argue when the independent variables (regressors) are highly correlated and the aim of the study is particularly limited to investigate how each one of the regressors relates to dependent variable, it may be preferable to run simple regressions separately for each one of them. And this is the approach we take in this study which utilizes (annual) panel data over the period of 1995-2003 for selected group of 9 CEEC that include Slovakia, Czech Republic, Hungary, Slovenia, Poland, Bulgaria, Romania, Croatia, and Macedonia. As briefly stated above the primary goal of our study is to test whether or not each one of a selected set of macroeconomic indicators (independent variables) has individually statistically significant effect on economic growth for our selected sample of CEEC. Almost all of these macroeconomic indicators (which are briefly specified above) are likely to be highly correlated with each other: for example, the level of inflation rate and the volatility of inflation rate are likely to be highly correlated with each other and individually with the share of domestic investment in GDP. On the other hand, two alternative measures of trade openness (namely sum of exports and imports in GDP) are likely to be not only perfectly correlated with each other but also (particularly) correlated with the level of inflation rate and its volatility of inflation rate. On the other hand, the share of domestic investment in GDP is likely to be correlated with the share of exports and imports in GDP and the respective ratios of budget balance and the stock of external debt to GDP. Under these circumstances and particularly when the fundamental motivation of the study is limited to testing the individual statistical significance of the effect of each one of the selected set of explanatory variables on the dependent variable instead of finding the best possible theoretical model that explains the behavior of that variable, then it may be preferable to run simple regressions for each explanatory (independent) variable separately (Desphande, 1997). Furthermore when the motivation of the study is as stated above, the estimated value of R^2 (the coefficient of determination) for each regression is not of particular interest since the primary focus of the study is not on finding out the extent of variation in the dependent variable that can be accounted by the variation in the corresponding explanatory variable. In this context it is worthy to note the following observation of Desphande (1997): even when one chooses a specific theoretical model (which in turn, specifies a certain set of explanatory variables) out of competing alternative theoretical models (in relation to the behavior of the dependent variable), the model chosen naturally reflects the subjective judgment of the researcher about what the true model is. The implication of this is that the estimated coefficients of the underlying explanatory variables if any selected theoretical model can suffer from specification bias. This could be the case particularly when one attempts to analyze economic growth using econometric tools. Depending on the theoretical model or hypothesis chosen out of a variety of alternatives (such as neoclassical and endogenous growth models, exports-led-growth, trade openness, debt overhang and Keynesian crowding-out hypothesis), the corresponding explanatory variables that need to be chosen in analyzing economic growth could be very different. This is why we preferred to run individual simple growth regressions for each one of our selected set of explanatory variables. Each one of these variables can be directly or indirectly linked to at least one of the above listed hypothesis or theories about economic growth. We note that as part of our econometric methodology we apply "specification tests" to determine the optimal model for each growth regression and as Chubrik (2005) observes this is missing in most of the early literature on these countries. The organization of the rest of the paper is as follows: the first section specifies the econometric model and sources of data, and presents important aspects of our empirical methodology. Empirical results are presented in section two and section three is devoted to interpretation of results. The last section concludes with a summary and policy implications of results.

1. The model specification and empirical methodology

The general specification of the model we used for panel regressions of economic growth is given by equation (1) below:

$$y_{it} = a_i + b' x_{it} + \varepsilon_{it}, \quad (1)$$

where i = 1,..., n (n – the number of countries); t = 1,…, T (T – the number of periods); y_{it} – growth rate of GDP for country i for period t; x_{it} – the vector of k regressors (independent variables); b' – the vector of k coefficients; a_i – intercept for country i which represents country specific (or individual) effects; ε_{it} – error term for each observation distributed normally with "0" mean and constant variance.

As argued in the introduction section, when the regressors are highly correlated and/or the fundamental motivation of the study is to investigate the nature of the effect of each one of the regressors on economic growth, it may be preferable to run simple regressions with each one of the independent variables separately.

