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Neil Foster and Robert Stehrer

Modelling GDP in CEECs Using Smooth Transitions

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Modelling GDP in CEECs Using Smooth Transitions

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Abstract

This paper employs smooth transition models to investigate the GDP series of ten CEECs. Allowing for a transition in both trend and intercept we examine the response of GDP to reforms in CEECs. Our results indicate that in only a small of number of countries is there evidence to suggest that the impact of the reforms on long-run growth has been positive. In most cases there has been no significant impact of the transition on the trend growth rate. There also appears to be little difference in terms of the depth of recession, speed of adjustment and the impact of reforms on GDP growth depending upon whether a country adopted a gradual or a fast approach to reforms.

Keywords: *CEECs, GDP growth, smooth transitions, time series analysis*

JEL classification: *C22, O57*

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Modelling GDP in CEECs using smooth transitions

1 Introduction

The transition of former planned economies to market economies in the countries of Central and Eastern Europe (CEECs) attracted a great deal of attention from economists and politicians. While the list of reforms required for such a transition was generally agreed upon, when and how to undertake such reforms was the subject of much debate. The reforms undertaken spanned a wide spectrum of economic and political adjustments including market liberalization, stabilization policies, entry regulations and privatization, (state) enterprise restructuring, tax reforms, bankruptcy reforms and banking reforms; see Roland, 2000, p. 15 and Lavigne, 1999, Table 7.1 for an exhaustive overview. Kornai (2005) presents a broad evaluation of reform success and disappointments for the eight countries which became members of the European Union in 2004.

The introduction of reforms differed widely across countries in their scope and in particular in the speed and sequencing of their introduction. While a number of renowned economists argued for a big-bang approach of simultaneous and quick reforms (e.g. Berg and Sachs, 1992; Murphy, Shleifer and Vishny, 1992; Sachs, 1993), others argued for a more gradual approach with an appropriate sequencing of reforms (e.g. Portes, 1990 and 1991; Roland, 1991; Aghion and Blanchard, 1994). In practice a number of transition countries adopted the big-bang approach (such as Poland, the Czech Republic and the Slovak Republic), while others opted for a more gradual approach (such as Hungary and Slovenia). Svejnar (2002) distinguishes between type I (macroeconomic stabilization, price liberalization, etc.) and type II reforms (large-scale privatization, banking sector reform, tax system, etc.). It is argued that most countries carried out the type I reforms rather quickly but differed in the speed of carrying out the type II reforms. In addition to uncertainty over the appropriate speed of reforms, most economists were also surprised by the large initial declines in output that accompanied transition. While a sluggish supply response to price liberalization and a mild economic downturn were maybe expected, the large and sudden declines in output were largely unexpected (see, however, e.g. Laski (1992) and Levcik (1992) for an early critical view on the reforms in some countries).

There are a small number of papers focusing on the relative merits of the big-bang versus the gradualism approach to reform.[1] Fischer and Sahay (2000) conclude from a survey of relevant literature that the faster the speed of reforms, the quicker is the recovery and the higher is growth. More recently Gros and Steinher (2004) argue that it paid to reform

[1] Assessments of the achievements of the reforms in particular countries are widely discussed in the literature and are beyond the scope of this paper (for overviews see Campos and Coricelli, 2000; Fischer and Sahay, 2000; Gomulka, 2000; Wolf, 1999).

quickly and comprehensively. Earlier studies include Selowsky and Martin (1997), De Melo et al. (1997) and Berg et al. (1999). Gros and Vandille (1997) show that there is no link between the speed of reform and the size of the initial output decline.

Havrylyshyn, Izvorski and van Rooden (1998) examine the determinants of growth for 25 transition countries over the period 1990-97. They relate the growth of GDP to the main factors which are thought to promote recovery and sustained growth, namely initial conditions, stabilization and structural reforms. While unfavourable initial conditions are found to impact negatively upon growth, their importance relative to that of stabilization and structural reforms is limited. Growth performance is found to be better where stabilization has been achieved earliest and where structural reforms have progressed the most. The impact of structural reforms is found to have deleterious effects on growth immediately following reform, but this is found to be offset by a positive impact shortly after. The reduction of government size and spending is also found to positively affect growth, as are decreases in the inflation rate.

An overview over the recent literature is also provided in Fischer and Sahay (2000). They conclude that anti-inflation policies and structural reform policies are beneficial to growth. Moreover, institutional variables, price liberalization and small-scale enterprises contributed to growth more than large-scale privatization and other variables. The results on fiscal balances are not clear-cut however.

All of these studies and the studies reviewed in the literature are based on cross-country analyses of growth performance. Fidrmuc and Tichit (2003) argue that cross-country econometric analyses for these countries may be vulnerable to structural breaks and show that for most countries one or even two structural breaks can be found empirically. They argue that there is robust evidence that growth patterns have changed at least two times.

A further issue relates to whether following the transformational recession countries experience growth rates higher than those prior to reforms. This question has rarely been addressed in the literature and is the main issue taken up in the current paper. On the other hand, Popov (2000) argues that when accounting for initial conditions and non-policy factors in general, the impact of liberalization becomes insignificant. Radulescu and Barlow (2002) also doubt the long-term effects of liberalization, fiscal and exchange rate policies on growth. We use time series data to examine whether the trend growth rate in CEECs is higher following the transformational recession than it was prior to reforms. Using our time series results we also examine whether both the severity of recession and the impact on the trend growth rate are affected by the reform strategy (big-bang versus gradualism). The literature on these topics is to date far from conclusive, especially when taking econometric caveats into account (see Fidrmuc and Tichit, 2003).

To address the above issues we model the GDP series for ten CEECs using smooth transitions. Smooth transition analysis allows us to model the shift from one regime (i.e. centrally planned economy) to another (i.e. market economy) as a smooth transition between regimes rather than as a discrete break between growth regimes, which is the approach adopted by previous authors.[2] A smooth transition model allows for gradual changes in levels and trend growth rates. In our analysis we allow for a shift in both the intercept (i.e. the level of GDP) and the trend (i.e. the growth rate) of the GDP series, in both cases allowing the shift to occur over time rather than instantaneously. For some countries which went through a second recession we also estimate the model allowing for two regime changes in line with the findings of Fidrmuc and Tichit (2003). In this way we address whether there is any evidence of reforms in transition economies having an impact on the trend growth rate of output after the recession; other estimated parameter values provide insights into the speed of transition and the severity of the recessions. Using information on reform processes in the particular countries from the literature we address the issue of whether the fast or gradual approach to reforms resulted in larger initial output falls and in larger responses of growth to reforms.

Apart from the issues raised above, the approach adopted allows us to consider a more theoretical issue concerning the impact of economic reforms. On the one hand, endogenous growth theory suggests that changes in government policy, such as price and trade liberalization, macro stabilization policies and policies related to property rights, may impact on the long-run growth rate, whereas traditional neoclassical theory would predict a one-off increase in the level of GDP. Our results may provide further insight into this issue. Moreover, there are obvious concerns that the initial deep transformational recession may lead to hysteresis effects, leading to a long-run negative impact on the growth rate of output. Smooth transition analysis also allows us to identify whether there is any evidence of such a change and whether any such change in growth can be related to the transition.

The rest of the paper is organized as follows: In Section 2 we describe our data and review the performance of GDP per capita in our sample of countries. Section 3 describes the smooth transition model and presents the results from the model. Section 4 summarizes our results and concludes.

2 Review of performance in CEECs

The data we use for our analysis are from the wiiw (The Vienna Institute for International Economic Studies) annual database.[3] We have data on the log of real GDP series at

[2] Breaks have either been imposed arbitrarily as in Selowsky and Martin (1997) and Tichit (1999) or estimated as in Fidrmuc and Tichit (2003).

[3] Data are collected from national statistical offices and are continuously updated with respect to new available data and revisions (see www.wiiw.ac.at for details).

constant 2002 prices for ten CEECs: the Czech Republic, Hungary, Poland, Slovakia, Slovenia, Estonia, Latvia, Lithuania, Bulgaria and Romania, eight of which are new members of the EU with the other two being candidate countries. The length of the GDP series varies a great deal. For a number of countries we have fairly long data series (e.g. Hungary, 1960-2004; Poland, 1983-2004; Bulgaria, 1982-2004; Romania, 1976-2004), while for others our data begin towards the end of the 1980s (e.g. Czech Republic, 1986-2004; Slovakia, 1986-2004; Slovenia, 1988-2004). Finally, for the Baltic states we only have data from 1990-2004. In Appendix A (Tables A1 and A2) we report an index of GDP for each of the countries along with the growth rates of GDP for the sample period.[4]

In Table 1 we overview the periods before and after 1989 of each country in our sample and present growth rates at different stages of the transition.[5] Where available we report the average growth rate of GDP in the three years prior to the start of the transition (1986-1988), the average growth rate in the three years after start of the reforms (1990-1992) and the average growth rate in the three years after the minimum level of GDP was reached ('turning point') in order to examine the speed of recovery.

Considering the figures in the table we see that all countries experienced a significant recession in the period following reform in 1989. This was particularly the case in the Baltic states and in Bulgaria and Romania. In the remaining five countries there were also significant declines. The table suggests that little can be said about the depth of recession in the countries based on the classification with respect to liberalization strategy. The Czech Republic, which undertook fast reforms, suffered the least from the transitional recession, but the other countries that also followed faster approaches generally suffered larger declines in growth rates immediately following reform than the countries taking the gradual approach. Considering the growth performance of our countries immediately following the low-point of the transitional recession, we find that growth rates were relatively large, with growth rates ranging from 1.9% in Hungary to 6.5% in Estonia. What is also apparent is that regardless of the strategy of reform undertaken, growth rates tended to be higher in the period immediately following the recession than they were immediately prior to reform. This

[4] As with all studies of the transition process in Eastern Europe, we have to be aware of important caveats regarding the data, which are likely to be biased. This is because the prices at which goods were valued before the transition process were out of line. Attempts at correcting these biases are unlikely to capture fully differences in quality, since goods were often not available and relative prices were different from world prices. Fischer et al. (1996) argue that this problem is likely to overstate the initial declines in GDP following reforms. Measurement problems are also likely to be an issue with many countries having to set up independent statistical services. Where such services already existed they were often set up to measure output from the state sector, thus following reforms that reduce the share of the state sector in total output recorded output is likely to fall (Fischer et al., 1996).

[5] There is a wide literature which tries to classify the reform strategies (speed, sequencing, etc.) as well as the start of different reforms (e.g. Roland, 2000; Lavigne, 1999). Here the literature is not conclusive at all. E.g. Wolf (1999) classifies the countries based on a reform index constructed by De Melo, Denizer and Gelb (1996). According to this definition all countries with the exceptions of Slovenia, Romania and Latvia have been 'radical reformers' since 1991 (Czech Republic, Hungary and Poland) or 1992 (Estonia and Latvia). In table 1 we have thus used the terms 'fast' and 'gradual' to distinguish the speed of the reforms undertaken in the particular countries.

may reflect the catching-up process or may relate to the outcome of a more efficient use of factors of production due to market reforms. (See e.g. Aghion and Blanchard, 1998, and Blanchard and Kremer, 1997). The only exception to this was Bulgaria whose growth performance following the recession (2.5%) was lower than that prior to reform (4.3%); although when looking at the period after 1998 the growth rate recovered to 3.9%. The above results are likely in some ways to reflect economic crises that occurred prior to (and may have contributed to) reforms. In addition, the explicit reform measures and the speed of reforms were not independent of initial conditions and the severity of the crises.

Table 1

Growth rates in CEECs following reform

	Liberalization		Three-year average growth rates of GDP			
			Prior to reforms 1986-1988	Following start of reforms 1990-1992[2]	Recovery stage	
	Reform Strategy[1]	Years of recession			Turning point[3]	Growth[4]
Czech Rep.	Fast	1990-1992	1.6	-4.4	1994	4.1
Hungary	Gradual	1990-1993	1.8	-6.2	1994	1.9
Poland	Fast	1990-1991	3.4	-5.3	1992	3.9
Slovakia	Fast	1990-1993	2.8	-7.9	1994	6.0
Slovenia	Gradual	1989-1993	N/A	-5.1	1994	4.1
Estonia	Fast	1991-1995	N/A	-12.0	1996	6.5
Latvia	Fast	1992-1994/1996	N/A	-16.1	1997	5.6
Lithuania	Gradual	1990-1995	N/A	-10.1	1996	5.0
Bulgaria	Fast	1989-1993	4.3	-9.4	1994	2.4
					1998	3.9
Romania	Fast	1989-1992	0.9	-9.1	1993	4.2
					2000	4.3

Notes: 1) See footnote 5. - 2) For Baltics 1991-1993. - 3) First year of 'substantial' growth. – 4) Three year average growth rate.

