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Convergence in Transition Countries – Focus on Investment: Central and Eastern Europe, 1970–1996

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Abstract. Our data on investment in Central and Eastern European economies reveal that, though investment rates were typically high in the 1970s, the marginal efficiency of investment was low. Investment shares begun to decline in the 1980s, before the collapse of the communist system, but there was some recovery in most countries after transition. We use the Kalman filter framework to test for convergence in investment rates. We find some evidence of convergence in Central European countries – former Czechoslovakia, Poland and the countries of the former Yugoslavia. For the remainder of the socialist bloc, however, we were unable to isolate convergence in investment shares.

Key words: convergence, growth models, investment rates, Kalman filter, transition countries

1. Introduction

The standard picture of the growth process in the socialist economies of Central and Eastern Europe until the mid-1980s is one of relatively high rates of growth of GDP, driven by high investment shares (see e.g. Dyker, 1984, Ellman, 1988). To bring this picture up to date, analyses by for example Boone et al. (1998) or Aslund et al. (1997) highlight drastic falls in GDP – in excess of 50% in some parts of Soviet Union – associated with a major decline in investment shares. In a companion study (see Estrin et al., 1999), we used a framework derived from the Western growth and convergence literature to explore the growth patterns. One of the main issues was whether, as suggested above, a common growth pattern pertained within the Soviet block. A second was whether the socialist bloc as a whole, and sub-groups within it, was actually catching up with the West, represented by the OECD or Western Europe in the period 1970–1996. Our findings were striking. In contrast to the standard picture,[1] we found little evidence of growth convergence within the communist group of countries, or even within obvious regional groups such as the Central European countries. Moreover, we were unable to find evidence of convergence with the West, even for the more advanced countries in the region. This suggests that the planners' objectives – to equalise incomes within the CMEA,

and between the socialist block and the West – were not successful (see Ellman, 1988). Moreover, the experience of seven years or more of transition has not yet begun to reverse this finding.

In this paper, we take the analysis further by focusing on the investment levels within socialist countries. These are of interest in their own right, though investment shares are often regarded as a parameter to be set centrally in planned economies. The exercise we undertake indicates whether planners in the Soviet bloc pre-transition converge to a single investment rate, and whether that rate was similar to levels pertaining in the developed market economies. It also addresses the question of whether, if such convergence in investment rates were attained under planning, it was maintained in the transition period.

It is not our intention in this paper to undertake the massive task of estimating a structural growth model of Central and Eastern European economies under planning and in transition. Rather, we offer a simple exercise using an econometric method to address the issue of convergence in investment shares. Nonetheless, our study combined with our previous findings provides some indications for growth relationships in the economies under consideration. If the results of the previous study – non-convergence in GDP per capita growth rates – is accepted, a finding of convergence in investment shares would seem to imply that variation in investment shares was not the primary determinant of growth. If however we also find non-convergence in investment shares, this is at best consistent with the view that heterogeneity in growth performance across the socialist bloc was validated in investment behavior. Since we are not estimating a structural model, we cannot go further to say that non-convergence in investment rates was a cause of non-convergence in development levels. However, such a finding would indicate that the conventional picture of policy under socialist planning – with high investment rates in industrial development as a systematic policy to equalise income levels – was not in fact correct in final years of the communist era and beyond.

In our analysis, we employ the same dataset as Estrin et al. (1999) consisting of investment rates for 26 transition countries over the period 1970–1996.[2] The structure of the paper is as follows. Section 2 summarizes concepts of convergence and the alternative methods available for testing it. In Section 3 the time varying parameters procedure is explained and a detailed description of the dataset is given. We then comment on the development of investment rates and report the results from testing for convergence using the Kalman filter procedure. Section 4 concludes the paper.

2. Convergence concepts

The concept of convergence is clear intuitively but difficult to formulate and there are a variety of measures. Different approaches are appropriate in different contexts, and some definitions of convergence have been shown to be invalid in the

convergence debate. In the following paragraphs a brief account of existing definitions is given.