For the purposes of our study, we adopt the same approach implying that in equation (1) the number of regressors is 1. However, there is further complication regarding the econometric specification of the model, which requires statistical testing. The issue of specification of the model (in the context of our growth regressions) centers on determining the nature of the country specific (individual) effects. There are three distinct possibilities: individual effects could be "fixed" or "random" or simply "non existent" (in terms of statistical significance). The first case is referred to as "fixed effects model". The second one is called the "random effects model" and finally the last one could be defined as the "model without individual effects". Statistical test that is used to choose between the "fixed effects" vs. "random effects" models is known as Hausman test, which involves computing a test statistic, distributed as a chi-square random variable (Hausman, 1978).

One can represent the "fixed-effects" and "random-effects" models as follows:

Fixed-effects model

$$y_{it} = a_i + bx_{it} + \varepsilon_{it}, \quad (2)$$

Random-effects model

$$y_{it} = a_0 + bx_{it} + \varepsilon_{it} + u_i, \quad (3)$$

where a_0 is a constant term and u_i is the error component of country-specific (individual) effect for country i which is assumed to be distributed normally with "0" mean and "constant" variance.

After applying Hausman test that allows us to determine whether or not the country-specific (individual) effects are of "fixed-effects" type or "random-effects" type, the next step is to determine whether or not these country-specific effects are statistically significant. If the result of Hausman test has preferred the "fixed-effects" model, the statistical significance of country-specific (individual) effects is tested by applying the F-test. If the model preferred by Hausman test is "random-effects" model, the statistical significance of country-specific effects is tested by applying the Lagrange Multiplier (LM) test. If F test or LM test rejects the hypothesis of country-specific (individual) effects then the appropriate specification of the model is one "without country-specific (individual) effects" specified below as model C:

Model without country-specific (individual) effects

$$y_{it} = a_0 + bx_i + \varepsilon_{it}. \quad (4)$$

Data that we utilized in our study are taken from World Bank Database of the World Development Indicators[1]. The only exception is the data for the stock of external debt of Slovenia, which is taken from Deutsche Bank Research Unit[2]. We note that several observations for a variety of variables for certain countries are missing in our data set. That is why our model is an "unbalanced model" in terms of the terminology of panel data analysis. As Stock and Watson (2003) point out an "unbalanced model" is also capable of yielding informative estimates in the framework of models discussed above.

It is worth to note that our choice of annual data instead of quarterly data was particularly due to the fact that we were unable to find (reliable) quarterly data for all the transition economies (that were included our selected sample) for the sample period of our study (1995-2003). However, it is worth to note that some research in econometrics suggested that the power of tests is more influenced by the span than the number of observations (Perron, 1991). In other words, limiting the span of one's study to time period such as 1997-2003 instead of 1995-2003 in order to be able to use quarterly data instead of annual data so as to increase the number of observations would not necessarily increase the power of statistical tests.

2. The empirical results

As we noted in the previous sections, the main motivation of our work is to investigate the nature of the individual relationship between each one of the selected macroeconomic indicators (listed below in Table 1) and the growth rate of GDP of an average country in a selected group of 9 CEEC; these countries are Slovakia, Hungary, Czech Republic, Poland, Slovenia, Romania, Bulgaria, Croatia and Macedonia. Except for the last two, all of them have joined EU either in 2004 or in 2007. Due to the possibility of structural shift in coefficients of the regressors in post-EU membership era, we limited the panel data analysis to period prior to EU membership. Also limitations regarding the availability of reliable data for certain countries before 1995 made us choose 1995-2003 as the sample period for our study. Finally, we note that to deal with the possible problem of heteroskedasticity that can appear in models A and C ("fixed-effects" model and the model "without individual effects") we applied "white heteroskedasticity consistent covariance estimator" so that the resulting standard errors are heteroskedasticity-robust and the corresponding t statistics are heteroskedasticity consistent.