Figures 1-3 below show the response of the *level* of GDP to the change in the political system in our ten CEECs. Figure 1 shows the response for the five EU accession countries that have tended to respond quickly to the sharp economic downturn following reform. The figure shows us that while all countries experienced an initial downturn, the depth of the recession did vary across countries. In the two countries that undertook more gradual reforms the decline in GDP levels was around 17% for Hungary and 9% for Slovenia, while for the three countries, which undertook faster reforms, the decline in GDP was 17% for Poland, 8% for the Czech Republic and 13% for Slovakia. The speed with which these countries adjusted also varied, with Poland equalling or surpassing its 1989 GDP level in 1996 and Hungary in 2000. The two countries that undertook a gradual approach to reform (Hungary and Slovenia) took longer to return to pre-reform GDP levels (2000 and 1998 respectively) than Poland (1996) and the Czech Republic (1997), both of which followed

the fast approach, but Slovenia, at least, recovered more quickly than Slovakia (1999), which also followed faster reforms.

Figure 2 shows the response of GDP for the Baltic states, for which data are only available from 1990. In these cases the decline in GDP was much greater than that for the five countries discussed above, with declines ranging from 37% in Estonia to 44% in Latvia. The recovery from the recession has also, unsurprisingly, taken much longer, with only Estonia reaching 1990 levels in 2004. Given the large initial decline in GDP for this country, the fact that it has recovered to 1990 levels is indicative of how well Estonia has performed in terms of growth in the past ten or so years.

Finally, Figure 3 reports the response of GDP for the two EU accession countries, Romania and Bulgaria. While the initial declines in GDP were quite similar, a second recession in Bulgaria reduced GDP to levels much below minimum levels found in Romania (34% versus 18%). Neither country had reached 1990 levels of GDP by 2004.

The descriptive results suggest that the data indicate that there is little difference in the performance of countries that followed faster reforms when compared with those that followed a more gradual approach. This is the case both for the extent and length of recession and for the speed and extent of the recovery. The results also suggest that growth rates immediately following reforms have been in most cases higher than immediately prior to reforms.

Figure 1

Output response in accession countries

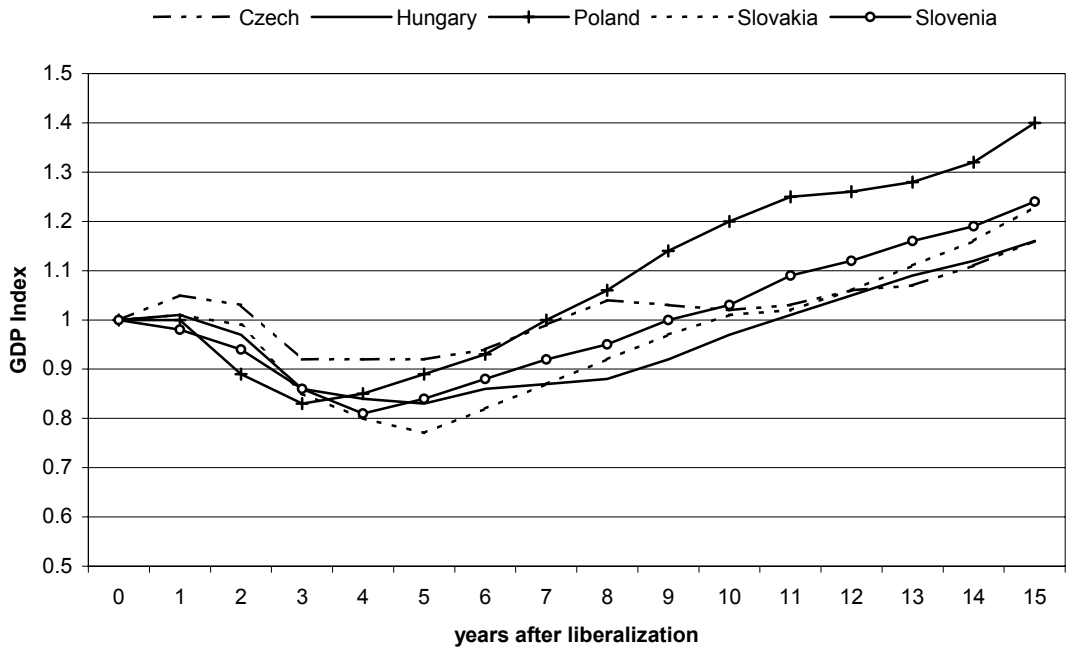


Figure 2

Output response in Baltic states

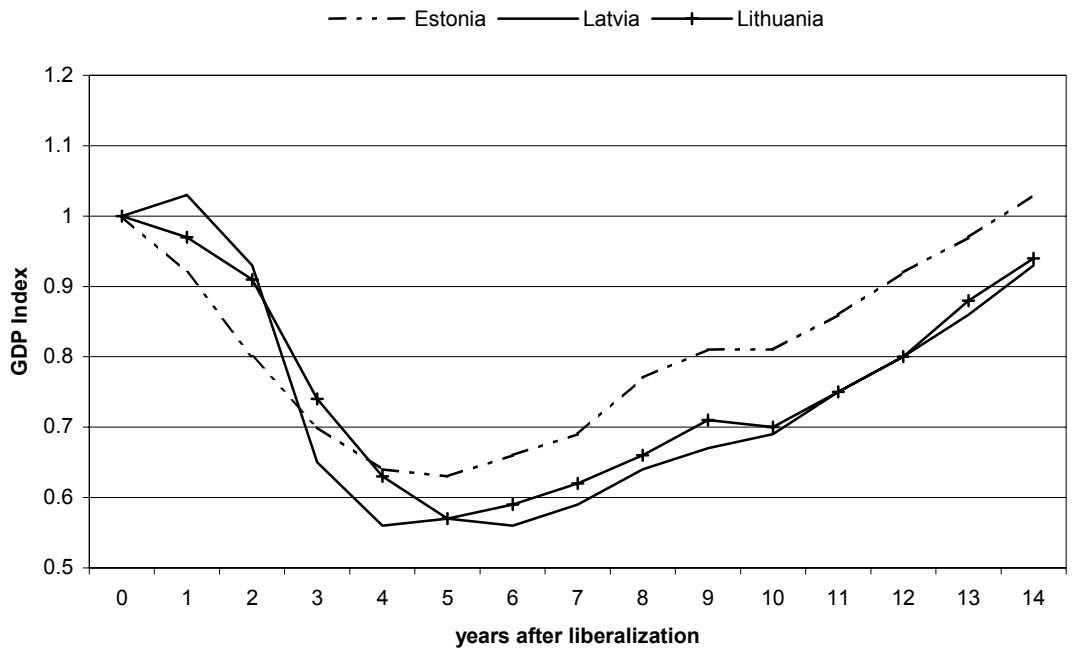
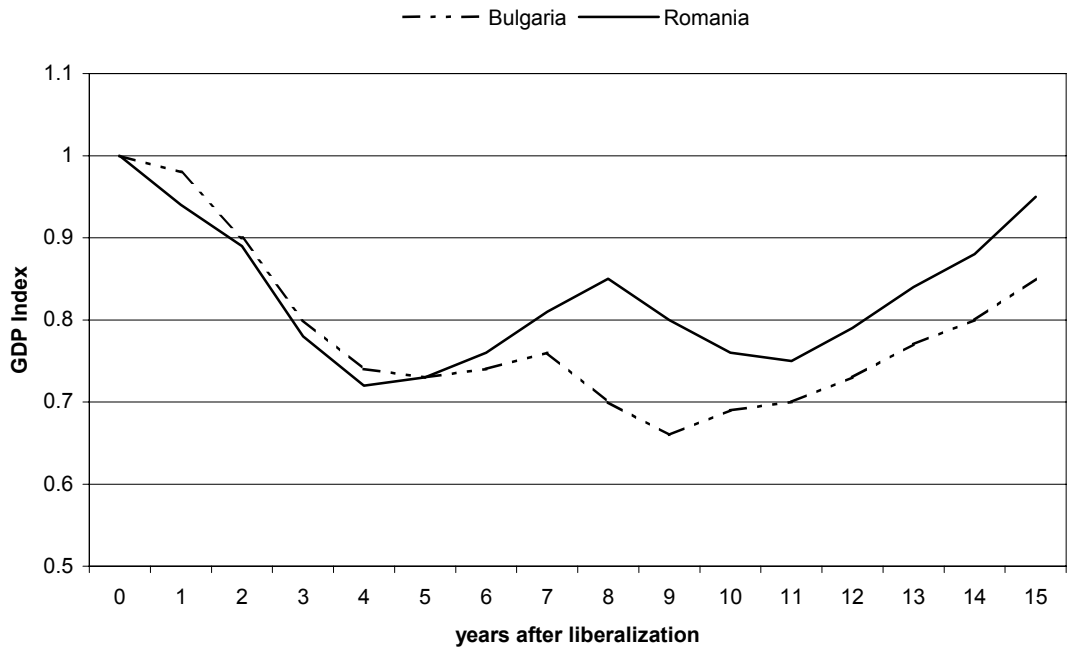


Figure 3

Output response in EU candidate countries



3 Modelling GDP in CEECs

3.1 Smooth transition models

Smooth transition regressions as proposed by Bacon and Watts (1971) and Maddala (1977), and more recently considered by Granger and Terasvirta (1993) are a means of modelling deterministic structural change in a time series regression. One advantage of modelling structural change using this approach is that it allows for gradual structural change rather than a single structural break, whilst being flexible enough that the conventional case of instantaneous structural change arises as a special case.[6] In the case of a shift from a centrally planned to a market economy there are numerous reasons to expect the transition to be gradual rather than immediate. One obvious reason is that in a number of countries reforms were also gradual, implying that the response of output to the start of reforms is likely to occur gradually. Moreover, economic agents are likely to react at different speeds to reforms, due for example to the efficiency in the different markets they operate, making the change in the economic aggregate considered to be spread over a longer period of time. In the case of transition economies there were particular concerns over the possibility of predatory taxation or policy reversals that could capture the returns to private economic activity, at least in an initial stage, which may have delayed the response of economic agents to reforms. After a period of time however, when trust and an adequate system of property rights had been built up, agents were more likely to respond to reforms.

A simple logistic smooth transition regression (LSTR) model allowing for a transition in both intercept and trend may be written as:

$$\log(y_t) = (\alpha_1 + \beta_1 t) + (\alpha_2 + \beta_2 t) S_t(\gamma, \tau) + \nu_t, \qquad t = 1,\ldots,T \qquad (1)$$

where ν_t is a zero-mean I(0) process and $S_t(\gamma,\tau)$ is the logistic smooth transition function, based on a sample of size T,

$$S_t(\gamma, \tau) = \{1 + \exp[-\gamma(t - \tau T)]\}^{-1} \qquad (2)$$

Under this formulation and assuming $\gamma > 0$, the model transition occurs smoothly between the initial state,

$$\log(y_t) = \alpha_1 + \beta_1 t + \nu_t, \qquad t \to \infty$$

and the final state

$$\log(y_t) = (\alpha_1 + \alpha_2) + (\beta_1 + \beta_2) t + \nu_t \qquad t \to \infty$$

[6] Smooth transition models have been applied to the GDP series of a number of countries liberalizing their trade regimes by Greenaway, Leybourne and Sapsford (1997). They often find that the transition in GDP was negative, suggesting that trade reform had deleterious effects on performance in reforming countries. It was often the case however that transitions in GDP could not be related to specific trade reforms.

corresponding to $S(-\infty) = 0$ and $S(\infty) = 1,$ respectively. Hence the growth rate of y_t, the coefficient on the trend variable, changes from β_1 to $\beta_1+\beta_2$ through time. The model also allows the intercept to change from α_1 to $\alpha_1+\alpha_2$. Here τ is a location parameter which determines the timing of the transition. For $T = \tau$ we have

$$\log(y_t) = (\alpha_1 + 0.5\alpha_2) + (\beta_1 + 0.5\beta_2)t + \nu_t$$

such that τ identifies the transition midpoint. The velocity of transition is controlled by the parameter γ. If γ takes a large value then the transition is completed in a short period of time and as γ tends to infinity the model collapses to one with an instantaneous structural break in intercept and trend at time $t = \tau$. Thus (1) embeds the standard structural break model as a special case.[7] The parameters α_2 and β_2 determine the direction of the transition in the intercept and trend respectively. If $\gamma < 0$, the initial and final model states are reversed but the interpretation of the parameters remains the same.[8]

The model (1) is nonlinear in parameters and may be estimated by nonlinear least squares (NLS). As pointed out in Granger and Terasvirta (1993), whilst the other parameter estimates may converge rapidly, that for γ may do so only very slowly, particularly if the true parameter value is large (such that the transition occurs quickly). This is because a large set of estimated values of γ lead to very similar values of $S(t)$, which deviate noticeably from each other only in a local neighbourhood of the location parameter τ. The practical consequence of this is that standard errors of the NLS estimate of γ may appear artificially large and should not, therefore, be taken necessarily to indicate the insignificance of the estimate.