2.1. σ-CONVERGENCE AND β-CONVERGENCE

One possible approach to convergence is to examine the behaviour of cross-section levels of output. Barro and Sala-i-Martin (1991) define and use two concepts of convergence, σ- and β-convergence. σ-convergence is when the dispersion of cross-section levels diminishes over time, and is usually measured by sample standard deviation. Thus if

$$\sigma_t = \sqrt{\frac{1}{N}\sum_{j=1}^{N}(Y_{jt} - \bar{Y}_t)^2},$$

where $\bar{Y}_t$ is the sample mean, N is the sample size, then the variable Y shows σ-convergence if $\sigma_t \leq \sigma_{t-1}$ for all t.

There are several drawbacks to this definition. Some series are available only in index number form which implies that at any arbitrarily chosen base period dispersion will be zero. Furthermore, the measure of sigma-convergence is uninformative for an income distribution's dynamics. The same time path of dispersion can be compatible with entirely diverse intra-distribution dynamics (Quah, 1996). Sigma convergence is theoretically interesting only if one believes that countries approach a common equilibrium at the same speed of convergence. Moreover, the degree of dispersion may be affected by an external factor which is so strong that it obscures the underlying processes at work on convergence (Hall et al., 1992).

β-convergence occurs when a cross-section regression of (time-averaged) growth rates on initial levels the coefficient on initial levels is negative – "poorer regions grow faster". If the coefficient on initial levels is negative in a univariate regression,

$$\log Y_{i,T} - \log Y_{i,0} = \alpha + \beta \log Y_{i,0} + u_i,$$

the data are said to display absolute convergence. Conditional β-convergence is a negative coefficient but only when the regression has the appropriate, additional explanatory variables on the right-hand side,

$$\log Y_{i,T} - \log Y_{i,0} = \alpha + \beta \log Y_{i,0} + \gamma' X + u_i.$$

Speed of convergence is the parameter β in the regression

$$\frac{1}{T}\log\frac{Y_{i,T}}{Y_{i,0}} = \alpha - \left(\frac{1 - e^{\beta T}}{T}\right)\log Y_{i,0} + \gamma' X + u_i.$$

The conventional approach to testing whether economies converge, i.e. cross-sectional analysis of the relationship between the growth rate of per capita output over some time period and the initial level of per capita output, has been the subject

of many criticisms. As some authors noted (Friedman, 1992; Quah, 1993), β-convergence is only a necessary and not a sufficient condition for σ-convergence. That means that the finding of a certain rate of β-convergence does not imply poor regions catching up to rich regions at that rate.[3]

Bernard and Durlauf (1996) show that these cross-section tests cannot identify groupings of countries which are converging and that they are ill-designed to analyze data where some countries are converging. Working with the null hypothesis that no countries are converging and the alternative that all countries are leaves out a host of intermediate cases (Bernard and Durlauf, 1995). Moreover, the econometrician may erroneously conclude that all countries in the cross-section are converging when countries are converging to different steady states.[4]

2.2. TIME SERIES APPROACH

Another possibility is to explore time variations in data. There are several possible definitions of convergence for time series, including pointwise convergence and convergence in probability,[5] but these are very stringent definitions. The preferred is convergence in expectation defined as follows:

Convergence in expectation - Two series X_t and Y_t converge in expectation if

$$\lim_{t\to\infty} \mathrm{E}(X_t - Y_t) = \alpha.$$

If e.g. $(X_t - Y_t)$ is an α-mean stationary process, then X_t a Y_t converge in expectation. If $\alpha = 0$ then the convergence is said to be absolute.

Common trends - Series X_t and Y_t contain a common trend if

$$\lim_{t\to\infty} \mathrm{E}(X_t - \theta Y_t) = \alpha, \qquad \theta \neq 0, \theta \neq 1.$$

Extension: n variables can have up to $n - 1$ common trends.

Variables X_t and Y_t have common trends if they are cointegrated. When their cointegration vector is $[1, -1]$, then they converge in expectation. Cointegration analysis appears e.g. in works of Bernard and Durlauf (1995 and 1996) and Estrin, Urga and Lazarova (1999). The main advantage of the time series approach is that we can test for pairwise convergence and thus obtain a more precise picture of "convergence clubs". A setback is, however, that while convergence is determined by limiting behaviour of the series, cointegration is a property of the entire time history of the series (Hall et al., 1993). If data are taken from economies which are far from their steady states, then the null of no convergence may be erroneously accepted when time series tests are used (Bernard and Durlauf, 1996). Hence time series techniques appear to more naturally apply to data characterized by steady state dynamics, testing for what Estrin et al. (1999) call "achieved convergence".