Table 1. Macroeconomic indicators (independent variables)

IR	The level of inflation rate
VIR	The volatility of inflation rate measured as the (absolute) deviation of inflation rate from its long-run mean
INVGDP	The share of domestic investment in GDP
EGDP	The share of exports in GDP as a measure of "openness"
EMGDP	The ratio of the sum of exports and imports to GDP as an alternative measure of "openness"
EXDGDP	The ratio of the stock of external debt to GDP
BBGDP	The ratio of the central government's budget balance to GDP

The results of running separate simple growth regression for each one of the above listed macroeconomic indicators for all three models (models A, B and C respectively) and then carrying out the specification tests discussed in the previous section are summarized below in Table 2.

[1] The World Bank Database: http://devdata.worldbank.org/data online/
[2] http://www.dbresearch.com/servlet/reweb2.ReWEB?rwkey=u905&%24rwframe=0

Table 2. The relationship between economic growth and selected macroeconomic indicators

Indicator	H [1]	F [2]	LM [3]	Specification (model)[4]	R^2	Coefficient [5]	Intercept[6]
IR	0.01	--	0.44	C	0.17	-0.01 (-4.02) [6]	3.35 (10.28) [6]
VIR	0.00	--	0.20	C	0.09	-0.09 (-2.84) [6]	3.3 (9.63) [6]
INVGDP	6.42 [6]	5.68 [6]	--	A	0.43	0.57 (5.61) [6]	--
EGDP	0.23	--	0.9	C	0.0003	0.004 (0.16)	2.85 (2.35) [7]
EMGDP	2.33	--	0.97	C	0.0014	0.86 (1.73) [8]	1.75 (1.73) [8]
EXDGDP	15.85 [6]	4.27 [6]	--	A	0.38	-15.77 (-4.87) [6]	--
BBGDP	2.15	--	0.19	C	0.12	0.11 (2.14) [7]	0.01 (0.99)

Notes:

1. Hausman specification test statistic for testing the presence of "fixed vs. random effects" i.e. choice between model A and B.
2. F – statistic for testing the presence of country-specific (individual) effects in "fixed effects" model (model A): The choice between models A and C.
3. LM (Lagrange Multiplier) statistic for testing the significance of country-specific (individual) effects in the model with random-effects: Choice between models B and C.
4. Model selected as a result of specification tests listed above as Hausman, F and LM tests:
   - Model A with "fixed effects";
   - Model B with "random effects";
   - Model C "without country-specific (individual) effects".
5. Values in parenthesis under coefficient estimates are heteroskedasticity consistent t-statistics.
6. Significant at 1% level.
7. Significant at 5% level.
8. Significant at 10% level.

Source: Authors' computations.

In the next section, we interpret and discuss economic implications of the empirical results presented in Table 2.

3. Interpretation of empirical results

The specification tests have suggested that the appropriate econometric model for growth equation when the regressor is either the level of inflation rate (IR) or its volatility (VIR) is the model "without country-specific (individual) effects" which is denoted by model C. The signs of coefficients of both IR and VIR are negative (as theoretically expected) suggesting that not only higher level of inflation but also higher volatility of inflation is likely to be negatively related to the long-run growth rate of GDP. Furthermore, t-statistics for the estimated coefficients of IR and VIR are statistically significant at 1 percent level. The numerical estimates for the coefficient of IR and VIR (-0.01 and -0.009 respectively) imply that every 1 percent decrease in either in the level of inflation rate or its deviation from its long-run mean has been (on average) accompanied by 0.01 percentage points increase in the growth rate of GDP.

As one can see from Table 2, the optimal specification for growth regression when the regressor is INVGDP, is the "fixed effects" model (Model A). Since in this model, country-specific (individual) effects on growth give rise to separate intercept estimates for each country, there is no common intercept estimate in the estimated regression equation. The estimated coefficient of INVGDP (the investment share of GDP) is both positive (as theoretically expected) and highly significant at 1% level. The magnitude of the estimated coefficient (0.57) as well as relatively high value of R squared suggest that a non-marginal portion of cross-country differences in economic growth among countries in our sample (over 1995-2003) could be attributed to differences in their respective investment shares of GDP. This result is actually supported by the observed positive correlation between the average growth rates of different countries and their respective investment shares of GDP: for example, Slovakia which has had the third-highest (average) growth rate of GDP (4.08%) in our sample of CEEC also happens to be the country with second-highest (average) investment share of GDP (29.6%) over 1995-2003. On the other hand, Bulgaria, Macedonia, and Romania which are the lowest performing countries in the group (with average growth rates respectively 1.41%, 1.46%, and 1.87%) also have had the lowest (average) investment shares of GDP (16.5%, 20.5%, and 21.2% respectively) over the same period (Source: authors' computations).