The standard likelihood ratio test for the restriction $\gamma = 0$ does not provide us with a valid test of the null hypothesis of constancy of the intercept and trend against the smooth transition alternative. This is because under this null the parameters α_2, β_2 and τ are no

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[7] The above specification is quite flexible, in that it embeds the two standard paradigms of no change and instantaneous structural change as limiting cases. The transition in intercept and slope are however constrained to occur only once, simultaneously and with the same speed. A specification which does not impose these restrictions could also be considered, for example by applying different transition functions to the intercept and slope. Moreover, the function $S_t(\gamma,\tau)$ specified here does impose certain restrictions, in that the transition path is monotonic and symmetric around the midpoint. Sollis, Leybourne and Newbold (1999) allow for asymmetry in the function modelling the transition, by employing the generalized logistic function investigated by Nelder (1961). Such generalizations rapidly increase the number of parameters to be estimated, reducing the available degrees of freedom. Given the relatively small number of observations for a number of countries we do not attempt such extensions here. Moreover, the models estimated appear to fit the data well.

[8] This model has also been used to distinguish between series that are non-stationary and those that are stationary with a deterministic and smooth transition in level and trend (see Leybourne, Newbold and Vougas, 1998). Such a test has been used on GDP data for EU countries by Greenaway, Leybourne and Sapsford (2000). While not the main focus of this paper, we find support in about half of cases for modelling GDP as a smooth transition model (in either intercept or intercept and trend) as opposed to a non-stationary (I(1)) process. The countries where support is found for either a transition in intercept or in intercept and trend using either the full sample or the restricted sample of data are the Czech Republic, Hungary, Slovakia, Bulgaria, Romania and Latvia. Support for the smooth transitions approach tends to be found in cases where we have longer series of data suggesting that an adequate period of time is required before reform for the benefits of the smooth transition model to become more apparent.

longer identified. Hansen (1996, 2000) proposes a bootstrap procedure to simulate the asymptotic distribution of the likelihood ratio test, allowing us to obtain a p-value of the test of the restriction that γ = 0. To do this one firstly estimates the model under the null hypothesis of linearity (γ = 0) and the alternative hypothesis (smooth transition with $\gamma = \hat{\gamma}$). Using the sum of squared of errors from these models gives us the actual value of the likelihood ratio test, (F_1),

$$F_1 = \frac{S_0 - S_1(\hat{\gamma})}{\hat{\sigma}^2} \qquad \text{where} \qquad \hat{\sigma}^2 = \frac{1}{n(t-1)} S_1(\hat{\gamma})$$

Then a bootstrap is created by drawing from the normal distribution of the residuals of the estimated threshold model. Hansen (2000) recommends fixing the regressors in repeated bootstrap samples. Using this generated sample, the model is estimated under the null and alternative and the likelihood ratio F_1 is obtained. This process is repeated a large number of times (in our case 1000). The bootstrap estimate of the p-value for F_1 under the null is given by the percentage of draws for which the simulated statistic F_1 exceeds the actual one.

3.2 Smooth transition results

We have data series for GDP that differ in length quite markedly across countries, ranging from 1960-2004 for Hungary to 1990-2004 for Estonia, Latvia and Lithuania. To make our results more comparable we estimate the smooth transition model above for each of our ten countries using more comparable series of data. Where available therefore we consider the period 1986-2004. This leaves us with four countries for which slightly shorter data series are available, namely Slovenia (1988-2004), Estonia, Latvia and Lithuania (all 1990-2004). Table 2 below reports the results from our smooth transition model. In Appendix B we also report the results using the full data series for each country. We will discuss important differences in the two sets of results below.

Considering Table 2 we find that the models in general explain GDP in our countries reasonably well with the value of R^2 being in general above 0.95. The main exceptions to this are Bulgaria and Romania and to a lesser extent the Czech Republic, all of which in our sample period encountered a second recession. We will come back to this issue below.

Turning to the coefficients, the coefficient on α_1 is an estimate of the intercept (i.e. the initial logged values of GDP), while the negative and significant coefficients on α_2 indicate that all countries experienced a (negative) transition in the level of GDP. This result is expected given the large transitional recessions that occurred following reforms. As expected the coefficients are relatively large in those countries that suffered the greatest

decline in their levels of GDP (e.g. the Baltic countries and Bulgaria) and much smaller in the Czech Republic where the decline in GDP was much smaller.

Table 2

Smooth transition results (common time period)

	α_1	α_2	β_1	β_2	τ	γ	*Bootstrapped p-value*	R^2
Czech Republic	25.55	-0.17	0.021	-0.0019	0.34	4.02	0.00***	0.90
	(0.00)***	(0.00)***	(0.00)***	(0.79)	(0.00)***	(2.11)**		
Hungary	25.35	-0.45	0.028	0.008	0.35	1.23	0.00***	0.98
	(0.00)***	(0.00)***	(0.00)***	(0.27)	(0.00)***	(7.19)***		
Poland	26.18	-0.41	0.03	0.01	0.47	3.08	0.00***	0.97
	(0.00)***	(0.00)***	(0.03)**	(0.29)	(0.00)***	(1.50)		
Slovakia	24.58	-0.52	0.027	0.016	0.36	1.90	0.00***	0.98
	(0.00)***	(0.00)***	(0.00)***	(0.02)**	(0.00)***	(5.58)***		
Slovenia	24.08	-0.49	-0.02	0.06	0.29	2.68	0.00***	0.99
	(0.00)***	(0.00)***	(0.02)**	(0.00)***	(0.00)***	(2.63)***		
Estonia	23.54	-0.89	-0.078	0.13	0.29	1.31	0.00***	0.99
	(0.00)***	(0.00)***	(0.09)*	(0.00)***	(0.00)***	(3.69)***		
Latvia	23.88	-0.88	0.15	-0.09	0.22	1.40	0.00***	0.99
	(0.00)***	(0.00)***	(0.12)*	(0.32)	(0.00)***	(7.20)***		
Lithuania	24.42	-0.95	0.014	0.043	0.28	1.32	0.00***	0.98
	(0.00)***	(0.00)***	(0.81)	(0.47)	(0.00)***	(4.69)***		
Bulgaria	24.91	-1.0	-0.029	0.072	0.66	3.79	0.00***	0.74
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.27)		
Romania	25.76	-0.44	0.003	0.014	0.34	1.73	0.00***	0.80
	(0.00)***	(0.00)***	(0.90)	(0.56)	(0.00)***	(1.63)		

Notes: The data series for all countries is 1986-2004 with the exception of Slovenia (1988-2004), Estonia, Latvia and Lithuania (all 1990-2004). p-values are in brackets. ***, ** and * indicate significance at the 1, 5 and 10 per cent levels respectively. In the table we also report the bootstrapped p-value based on the Hansen approach, which gives a valid test statistic of the restriction that $\gamma = 0$. The bootstrapped p-value is calculated using 1000 repetitions of the procedure described in Hansen (1996).

The coefficients on β_1 are generally positive, suggesting a positive trend growth rate of GDP prior to the transition. In the majority of cases these positive coefficients are significant. In three cases (Slovenia, Estonia and Bulgaria) we find that the coefficient on the trend in GDP was negative and significant. For Slovenia and Estonia our data series only starts at the beginning of the recession which explains the negative sign, while for Bulgaria the negative trend turns into a significant positive one when we use the full sample of data and when we allow for a second smooth transition (see below). The main variable of interest for us regarding the trend in GDP however is β_2, which indicates whether any transition in trend has been positive or negative. With the exception of the Czech Republic and Latvia, for which negative, albeit insignificant transitions in trend were found, the results suggest that any change in the trend of GDP has been positive. The

results suggest that in four cases (Slovakia, Slovenia, Estonia and Bulgaria) the change in the trend growth rate has been positive and significant. In general therefore, the results suggest that the growth rate of GDP increased following the transition, with positive and significant impacts being found in a number of cases.

In line with previous results there appears little relationship between the speed of reforms and whether a country experienced an increase in trend growth. Positive and significant impacts on trend growth rates were found both in countries following a faster (Slovakia, Estonia and Bulgaria) and more gradual (Slovenia) approach to reforms. Similarly, from these results one cannot distinguish between outcomes hypothesized by endogenous versus traditional growth theory, though for a number of countries the positive and significant impact on the trend growth rate is more supportive of the endogenous growth literature. It may also be concluded that there have not been adverse hysteresis effects with respect to the long-run trend growth rate as we never find significant negative transitions in the trend.

Finally, the coefficient on γ shows us the speed at which transition takes place. As discussed above the standard errors of the estimate of γ may appear large and the reported p-values should not be taken as indicative of the significance of the estimate. Moreover, the reported p-values are not valid since under the null hypothesis α_2, β_2 and τ are not identified. In the table we report the bootstrapped p-value using the approach of Hansen (1996), which provides a valid test of the restriction that $\gamma = 0$. In all cases, the bootstrapped p-value indicates the significance of γ, which therefore supports the hypothesis of a transition in intercept and trend. Corresponding to the discussion in Section 2, the coefficients on γ indicate that the speed of transition was particularly fast in the Czech Republic, Poland, Bulgaria and to a lesser extent Slovenia. The first three of these countries undertook faster reforms, suggesting that the recovery following the transformational recession may well be quicker in countries following faster reform approach.

The coefficient on τ allows us to calculate the mid-point of the transition for each country. Midpoints are found to occur between 1992 and 1994 for most countries. The one exception is Bulgaria where the mid-point is found to occur in 1998. To give a greater insight into the starting point of any transition and to give a visual indication of how quickly countries responded to the transition, Figures B1 through B10a plot the fitted and actual values for each country for both the restricted data and the full sample period. In the majority of cases the transition occurs around the period 1990/1991 as would be expected. There are a small number of exceptions however. In Figure B2a for Hungary (1960-2004), Figure B9a for Bulgaria (1982-2004) and Figure B10a for Romania (1976-2004) we find that the transition begins between 1986 and 1989, which is slightly earlier than we may expect. This is likely to reflect economic crises that had already started before the political

collapse in 1989. This view is supported by the growth rates reported in Table A2. In Figure B9 for Bulgaria (1986-2004) we find that the transition begins around 1996 reflecting the fact that the model for the restricted sample of data on Bulgaria appears to capture Bulgaria's second recession and not the initial transition. The figures also highlight the difference in speed of transition with relatively rapid transitions found in most cases, but slower transitions found in Hungary, Estonia, Lithuania and Latvia.

Comparing the results from Table 2 with those in Table B1 for the full available sample of data we find a number of differences. Firstly for the four countries with longer samples of data (i.e. Hungary, Bulgaria, Romania and Poland) we tend to find that the speed of transition is slower for the full sample than for the restricted sample. For Poland this is the only significant change in results. For Hungary we also find that the transition in intercept and the initial trend growth rate are bigger in the full sample, the latter result due to the relatively strong economic performance of Hungary until the early 1980s. Once again there is no significant evidence of a positive change in the trend growth rate. For Bulgaria we find evidence of a positive trend growth rate of around 5.6 per cent for the full sample of data, once again capturing the strong performance of Bulgaria in the early 1980s. The change in trend growth rate is found to be slightly negative in the full sample, as opposed to the positive and significant change in trend GDP when compared to the results for the period 1986-1990. For Romania the trend growth rate is positive and significant for the full sample, while the change in trend is negative and significant versus the insignificant change in trend for the restricted sample of data. The results suggest that Hungary, Romania and Bulgaria performed relatively well until the mid- to late 1980s and that as a result restricting our sample of data to the period 1986-2004 suggests a stronger response of growth to reform in these countries than when we consider over a longer period of time prior to reforms.