Consequently, for assessing convergence in transition countries another method should be contrived.

2.3. PANEL DATA

In order to utilize both cross-section and time variations in growth rates, several authors were induced to use panel data methods. Canova and Marcet (1995) estimate separate dynamic regressions for each country, imposing a Bayesian prior on the parameters and combining it with the sample information to construct posterior estimates.

Lee et al. (1996) develop an empirical version of a stochastic Solow model. They estimate ARMA(2,1) models of the univariate process for the output, allowing for country-specific technology growth rates and speeds of adjustment to steady state.

Evans and Karras (1996) estimate AR processes for the deviation of output from the world average with country-specific fixed effects but with homogeneous slopes. In another paper, Evans and Karras (1997) use the Solow growth model as a basis for analyzing underlying variables. They estimate autoregressive processes for technology, saving rates and interest rates while incorporating fixed effects common for all economies as well as economy-specific fixed effects.

Islam (1995) employs three different panel data estimators: pooled regression on the basis of five-year span data, minimum distance estimator which does not eliminate the individual-effect term by differencing the equation, and the least square with dummy variables estimator.

2.4. MULTIPLE STEADY STATES

Several authors attempt to describe convergence in presence of multiple steady states or "convergence clubs".

Multiple regimes – Durlauf and Johnson (1995) suppose that there are different laws of motion for different groups of countries. They attempt to sort countries to groups according to initial conditions by means of the regression tree analysis.

Evolving distributions – Quah (1996) finds instead one law of motion but for the entire distribution. Let λ_t be a discrete distribution at time t and M a time invariant transition probability matrix. Then distribution at time $t + s$ is $M^s\lambda_t$ and by taking limit when $t \to \infty$ we can find the likely long-run or ergodic distribution of cross-country levels. If the resulting distribution has one distinct peak, convergence across countries occurs. If the distribution is bi- or multimodal, then there are convergence clubs; it is polarization or stratification that occurs, not convergence.

2.5. IMPLICATIONS FOR THE ANALYSIS OF TRANSITION COUNTRIES

Apparently, as highlighted in the previous paragraphs, an econometrician wishing to conduct a convergence analysis has many alternative techniques at hand. Ideally, one should use the various procedures and then compare and comment resulting estimates. In practice, however, this may not be possible for numerous reasons.

In the case of transition countries, there are several limitations. To start with, we face the problem of dimensionality of data. The number of countries in transition is restricted and we may even be concerned with a certain subgroup only. Thus the degrees of freedom across countries are very low and some of the measures of convergence become uninformative. For example, it is not suitable to use the notion of σ-convergence, cross-section analysis or some types of panel techniques.

Secondly, around 1990 structural breaks most probably appeared in transition countries, so it is not advisable to use any method which assumes structural stability. Another point is that after the start of transformation the countries were presumably far from their respective steady states. Therefore cointegration analysis would probably not reveal convergence even if there was any. Given these problems, we take another approach to convergence. We adopt a procedure that allows for time-varying parameters and structural changes and that is not set back by the low number of countries in the sample. The procedure is described in the following section.

3. Econometric model and empirical results

In this section, we first define the time varying parameters procedure used in our paper to test for convergence. We then comment on the dataset constructed from two different sources. Further, the development of investment ratio in the 26 sample countries from 1970 to 1996 is described. Finally, the Kalman filter procedure is used to investigate empirically whether the economies converge.

3.1. TIME VARYING PARAMETERS APPROACH

The methods described in Section 2 have emphasized different aspects of convergence. A measure that allows for dynamical structure changes and thus goes some way towards reconciling the distinct concepts of convergence is the time-varying parameter estimation procedure as used by Hall et al. (1992 and 1993) and Estrin et al. (1999).