We have investigated the hypothesis that "openness" of an economy affects economic growth positively using two alternatives measures of "degree of openness" of an economy; the share of exports in GDP (EGDP) and the ratio of the sum of exports and imports to GDP (EMGDP). The specification tests revealed that the optimal specification for both of the growth regressions is the model "without country-specific (individual) effects" (Model C). Even though the signs of both coefficients are positive as theoretically expected, the coefficient of EGDP is statistically insignificant while that of EMGDP is significant at 10% level. The fact that the statistical significance of the coefficient of "openness" improves to the extent that it becomes significant (even though only at 10% level) and at the same time the size of the estimated coefficient increases when EMGDP is used as a regressor can yield interesting insights about the relationship between imports and economic growth. There have been cases of countries where the increased availability of imported products in domestic markets has played a relatively more significant role in generating competitive pressures on domestic firms to innovate and lower their real cost of production (Lawrence and Weinstain, 1999). And this could be the case for our sample of CEEC.

One of the striking results of our work is probably the evidence produced by the data in support of "debt overhang" hypothesis. The estimated coefficient of EXDGDP (the ratio of external debt to GDP) is significant at 1% level based on the t-values obtained from the estimation of "fixed effects" model (Model A), which is the model we have chosen, based on specification tests. The estimated value of the coefficient (-15.77) suggests that a 10% increase in the ratio of stock of external debt to GDP (for example from 40% to 50%) is likely to be accompanied by to approximately 1.58 percentage points decrease in the growth rate of GDP. As argued in the introduction section, according to "debt overhang" hypothesis, accumulation of stock of external debt (particularly beyond some critical level) can have adverse effects on the level of investment through two channels; firstly, greater amount of domestic savings will have to be allocated for debt servicing each year leaving smaller amount of savings for domestic investment, and secondly, the likelihood of potential debt servicing problems in the future increases which, in turn, increases the overall macroeconomic risks for domestic and foreign investors leading to further reduction in the level of investment. Whether or not the statistical and economic significance of EXDGDP variable is continuing in post-EU membership era (for the relevant countries) is an issue that needs to be analyzed in the coming years as new data become available.

And finally, we note that the coefficient of BBGDP (the ratio of budget balance to GDP) is positive and significant at 5% level. The estimated value of the coefficient (0.11) suggests that reductions in the ratio of budget deficit to GDP is likely to be positively related to growth rate of GDP, and in general every 10 percent reduction in this ratio could be accompanied by 1.1 percent increase in the growth rate of output. Intuitively, lower budget deficits (or higher budget surpluses) implies an increase in the level of domestic savings and therefore in the level of investment. And this implies an increase in the rate of accumulation of physical capital exerting positive impact on economic growth.

Conclusions

In this paper, we used panel data approach to investigate the individual effect of some of the key macroeconomic indicators on economic growth of a selected group of CEEC over a period prior to the entry of the most of these countries in EU. The main findings are the following:

1. Both the level of inflation and its volatility negatively affects economic growth.
2. The share of domestic investment in GDP exerts both statistically and economically significant (positive) effect on growth rate of GDP.
3. "Openness" when measured as the share of exports in GDP has statistically insignificant (positive) effect on economic growth but its effect becomes statistically and economically (relatively more) significant when the ratio of total volume of trade (sum of exports and imports) to GDP is used as a regressor.
4. Deficit reduction has had positive effect on economic growth.
5. There is statistically significant evidence for "debt overhang" hypothesis, which can be taken as a warning signal for the policy makers of CEEC with regard to accumulation of external debt, which can boost private and public consumption in the short-run but possibly at the expense of lower investment and lower growth in the long-run.

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