3.3 Double smooth transition models

As discussed above the models for Romania and Bulgaria (and to a lesser extent the Czech Republic) are not as precise as those for the other countries due to the assumption of a single threshold in our smooth transitions model. Given that these countries experienced two recessions in the period of interest it is unsurprising that our models predict actual GDP less well. To account for this therefore we introduce the possibility of a second threshold in our smooth transitions model for these countries. The model estimated therefore is,

$$\log(y_t) = (\alpha_1 + \beta_1 t) + (\alpha_2 + \beta_2 t) S_{1t}(\gamma_1, \tau_1) + (\alpha_3 + \beta_3 t) S_{2t}(\gamma_2, \tau_2) + \nu_t, \quad (3)$$

where the $S_{it}(\gamma_i, \tau_i)$ are the logistic smooth transition functions given by equation (2). Once again the mid-points for the transitions are given by $\tau_1 T$ and $\tau_2 T$ for sample size T and the transition speeds are given by γ_1 and γ_2.

In the case of the double smooth transition model we perform a test to discriminate between one and two transitions. An approximate likelihood ratio test of one versus two transitions is given by the following statistic,

$$F_2 = \frac{S_1(\hat{\gamma}_1) - S_2(\hat{\gamma}_2)}{\hat{\sigma}^2} \qquad \text{where} \qquad \hat{\sigma}^2 = \frac{1}{n(t-1)} S_2(\hat{\gamma}_2)$$

Here $\hat{\gamma}_1$ and $\hat{\gamma}_2$ refer to the estimated speeds of transition for the first and second transitions respectively. To obtain the p-value a bootstrap procedure is once again followed with the dependent variable being generated under the null hypothesis of a single transition. The Table below reports the bootstrapped p-value of this test.

Table 3

Double smooth transition results

	Restricted sample (1986-2004)			Full sample	
	Czech Republic	Bulgaria	Romania	Bulgaria (1982-2004)	Romania (1976-2004)
α_1	25.55 (0.00)***	24.7 (0.00)***	25.73 (0.00)***	24.59 (0.00)***	25.21 (0.00)***
α_2	-0.31 (0.01)***	-0.60 (0.00)***	-1.35 (0.00)***	-0.38 (0.07)*	-9.35 (0.07)*
α_3	-0.02 (0.82)	-0.19 (0.29)	0.15 (0.63)	-0.46 (0.02)**	7.80 (0.19)
β_1	0.02 (0.00)***	0.06 (0.00)***	0.02 (0.07)*	0.04 (0.00)***	0.06 (0.00)***
β_2	0.01 (0.13)	-0.01 (0.44)	0.09 (0.01)**	-0.01 (0.46)	0.36 (0.21)
β_3	-0.005 (0.50)	-0.006 (0.73)	-0.05 (0.15)	0.015 (0.29)	-0.35 (0.26)
τ_1	0.35 (0.00)***	0.33 (0.00)***	0.37 (0.00)***	0.45 (0.00)***	0.68 (0.00)***
τ_2	0.71 (0.00)***	0.63 (0.00)***	0.68 (0.00)***	0.69 (0.00)***	0.73 (0.00)***
γ_1	3.00 (3.12)***	1.05 (8.53)***	0.94 (6.18)***	1.40 (7.63)***	0.45 (4.65)***
γ_2	2.27 (1.46)	2.85 (3.59)***	1.37 (5.47)***	3.72 (1.35)	1.09 (2.76)***
Bootstrapped p-value	0.01**	0.00***	0.00***	0.00***	0.00***
R^2	0.97	0.99	0.99	0.99	0.97

Notes: The data series for all countries is 1986-2004 with the exception of Slovenia (1988-2004), Estonia, Latvia and Lithuania (all 1990-2004). p-values are in brackets. ***, ** and * indicate significance at the 1, 5 and 10 per cent levels respectively. In the table we also report the bootstrapped p-value based on the Hansen approach, which in this case gives a valid test statistic to discriminate between one and two transitions. The bootstrapped p-value is calculated using 1000 repetitions of the procedure described in Hansen (1996).

The results for both the full sample period of data and the restricted data are reported in Table 3. Allowing for a second transition significantly improves the fit of the model in all cases. Moreover, the bootstrapped p-values indicate support for the double transition model in all cases at the 5 per cent level or better. The transition in the level of GDP following reforms is found to be negative and significant in all cases as expected, with the shifts being larger for Romania and Bulgaria than for the Czech Republic. This result echoes those from above. The impact of the second transition (i.e. the second recession) on the level of GDP tends to have been negative, but not significant, with only Bulgaria (1982-2004) showing a significant decline in the level of GDP. This reflects the fact that these recessions tended to be relatively shallow and short-lived (as indicated by the speed of adjustment to the second recession, γ_2). In terms of the transition in trend only Romania (1986-2004) shows evidence of an increase in the trend growth rate of GDP following the initial transformational recession. For Bulgaria the coefficient on β_2 is found to be negative, but not significant. There is no evidence of the second recession having a significant impact on the trend growth rate of GDP, with both positive and negative coefficients found, none of which are significant.

Figures B11 through B13a plot the actual and fitted values for the double threshold model. The figures indicate a much better fit of the data after accounting for a second threshold. In all cases the starting point of the first transition is found to be around the period 1989-1991, which is largely consistent with the results reported above.

4 Summary and concluding remarks

In this paper we have used a smooth transition model to investigate the path of GDP of ten transition countries. The method allows us to model the transition from one regime to another (i.e. from planned to market economies) as a continuous process rather than as a discrete jump. Using these models we examine whether there is any evidence of an improvement in the growth rate of GDP following reforms, as well as considering whether any differences in performance across countries can be related to the speed at which reforms were undertaken.

For all countries we find the expected significant decline in the level of GDP around the time of economic reforms. In no case however do we find that the trend growth rate fell significantly. This result reveals that the severe recessions following reforms – in some cases GDP dropped by up to 40% – had no negative hysteresis effect on GDP growth. For a number of countries we find evidence that the trend growth rate has increased significantly, suggesting that the movement to a market economy has resulted in an increase in the trend growth rate. We cannot however identify whether the increase in growth is due to an increase in the long-run growth rate or to the catching-up phenomena as these countries started from relatively low levels of GDP after the recession. Similarly, it

may also be that the improvement in growth is due to a change in the level of income following reforms that is slow in nature. Thus although one may safely conclude from the results that the transition has had no negative effect on the trend growth rate in general, one must be cautious to conclude that the transformation has had a positive long-run impact on GDP growth. While we find evidence of a change in the growth rate in a number of cases, this may be due to a continuous longer-term shift of the income level. To tackle this question appropriately a longer time span after the transformation would be necessary. Similarly, the results do not allow us to draw a conclusion on the endogenous versus neoclassical debate, which also would require longer periods of data. Finally, when comparing the results across countries it appears that there is no clear-cut relationship between the reform strategies in the particular countries and the severity of the recession, the time to recover and the trend growth rate after the recession. This last finding seems to be in line with other recent findings.

References

Aghion, P. and O. Blanchard (1998), 'On Privatization Methods in Eastern Europe and Their Implications', *Economics of Transition*, Vol. 6, No. 1, 87-99.

Aghion, P. and O. Blanchard (1994), 'On the speed of transition in central Europe', *NBER Macroeconomics Annual*, 283-319.

Bacon, D. W. and D. G. Watts (1971), 'Estimating the transition between two intersecting straight lines', *Biometrika*, 58, 525-534.

Berg, A., E. Borensztein, R. Sahay and J. Zettelmayer (1999), 'The evolution of output in transition economies: Explaining the difference', *IMF Working Paper* No. WP/99/73, International Monetary Fund, Washington, DC.

Berg, A. and J. Sachs (1992), 'Structural adjustment and international trade in Eastern Europe: The case of Poland', *Economic Policy*, 14, 117-174.

Blanchard, O. and M. Kremer (1997), 'Disorganization', *Quarterly Journal of Economics*, Vol. 112, No. 4, 1091-1126.

Campos, N. F. and F. Coricelli (2000), 'Growth in transition: What we know, what we don't, and what we should', *William Davidson Institute Working Paper Series* No. 470, William Davidson Institute at the University of Michigan Business School.

Davies, R. B. (1977), 'Hypothesis testing when a nuisance parameter is only present under the alternative', *Biometrika*, 64, 247-254.

De Melo, M., C. Denizer and A. Gelb (1996), 'Patterns of transition from plan to market', *World Bank Economic Review*, 10, 397-424.

De Melo, M., C. Denizer, A. Gelb and S. Tenev (1997), 'Circumstances and choice: The role of initial conditions and policies in transition economies', *World Bank Research Paper*, The World Bank, Washington, DC.

Fidrmuc, J. and A. Tichit (2003), 'Mind the break! Accounting for changing patterns of growth during the transition', *William Davidson Institute Working Paper Series* No. 643, William Davidson Institute at the University of Michigan Business School.

Fischer, S. R., R. Sahay and C. A. Végh (1996), 'Stabilization and growth in transition economies: The early experience', *Journal of Economic Perspectives*, 10, 45-66.

Fischer, S. and R. Sahay (2000), 'The transition economies after ten years', *NBER Working Paper* No. 7664, NBER.

Gomulka, S. (2000), 'Macroeconomic policies and achievements in transition economies, 1989-1999', Paper presented at the United Nations' Economic Commission for Europe Annual Seminar, 2 May 2000, Geneva, Switzerland.

Granger, C. W. J. and T. Terasvirta (1993), *Modelling nonlinear economic relationships*, Oxford University Press, Oxford.

Greenaway, D., S. Leybourne and D. Sapsford (1997), 'Modelling growth (and liberalisation) using smooth transitions analysis', *Economic Inquiry*, 35, 798-814.

Greenaway, D., S. Leybourne and D. Sapsford (2000), 'Smooth transitions and GDP growth in the European Union', *The Manchester School*, 68, 145-165.

Gros, D. and A. Steinher (2004), *Economic transition in central and eastern Europe: Planting the seeds,* Cambridge University Press, Cambridge.

Gros, D. and G. Vandille (1997), 'Output decline and recovery in the transition economies: Causes and social consequences', *Economics of Transition*, 5, 113-130.

Hansen, B. E. (1996), 'Inference when a nuisance parameter is not identified under the null hypothesis', *Econometrica*, 64, 413-430.

Hansen, B. E. (2000), 'Sample splitting and threshold estimation', *Econometrica*, 68, 575-603.

Havrylyshyn, O., I. Izvorski and R. van Rooden (1998), 'Recovery and growth in transition economies 1990-97: A stylized regression analysis', *IMF Working Paper* No. WP/98/141, International Monetary Fund, Washington, DC.

Kornai, J. (2005), 'The Great Transformation of Central Eastern Europe: Success and Disappointment', Paper presented at the I.E.A. 14th World Congress, Marrakech, Morocco.

Kolodko, G. W. (2001), 'Globalization and catching-up: From recession to growth in transition economies', Paper presented at the international conference on European Integration and Transatlantic Policymaking, Centre for European Studies, Carlton University, Ottawa, 7-8 May 2001.

Laski, K. (1992), 'Transition from Command to Market Economies in Central and Eastern Europe: First Experiences and Questions', in: S. Richter (ed.), *The Transition from Command to Market Economies in East-Central Europe*, Westview Press, Boulder, San Francisco & Oxford.

Lavigne, M. (1999), *The economics of transition. From socialist economy to market economy*, 2nd ed., Macmillan, London.

Levcik, F. (1992), 'The Thorny Path of Transition from Command to Market Economy', in: S. Richter (ed.), *The Transition from Command to Market Economies in East-Central Europe*, Westview Press, Boulder, San Francisco & Oxford.

Leybourne, S., P. Newbold and D. Vougas (1998), 'Unit roots and smooth transitions', *Journal of Time Series Analysis*, 19, 83-97.

Lin, C. J. and T. Terasvirta (1994), 'Testing the constancy of regression parameters against continuous structural change', *Journal of Econometrics*, 62, 211-228.

Maddala, G. S. (1997), *Econometrics*, McGraw-Hill, New York.

Murphy, K., A. Shleifer and R. Vishny (1992), 'The transition to a market economy: Pitfalls of partial reform', *Quarterly Journal of Economics*, 107, 889-906.

Nelder, J. A. (1961), 'The fitting of a generalisation of the logistic curve', *Biometrics*, 17, 89-110.

Popov, V. (2000), 'Shock therapy versus gradualism: The end of the debate (explaining the magnitude of transformational recessions)', *Comparative Economic Studies*, XLII, 1, 1-57.

Portes, R. (1990), 'Introduction to economic transformation of Hungary and Poland', *European Economy*, 43, 11-18.

Portes, R. (1991), 'The path of reform in Central and Eastern Europe: An introduction', *European Economy (Special Issue)*, 2, 3-15.