We consider the state space formulation of the convergence process for series X_t and Y_t,

$$X_t - Y_t = \alpha_t + \varepsilon_t,$$

where the unobserved component α_t follows the following process

$$\alpha_t = \alpha_{t-1} + u_t$$

Table I. Critical values for t-(ϕ_{ML})

Level of significance	t-value
0.5%	−3.702
1%	−3.479
5%	−2.479
10%	−1.970

and where the disturbances are normally distributed,

$$\varepsilon_t \sim \mathrm{N}(0, \sigma^2),$$

and

$$u_t \sim \mathrm{N}(0, \Omega_t).$$

The covariance matrix Ω_t is assumed to follow

$$\Omega_t = \phi\Omega_{t-1}, \qquad \Omega_0 \text{ given.}$$

In this setup, convergence in expectation will occur if $\phi < 1$ for then the time-varying process evolves into a deterministic constant and X_t and Y_t differ by only a stationary process.

To account for the structural changes after the beginning of the transition process we allow for change in magnitude of variance of the state variable α_t:

$$\Omega_t = \phi^t\Omega_0 + \beta d_t, \qquad \Omega_0 \text{ given,}$$

where d_t is a structural step dummy that is equal to one for years of the transition process. The inclusion of dummy variable resulted in lower estimated t-values across all pairs and made possible uncovering convergence despite the structural changes with the onset of reforms. In some cases, the beginning of transition was different for countries in the pair under examination. We then let the step dummy start at both years as well as intermediate years and we reported the lowest t-value. The figures given in the tables therefore represent the lowest t-values consistent with our model.

The decaying parameter ϕ is estimated by maximizing the likelihood function obtained via the Kalman filter procedure. For testing the null hypothesis of no convergence, $\phi_{ML} = 1$, against the alternative hypothesis of convergence, $\phi_{ML} < 1$, the critical values of the t-statistic are given in Table I.[6]

3.2. DATA DESCRIPTION

The data for this study were derived from two sources. For the period after reform

(between 1988 and 1991, depending on the country), each individual transition country adapted a conventional system of national accounting, which allowed gross domestic product and its components to be measured. These data were collected from the European Bank for Reconstruction and Development's Transition Report for the relevant years.

However, the transition economies did not use the UN system of national accounts (SNA) during the communist era. Rather, they adopted the material product system (MPS) which differs in method, coverage and classification. In order to use consistent series for the long pre-transition period in our datasets, we have drawn on the work by Paul Marer and colleagues (Marer et al., 1992), who have used "fixed" and "flexible" bridges to construct the most reliable estimates to date of GDP and its components for the 1980s in every former communist country. This work addresses the critical issues of relative price differences, the repressed inflation and valuing trade in non-convertible currencies, as well as problems of accounting conventions. Their study gives us the basis for constructing an internally consistent data series covering both the pre and post-reform periods using consistent indicators of national income.

The data used in this study have been constructed as follows. For the economies of Central and Eastern Europe (Albania, Bulgaria, Czech Republic, Slovakia, Hungary, Poland and Romania) for the years between 1990 and 1998, we have used data for gross domestic product and its components from National Accounts and checked against EBRD, Transition Report. These data have been deflated by the producer price index for 1987, and converted into dollars at the 1987 exchange rate. For the period from 1980–1990, we have used the series for Gross National Product at fixed prices, converted into dollars at the 1987 exchange rate (derived from Marer et al., 1992). For the period from 1970 to 1979, we have used net material product growth rates at constant prices denoted from National Accounts in each country, and applied these to the 1980 GDP figures, converting to dollars as previously. The only exceptions to this rule were Hungary, Poland and Romania, where data back to 1975 on GDP at constant prices were available from Marer et al., 1992. Exactly the same methodology was applied to investment (gross fixed capital formation).

For the countries of the former Soviet Union, a similar methodology was applied. Thus we use SNA accounts for these countries back to 1991 or earlier, and these were converted into dollars at the 1987 rate. However, for the pre-independence period, we have only information on the proportion of net material product by each republic (later independent state in the Commonwealth of Independent States) for every five years from 1970–1990. We also have the growth rate of net material product (NMP) for the Soviet Union for each year from 1970–1990. From these two information sources, we are able to construct an estimated GDP series back to 1970 on the assumption that NMP and GDP growth rates are equivalent.