Radulescu, R. and D. Barlow (2002), 'The relationship between policies and growth in transition countries', *Economics of Transition*, 10, 719-745.

Roland, G. (1991), 'Political economy of sequencing tactics in the transition period', in L. Csaba (ed), *Systemic change and stabilization in Eastern Europe*, 47-64, Aldershot, Dartmouth.

Roland, G. (2000), *Transition and economics: Politics, markets and firms*, The MIT Press, Cambridge, MA.

Sachs, J. (1993), *Poland's jump to the market economy*, Lionel Robbins Lectures, The MIT Press, Cambridge, MA.

Selowsky, M. and R. Martin (1997), 'Policy performance and output growth in transition economies', *American Economic Review (Papers and Proceedings)*, 87, 349-353.

Sollis, R., S. Leybourne and P. Newbold (1999), 'Unit roots and asymmetric smooth transitions', *Journal of Time Series Analysis*, 20, 671-677.

Svejnar, J. (2002), 'Transition economies: Performance and challenges', *Journal of Economic Perspectives*, 16, 3-28.

Tichit, A. (1999), 'Bad growth performance of FSU countries: Does unemployment matter?', Mimeo.

Wolf, H. C. (1999), *Transition strategies: Choices and outcomes*, Princeton Studies in International Finance, No. 85.

Appendix A: Levels and growth rates of GDP

Table A1

Index of GDP (1989 = 1.00)

	Czech Republic	Hungary	Poland	Slovakia	Slovenia	Estonia	Latvia	Lithuania	Bulgaria	Romania
1960		0.31								
1961		0.31								
1962		0.32								
1963		0.34								
1964		0.36								
1965		0.38								
1966		0.38								
1967		0.41								
1968		0.45								
1969		0.47								
1970		0.50								
1971		0.53								
1972		0.56								
1973		0.60								
1974		0.64								
1975		0.68								
1976		0.72								0.57
1977		0.75								0.64
1978		0.80								0.69
1979		0.84								0.74
1980		0.86								0.79
1981		0.87								0.83
1982		0.89							0.78	0.83
1983		0.92	0.78						0.80	0.86
1984		0.92	0.82						0.83	0.92
1985		0.95	0.87						0.86	0.97
1986	0.95	0.95	0.90	0.92					0.88	0.97
1987	0.97	0.96	0.94	0.96					0.92	1.00
1988	0.98	1.00	0.96	0.98	1.02				0.97	1.00
1989	1.00	1.00	1.00	1.00	1.00				1.00	1.00
1990	1.05	1.01	1.00	1.01	0.98	1.00	1.00	1.00	0.98	0.94
1991	1.03	0.97	0.89	0.99	0.94	0.92	1.03	0.97	0.90	0.89
1992	0.92	0.86	0.83	0.85	0.86	0.80	0.93	0.91	0.80	0.78
1993	0.92	0.84	0.85	0.80	0.81	0.70	0.65	0.74	0.74	0.72
1994	0.92	0.83	0.89	0.77	0.84	0.64	0.56	0.63	0.73	0.73
1995	0.94	0.86	0.93	0.82	0.88	0.63	0.57	0.57	0.74	0.76
1996	0.99	0.87	1.00	0.87	0.92	0.66	0.56	0.59	0.76	0.81
1997	1.04	0.88	1.06	0.92	0.95	0.69	0.59	0.62	0.70	0.85
1998	1.03	0.92	1.14	0.97	1.00	0.77	0.64	0.66	0.66	0.80
1999	1.02	0.97	1.20	1.01	1.03	0.81	0.67	0.71	0.69	0.76
2000	1.03	1.01	1.25	1.02	1.09	0.81	0.69	0.70	0.70	0.75
2001	1.06	1.05	1.26	1.06	1.12	0.86	0.75	0.75	0.73	0.79
2002	1.07	1.09	1.28	1.11	1.16	0.92	0.80	0.80	0.77	0.84
2003	1.11	1.12	1.32	1.16	1.19	0.97	0.86	0.88	0.80	0.88
2004	1.16	1.16	1.40	1.23	1.24	1.03	0.93	0.94	0.85	0.95

Notes: The index of GDP is equal to 1.00 in 1989 for all countries except Estonia, Latvia and Lithuania where the data series only begin in 1990. (In some cases the index is quite sensitive to the base year, e.g. in Poland it would become 1.60 in 2004 when setting 1990=1.00, as the decline started earlier.) The shaded area identifies the years in which GDP levels were lower than they were in the year of political change, while the more heavily shaded areas indicate the low point of the transformational recession. In the cases of Latvia, Romania and Bulgaria GDP levels started to recover, but were followed by a second recession, hence the two darker shaded cells.

Table A2

Growth rates of GDP

	Czech Republic	Hungary	Poland	Slovakia	Slovenia	Estonia	Latvia	Lithuania	Bulgaria	Romania
1960										
1961		4.7								
1962		6.1								
1963		5.7								
1964		4.7								
1965		1.0								
1966		7.4								
1967		7.5								
1968		4.9								
1969		6.9								
1970		4.7								
1971		6.2								
1972		6.1								
1973		6.9								
1974		5.9								
1975		6.2								
1976		3.6								11.4
1977		7.6								7.5
1978		4.4								8.0
1979		2.7								6.6
1980		0.2								4.3
1981		2.9								0.1
1982		2.8							2.3	4.0
1983		0.7	5.6						3.4	6.1
1984		2.7	5.6						3.4	5.9
1985		-0.3	3.6						2.7	-0.1
1986	2.1	1.5	4.2	4.1					4.2	2.4
1987	0.6	4.1	2.0	2.5					6.1	0.8
1988	2.1	-0.1	4.1	1.9					2.6	-0.5
1989	4.5	0.7	0.2	1.0	-1.7				-1.9	-5.8
1990	-1.2	-3.5	-11.6	-2.5	-1.8				-9.1	-5.6
1991	-11.6	-12.0	-7.0	-14.6	-4.7	-8.1	2.9	-3.3	-11.7	-12.9
1992	-0.5	-3.1	2.6	-6.5	-8.9	-13.6	-10.4	-5.7	-7.3	-8.8
1993	0.1	-0.6	3.8	-3.7	-5.5	-14.2	-34.9	-21.3	-1.5	1.5
1994	2.2	2.9	5.2	6.2	2.8	-8.8	-14.9	-16.2	1.8	3.9
1995	5.9	1.5	7.0	5.8	5.3	-1.6	0.6	-9.8	2.9	7.1
1996	4.2	1.3	6.0	6.1	4.1	4.5	-0.8	3.3	-9.4	3.9
1997	-0.7	4.6	6.8	4.6	3.6	4.5	3.8	4.7	-5.6	-6.1
1998	-1.1	4.9	4.8	4.2	4.8	10.5	8.3	7.0	4.0	-4.8
1999	1.2	4.2	4.1	1.5	3.6	5.2	4.7	7.3	2.3	-1.2
2000	3.9	5.2	4.0	2.0	5.6	-0.1	3.3	-1.7	5.4	2.1
2001	2.6	3.8	1.0	3.8	3.9	7.8	6.9	3.9	4.1	5.7
2002	1.5	3.5	1.4	4.6	2.7	6.4	8.0	6.4	4.9	5.0
2003	3.7	3.0	3.8	4.5	3.3	7.2	6.4	6.8	4.3	4.9
2004	3.8	3.9	5.4	5.3	2.5	5.1	7.5	9.7	5.6	7.8

Notes: Shaded areas indicate years after 1989 in which growth rates were negative.

Appendix B: Additional results

Table B1

Smooth transition results (full sample of data)

Country (Period)	α_1	α_2	β_1	β_2	τ	γ	*Bootstrapped p-value*	R^2
Czech Republic (1986-2004)	25.55 (0.00)***	-0.17 (0.00)***	0.021 (0.00)***	-0.0019 (0.79)	0.34 (0.00)***	4.02 (2.11)**	0.00***	0.90
Hungary (1960-2004)	24.14 (0.00)***	-1.32 (0.01)**	0.056 (0.00)***	0.0058 (0.60)	0.71 (0.00)***	0.29 (8.65)***	0.00***	0.99
Poland (1983-2004)	26.13 (0.00)***	-0.36 (0.00)***	0.04 (0.00)***	0.0045 (0.42)	0.40 (0.00)***	2.47 (2.91)***	0.00***	0.98
Slovakia (1986-2004)	24.58 (0.00)***	-0.52 (0.00)***	0.027 (0.00)***	0.016 (0.02)**	0.36 (0.00)***	1.90 (5.58)***	0.00***	0.98
Slovenia (1988-2004)	24.08 (0.00)***	-0.49 (0.00)***	-0.02 (0.02)**	0.06 (0.00)***	0.29 (0.00)***	2.68 (2.63)***	0.00***	0.99
Estonia (1990-2004)	23.54 (0.00)***	-0.89 (0.00)***	-0.078 (0.09)*	0.13 (0.00)***	0.29 (0.00)***	1.31 (3.69)***	0.00***	0.99
Latvia (1990-2004)	23.88 (0.00)***	-0.88 (0.00)***	0.15 (0.12)*	-0.09 (0.32)	0.22 (0.00)***	1.40 (7.20)***	0.00***	0.99
Lithuania (1990-2004)	24.42 (0.00)***	-0.95 (0.00)***	0.014 (0.81)	0.043 (0.47)	0.28 (0.00)***	1.32 (4.69)***	0.00***	0.98
Bulgaria (1982-2004)	24.56 (0.00)***	-0.77 (0.03)**	0.056 (0.01)**	-0.017 (0.31)	0.48 (0.00)***	0.47 (3.43)***	0.00***	0.86
Romania (1976-2004)	25.23 (0.00)***	-0.22 (0.21)	0.053 (0.00)***	-0.03 (0.00)***	0.52 (0.00)***	0.68 (4.14)***	0.00***	0.88

Notes: The data for all countries is 1986-2004 with the exception of Slovenia (1988-2004), Estonia, Latvia and Lithuania (all 1990-2004). p-values are in brackets. ***, ** and * indicate significance at the 1, 5 and 10 percent levels respectively. In the table we also report the bootstrapped p-value based on the Hansen approach, which gives a valid test statistic of the restriction that $\gamma = 0$. The bootstrapped p-value is calculated using 1000 repetitions of the procedure described in Hansen (1996).

Plots of actual versus fitted values

Figure B1

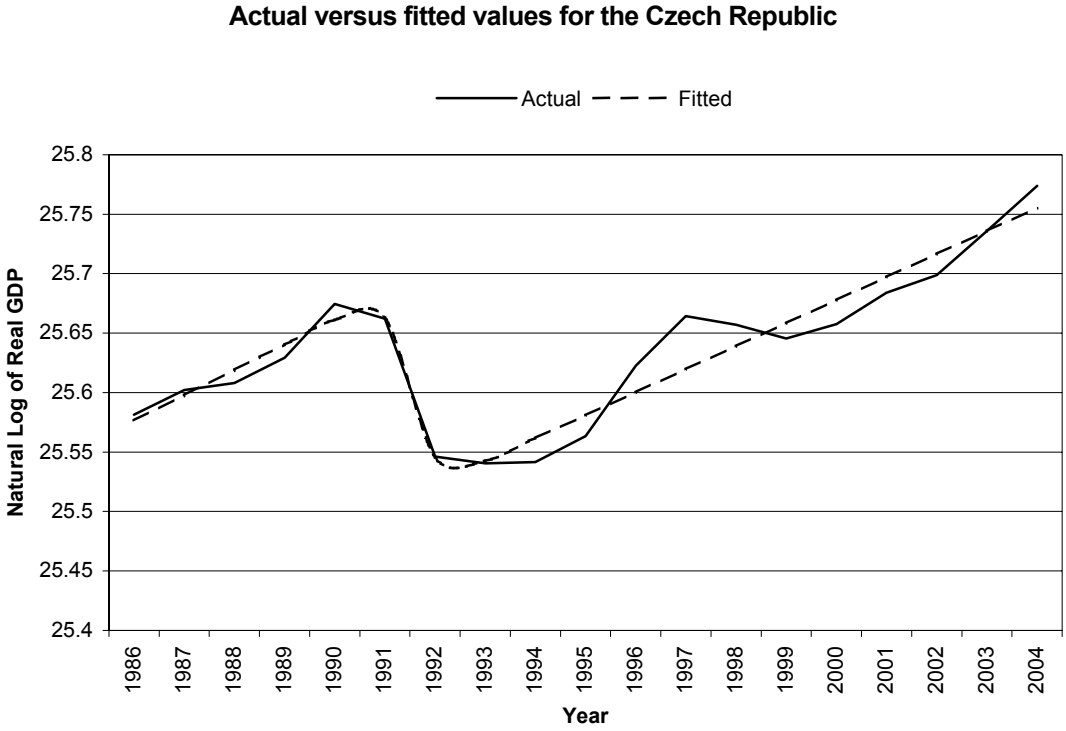


Figure B2

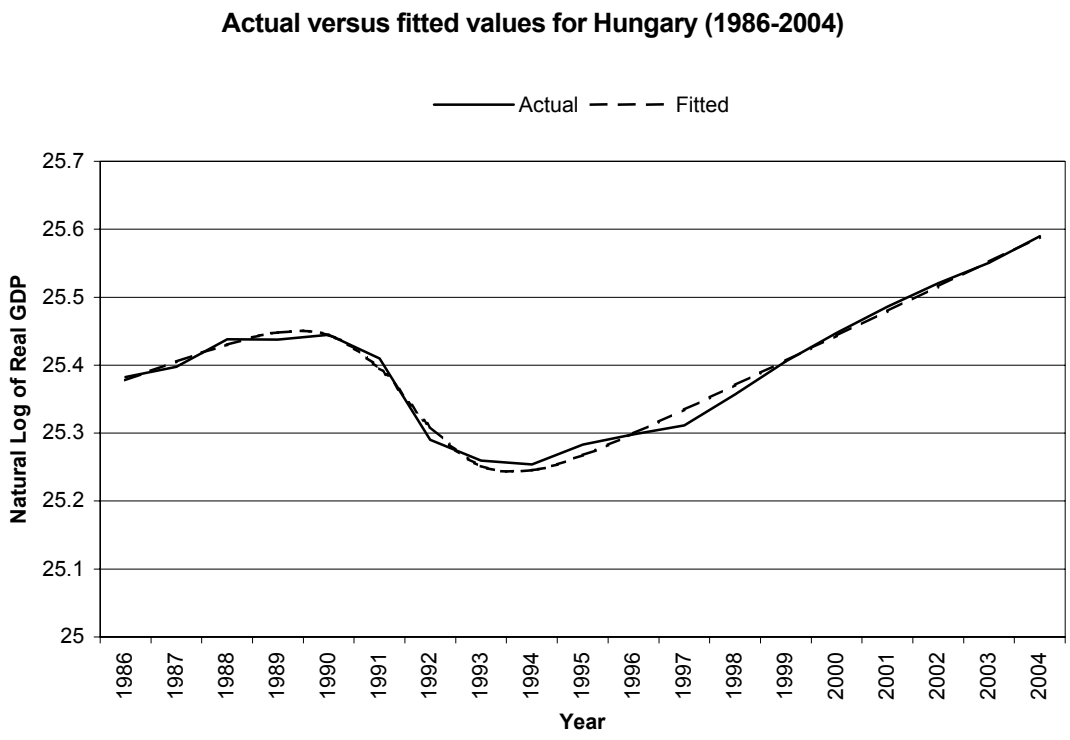
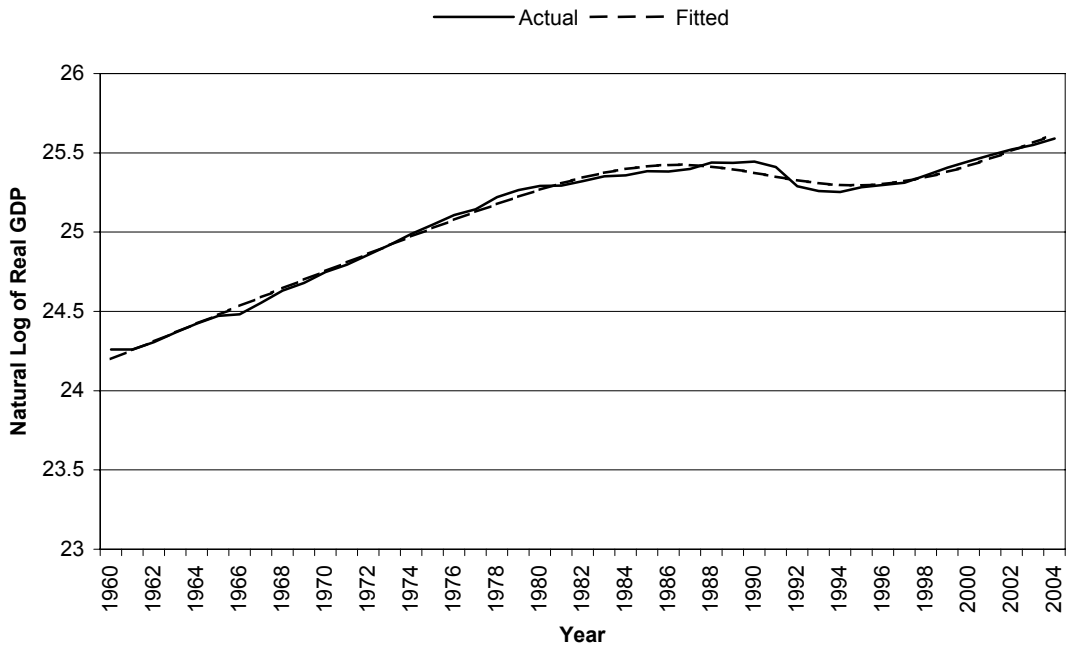


Figure B2a



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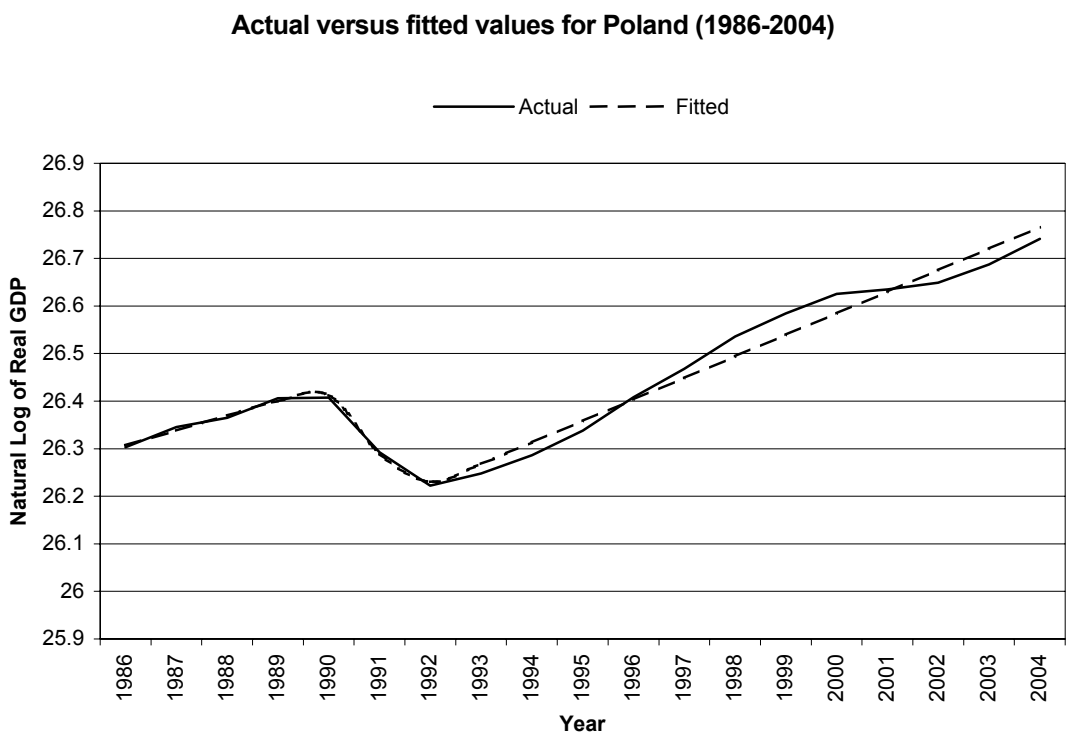
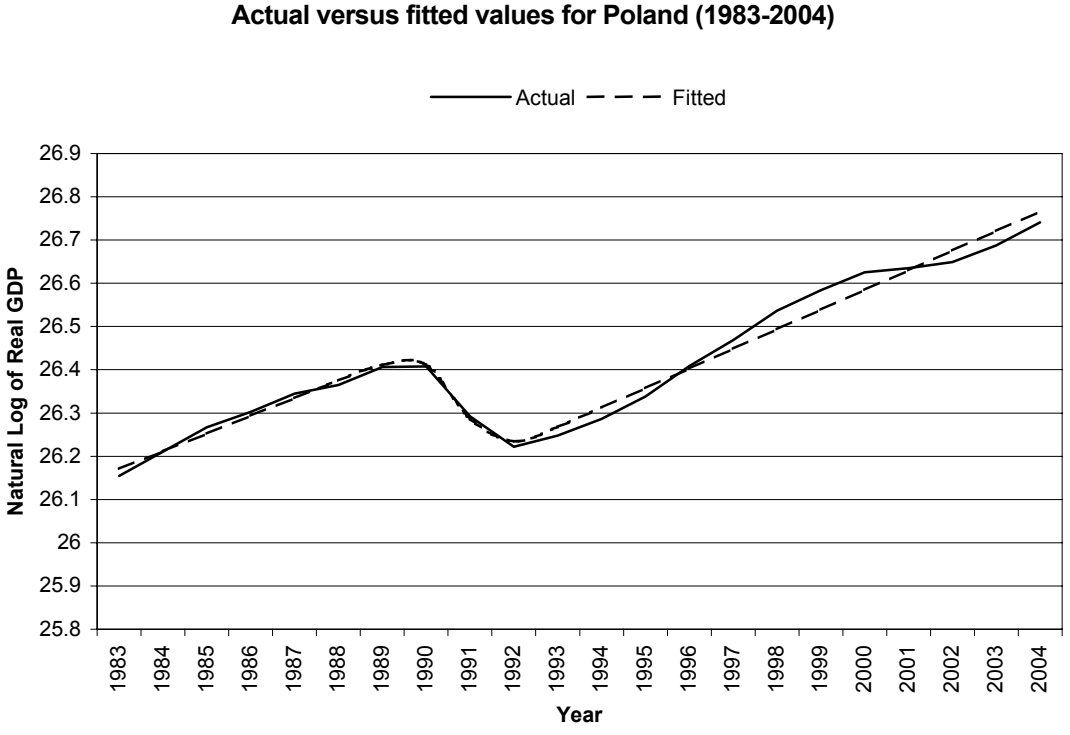


Figure B3a



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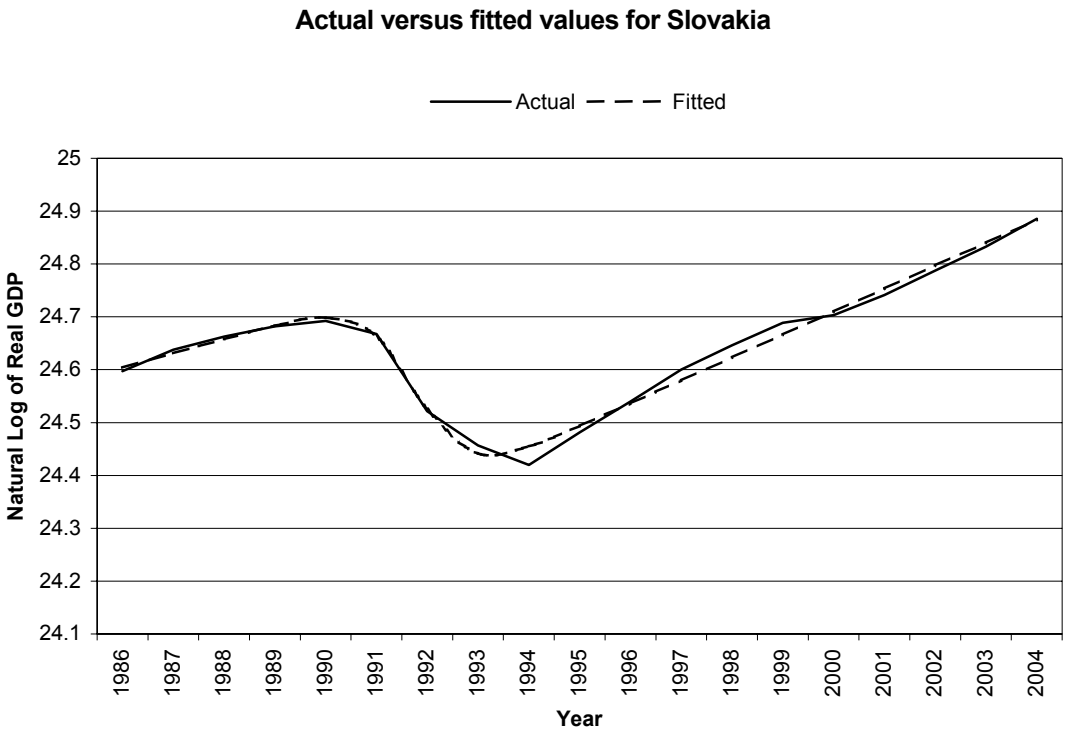