3.3. DEVELOPMENT OF INVESTMENT RATES

Though there are several types of patterns in the time paths of investment rates, by examining the graphs we can formulate several stylized facts. First, the investment ratio was very high in 1970s. According to the estimates of EBRD, savings and investment in the countries of Central and Eastern Europe, the Baltics and the Commonwealth of Independent States (CIS) have been on average on the level of 32 per cent of GDP in the period 1977–1988, while a world average has been about 24 per cent of GDP and an average in the advanced industrial countries 21 per cent over the same period. Sustaining of such high levels of investment was allowed by the fact that under the communist regime investment was under the direct control of the government (see e.g. Ellman, 1989). However, as investments were determined by the objectives of the central plan and other non-market criteria, the efficiency of investment was low (see e.g. Kornai, 1985, Blanchard et al., 1991).

Second, the investment rates generally began to decline during the 1980's, that is even before the collapse of the communist regimes. One possible explanation is that the high cost of forced savings in terms of foregone consumption may have gradually raised pressure on politicians to improve consumption possibilities (see e.g. Barr, 1994).

Third, the decline in investment rates were even steeper after the collapse of the communist block and the start of reforms. The fall of investment observed in the CIS and the Baltics was generally more severe than in the CEE countries (see EBRD, 1999).

Fourth, in many cases, particularly in the countries of the Central and Eastern Europe, the investment share began to rise after price liberalization, the recovery being swifter and stronger in rapidly liberalizing countries. In 1994, the level of investment in the region were quite high compared to the OECD average, though the high levels in some countries could be judged skeptically. For example, the high investment rates in Russia, Belarus or Turkmenistan do not correspond with similarly high levels of the GDP growth.

3.4. GROUPING OF COUNTRIES

The data as well as economic and geographical facts suggest that we can arrange the countries into groups in which convergence could have been possibly attained and in doing so reduce the number of pairs of countries to be tested for convergence. One possibility is to sort countries according to the stage of the transition process they were at in 1994. The first group, the countries at an advanced stage, would consist of Croatia, Czech Republic, Estonia, Hungary, Poland, Slovak Republic and Slovenia. The second group, the countries at an intermediate stage, would comprise Albania, Bulgaria, Macedonia, Kyrgyzstan, Latvia, Moldova, Romania and Russia. The other countries, the countries at an early stage of transition process or the countries in which transition process has not yet been started, would belong to the last group.

The other way to arrange countries into groups, is suggested by Estrin, Urga and Lazarova (1999). We restrict our analysis to the following groups:

Central and Eastern European (CEE) Countries – all the non-Soviet European countries – members of the Warsaw pact (except of Yugoslavia) and of the CMEA (except of Albania).

CEE Countries and Russia – Russia as a representative of the former Soviet republics.

CEE Countries and Russia, and Western Economies – Germany, USA, OECD, EC15.

3.5. EMPIRICAL RESULTS USING THE KALMAN FILTER PROCEDURE

We now test for the ongoing convergence applying the Kalman filter procedure on the first of the state space models described in Section 3.1, respecting the above grouping of countries.

3.5.1. *Convergence within the Central and Eastern Europe*

The results of the Kalman filter procedure test of convergence within this group of countries are given in Tables II and III.[7] In this case the former Yugoslavia countries seem to form a natural block. Beside this, investment ratio of Macedonia and Serbia-Montenegro converge to those of some more developed countries like Czech Republic, Slovak Republic and Poland. After inclusion of the reform years 1991–1996, these results still hold except for Macedonia *vis-a-vis* the countries outside former Yugoslavia. Hungary and Poland seem to start to converge after the launching of reforms. Czech and Slovak Republics do not converge neither in the pre-reform period nor in the whole period.

3.5.2. *Convergence of the Central and Eastern European countries and Russia*

We may also ask whether there was any convergence between the CEE countries and Russia as a largest of the former Soviet Union republics. As we can see from the Tables IV and V, there were few signs of convergence in this case; in fact, only Bulgaria's investment ratio seems to converge to the Russian one. This result suggests that the Soviet Union did not play a role of the leading economic force during the communist era and the beginning of the transition period.

Table II. Kalman filter procedure – convergence within the Central and Eastern Europe, 1970–1990

	bu	**cz**	**slo**	**hu**	**po**	**ro**	**cr**	**ma**	**sm**	**sl**
al	7.084	11.225	13.453	5.293	8.929	2.532	6.841	3.745	3.425	4.087
bu		4.583	5.739	0.428	5.112	3.176	2.342	−1.310	−2.044*	0.057
cz			3.184	3.120	6.316	9.485	−1.216	−3.632**	−3.830**	−2.182*
slo				6.407	1.911	11.638	−1.735	−3.979**	−2.180*	−0.016
hu					5.739	7.415	4.897	1.138	−1.103	0.275
po						9.386	−1.055	−3.410**	−3.641**	0.001
ro							9.830	2.354	4.403	5.748
cr								−4.215**	−4.662**	−3.210**
ma									−2.129*	−0.646
sm										−3.313**

Table III. Kalman filter procedure – convergence within the Central and Eastern Europe, 1970–1996

	bu	**cz**	**slo**	**hu**	**po**	**ro**	**cr**	**ma**	**sm**	**sl**
al	11.955	13.797	14.261	7.556	9.646	8.747	6.078	6.699	3.942	5.291
bu		6.327	11.192	−0.336	2.653	3.022	2.189	0.141	−2.015*	−2.119*
cz			4.144	2.764	5.613	8.804	3.700	−0.147	−3.967**	−1.779
slo				6.614	1.876	13.655	−2.676*	3.927	−2.208*	0.068
hu					−3.682**	7.044	−4.848**	0.929	−1.581	−0.233
po						7.456	−1.680	−1.394	−2.978**	−2.367*
ro							10.023	4.062	−2.978**	4.602
cr								−4.247**	−4.658**	−2.973**
ma									−2.107*	−0.696
sm										−3.579**

Table IV. Kalman filter procedure – convergence of the Central and Eastern European countries and Russia, 1970–1990

	Albania	Bulgaria	Czech Republic	Slovakia	Hungary	Poland
Russia	8.648	−3.093**	3.368	5.586	3.293	5.551
	Romania	Croatia	Macedonia	Serbia-Montenegro	Slovenia	
Russia	7.866	1.296	−1.059	−1.873	0.845	

Table V. Kalman filter procedure – convergence of the Central and Eastern European countries and Russia, 1970–1996

	Albania	Bulgaria	Czech Republic	Slovakia	Hungary	Poland
Russia	9.793	−3.107**	3.435	9.035	3.417	3.522
	Romania	Croatia	Macedonia	Serbia-Montenegro	Slovenia	
Russia	8.316	1.046	−1.095	−1.632	0.157	

Table VI. Kalman filter procedure – convergence between the four groups and Western economies, 1970–1990

	Germany	USA	OECD	EC15
Albania	12.488	11.291	15.044	15.683
Bulgaria	2.325	2.152	4.126	4.462
Czech Republic	−5.382**	−2.628**	−3.595**	−2.373*
Slovakia	0.895	4.287	−0.279	−1.487
Hungary	0.823	0.754	1.091	1.376
Poland	0.713	2.838	3.380	3.394
Romania	7.883	9.045	8.854	8.315
Croatia	−1.174	0.133	−0.961	−1.108
Macedonia	−3.538**	−3.049**	−3.718**	−4.145**
Serbia-Montenegro	−3.611**	−4.075**	−4.172**	−3.957**
Slovenia	−3.000**	−4.834**	−3.607**	−2.927**
Russia	0.814	−0.288	0.802	1.629

3.5.3. *Convergence between the CEE countries and Russia and Western economies (Germany, USA, OECD, EC15)*

If we select the CEE countries and Russia and examine the convergence between them and Western countries, we get an interesting pattern: Czech Republic, Macedonia, Serbia-Montenegro, and Slovenia are converging to all chosen countries and groups of countries of the West. They are joined in the last years by Hungary. This result is quite different from what we got for the growth rates (Estrin et al., 1999): we found Czech and Slovak Republics, Poland, and partly Croatia and Russia converging to the West during the pre-reform era but that none of them converge when the last five years were added.