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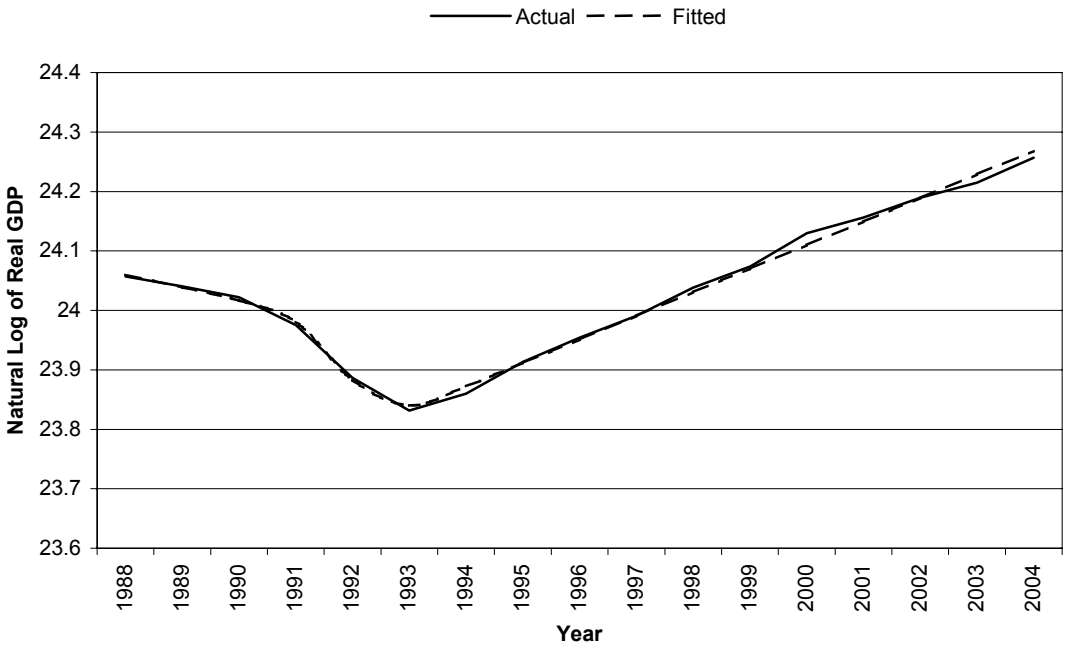

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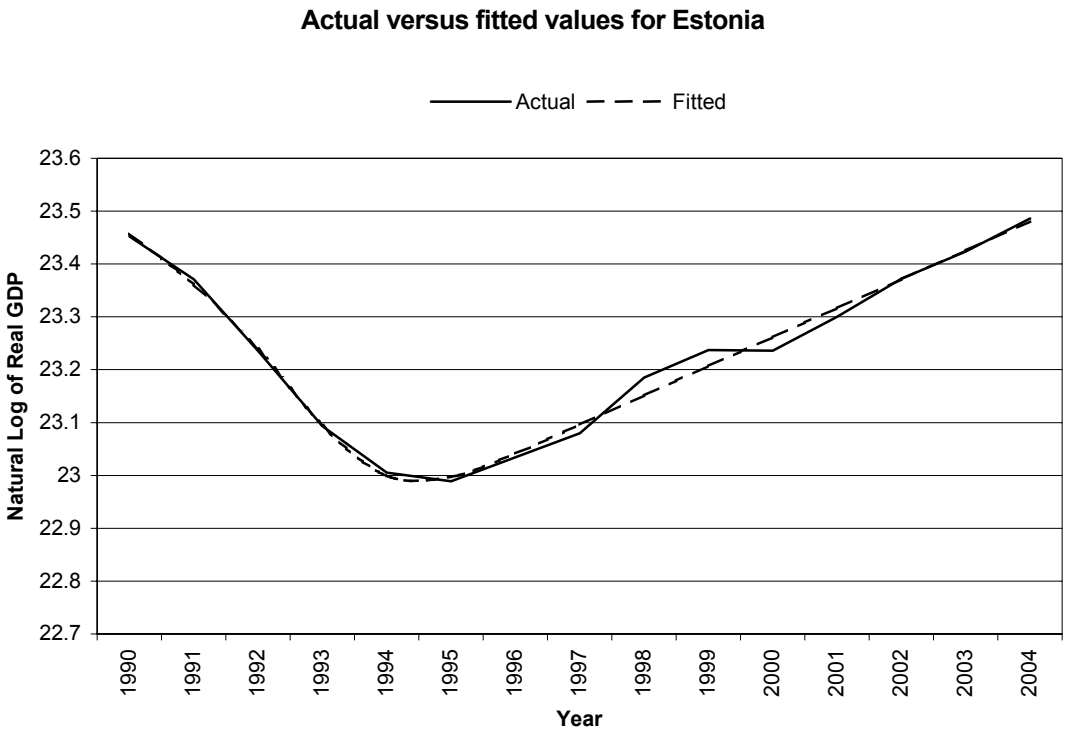

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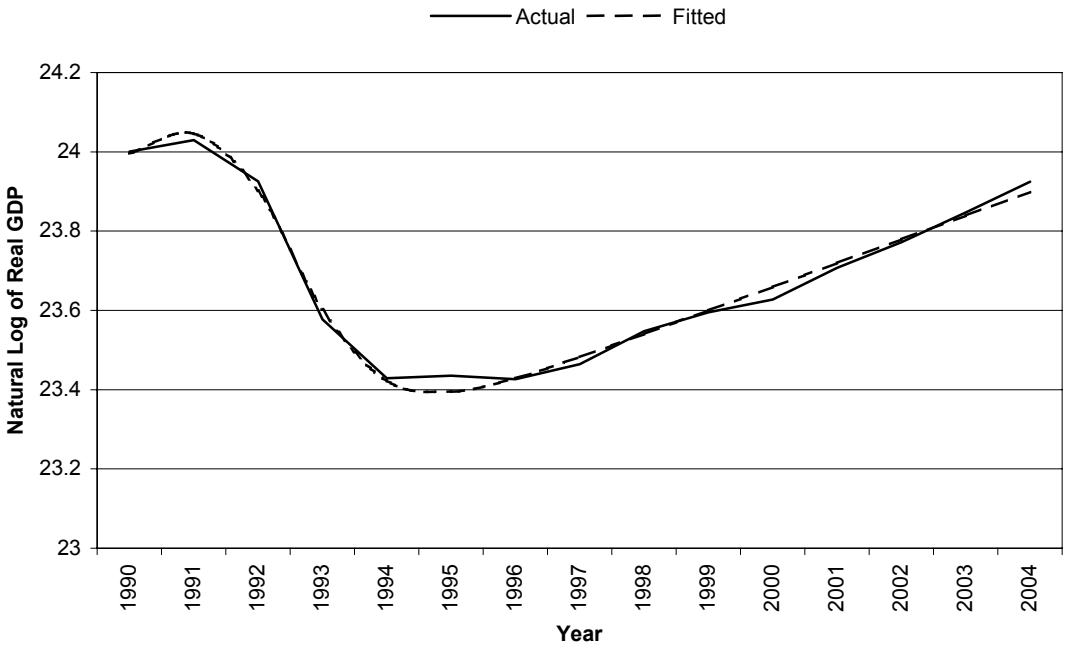
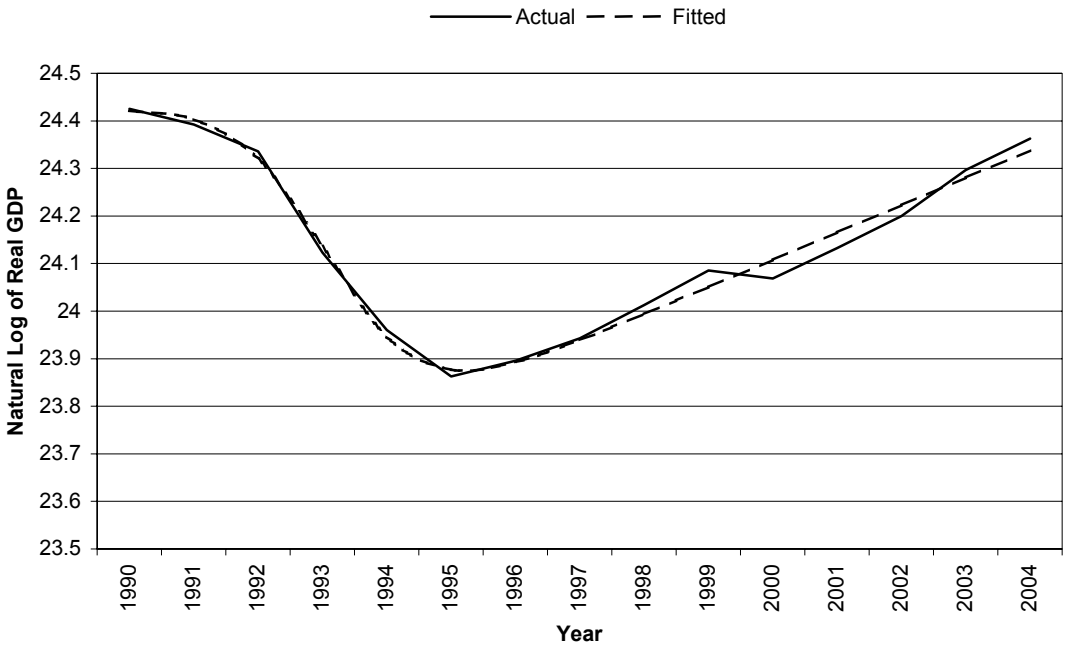