4. Conclusions

Our data on investment in Central and Eastern European economies reveal that, though investment rates were typically high in the 1970s, the marginal efficiency

Table VII. Kalman filter procedure – convergence between the four groups and Western economies, 1970–1996

	Germany	USA	OECD	EC15
Albania	15.131	12.884	17.071	17.865
Bulgaria	2.338	2.093	4.695	4.550
Czech Republic	−6.936**	−2.638**	−3.644**	−2.354*
Slovakia	0.937	4.429	4.439	4.238
Hungary	−3.011**	−2.065*	−2.424*	−1.704
Poland	−1.954	−0.372	−0.420	−0.127
Romania	6.107	8.037	7.881	8.190
Croatia	−0.954	−0.103	−1.059	−1.198
Macedonia	−3.269**	−2.992**	−3.666**	−4.057**
Serbia-Montenegro	−3.935**	−4.347**	−4.549**	−4.313**
Slovenia	−5.155**	−7.836**	−6.976**	−6.087**
Russia	0.968	−0.018	1.211	1.721

of investment was low. Investment shares begun to decline in the 1980s, before the collapse of the communist system, but there was some recovery in most countries after transition. There is a great deal of heterogeneity in country experience however. For example, investment shares have a clear downward trend over the period in Hungary, Poland and Russia, but an upwards one in the Czech Republic and Slovenia.

We use the Kalman filter approach to test for convergence in investment rates. We find some evidence of convergence in Central European countries – former Czechoslovakia, Poland and the countries of the former Yugoslavia. This result is in contrast with those in Estrin et al. (1999) for GDP per capita growth. This suggests that, even if the planners did manage to attain their desired level of investment share in Central Europe, this did not lead to convergence in growth rates. This may be associated with differences in the operation of the planning system, leading to variation in capital productivity. For the remainder of the socialist bloc, however, we were unable to isolate convergence in investment shares.

In conclusion, it should be stressed that our findings are not meant to bring into question the findings of earlier institutional and empirical studies which have established that there were systematic policies within COMECON to equalise levels of development (see e.g. IMF, World Bank, OECD, EBRD (1991)). There seems little doubt that this was a policy objective throughout the socialist era (see Popov, 1998, 1999), and one backed by significant inter-republican financial flows amounting for example in the Central Asian to up to 20% of republics' GDP (IMF, World Bank, OECD, EBRD (1991)). However, our findings suggest that the flows could not have raised investment shares in the poorer republics. Taken together with our results on

convergence, one might hypothesise that the failure of COMECON countries to converge with each other in income levels did not arise because of different capital productivity associated with income per capita, but because the redistribution of resources from richer to poorer republics acted to subsidise consumption rather than investment. In further work, we plan to investigate these relationships explicitly within the framework of a structural model which explores the links between investment and growth.

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6. Notes

1. Studies such as De Melo et al. (1997) find β-convergence in the 1990s in transition economies. Our approach is based on Kalman filter testing.
2. Albania, Bulgaria, Czech Republic, Slovakia, Hungary, Poland, Romania, Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, Croatia, Macedonia, Serbia-Montenegro, Slovenia.
3. In other words, it is possible for a set of countries which are diverging to exhibit the sort of negative correlation described by Baumol (1986) so long as the marginal product of capital is diminishing (Bernard and Durlauf, 1995).
4. Canova and Marcet (1995) plead that aggregating growth rates over the sample period wastes information, since unit-specific time variations in growth rates are ignored in the estimation process.
5. Pointwise convergence – Two series X_t and Y_t converge pointwise if

$$\lim_{t\to\infty}(X_t - Y_t) = \alpha$$

for some constant α.

Convergence in probability - Two series X_t and Y_t converge in probability if

$$\mathrm{p}\lim_{t\to\infty}(X_t - Y_t) = \alpha$$

6. Source: St. Aubyn (1995).
7. In order to keep these two tables in compact form, we employ the following shortcuts: al – Albania, bu – Bulgaria, cz – Czech Republic, slo – Slovakia, hu – Hungary, po – Poland, ro – Romania, cr – Croatia, ma – Macedonia, sm – Serbia-Montenegro, sl – Slovenia.

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