Figure B8

Actual versus fitted values for Lithuania



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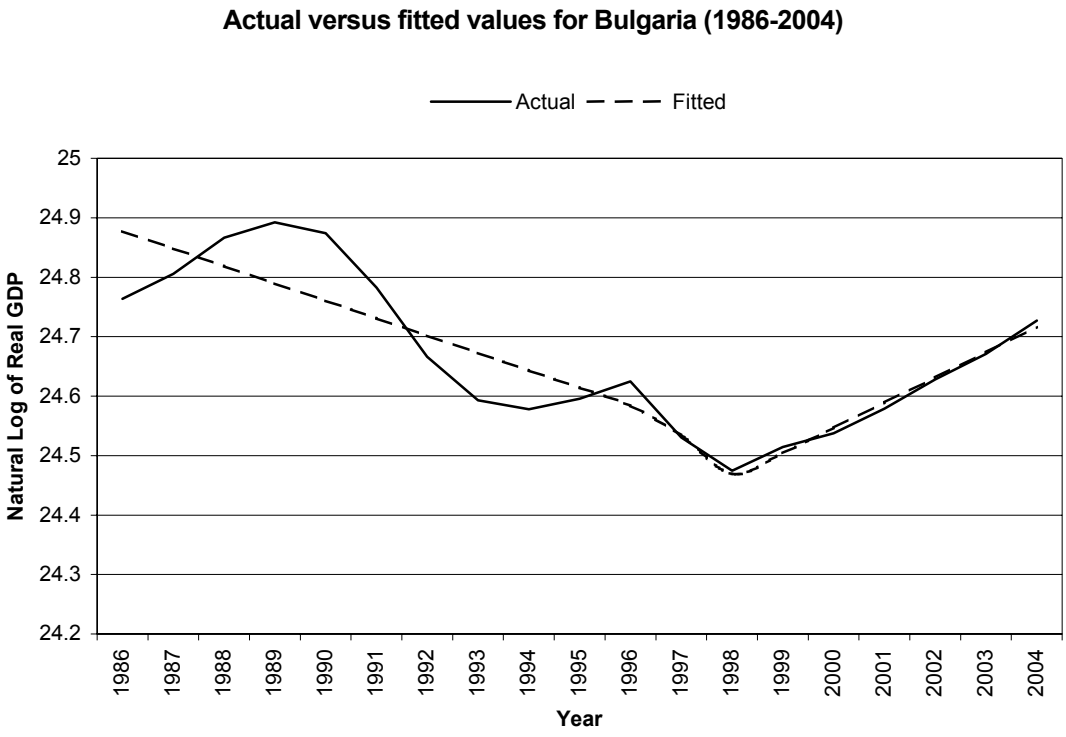
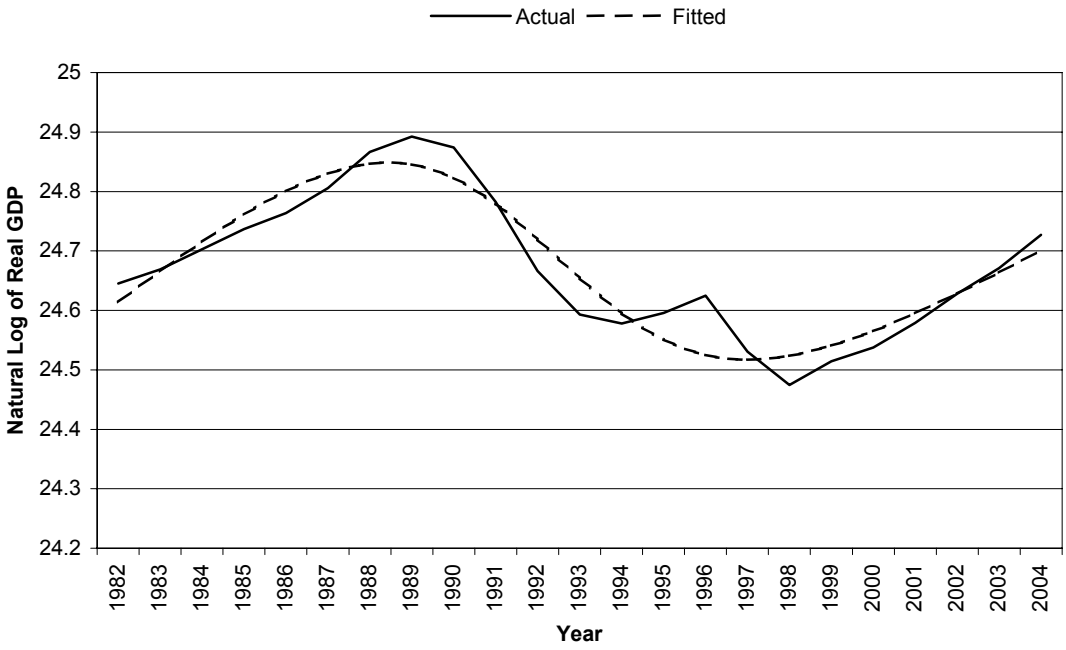


Figure B9a



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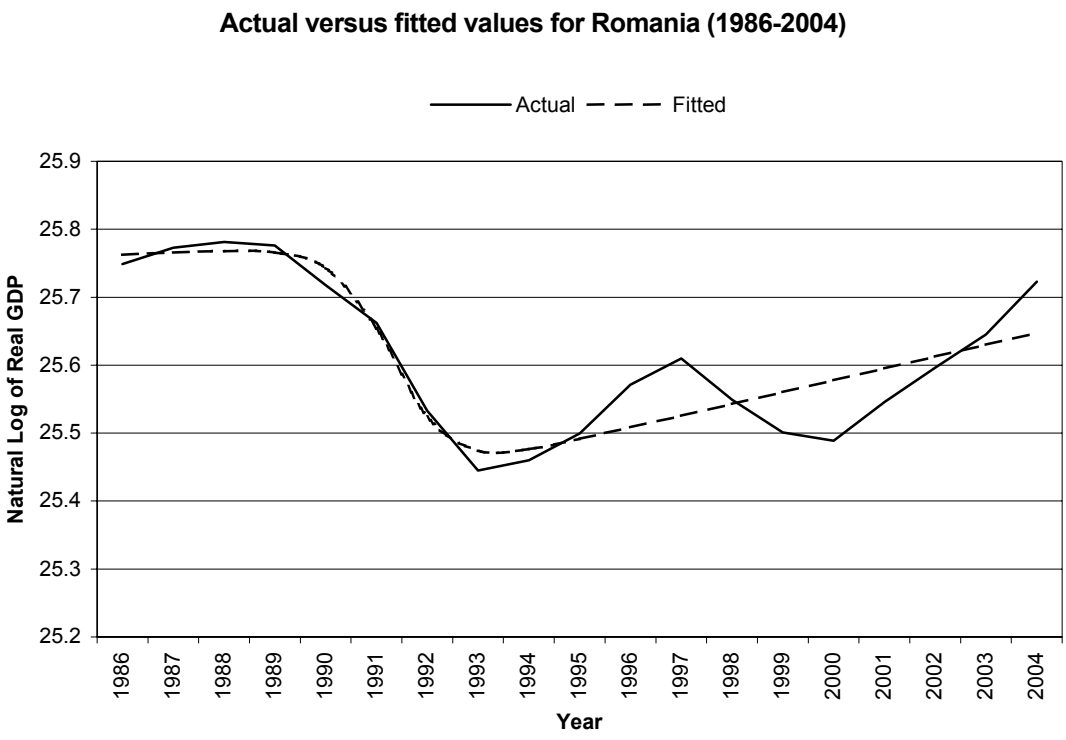

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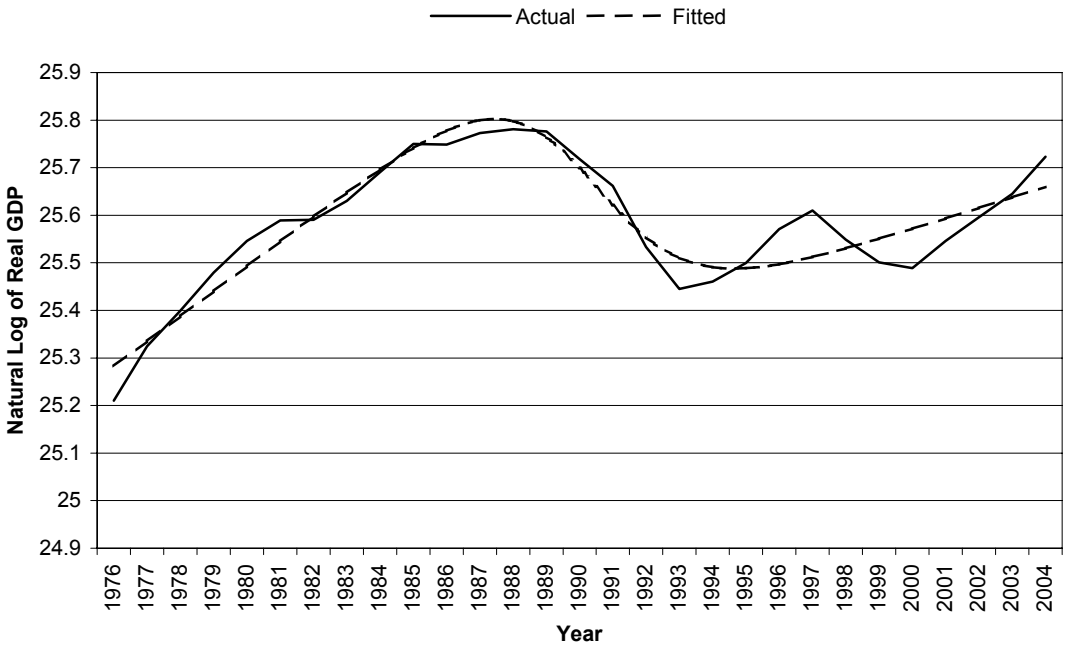
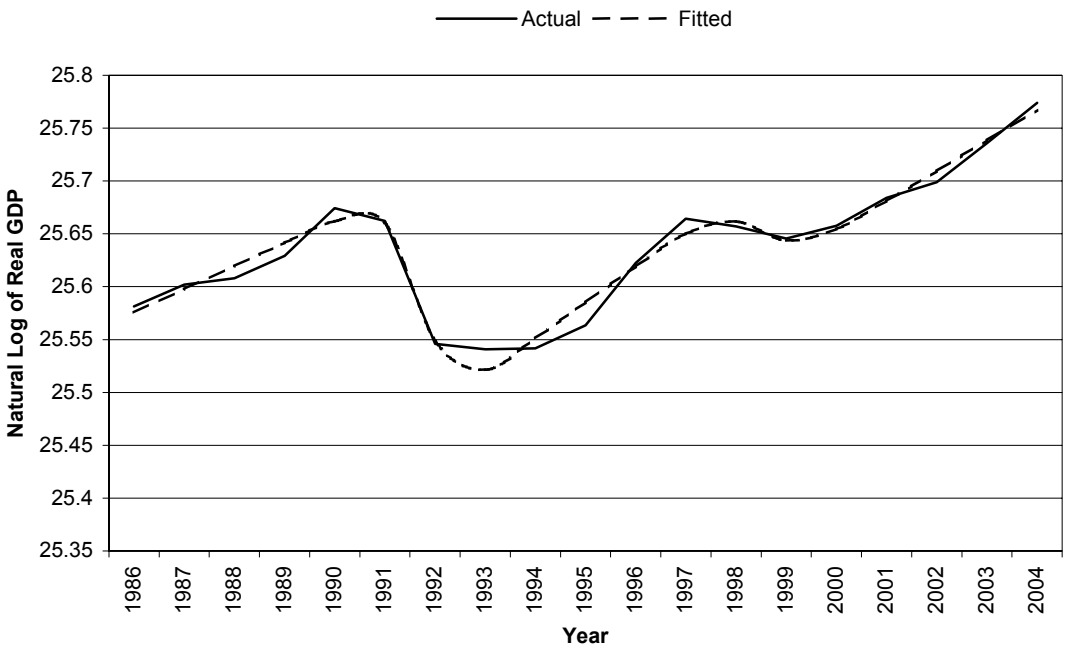


Figure B11

Double smooth transition plot for the Czech Republic (1986-2004)



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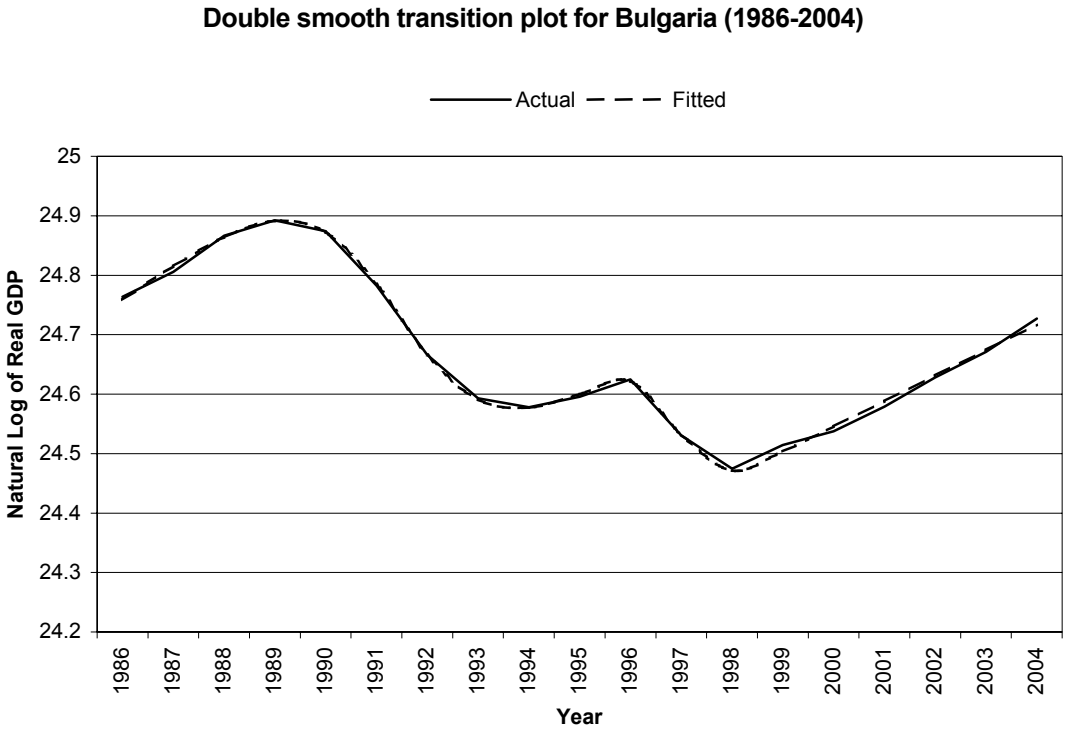
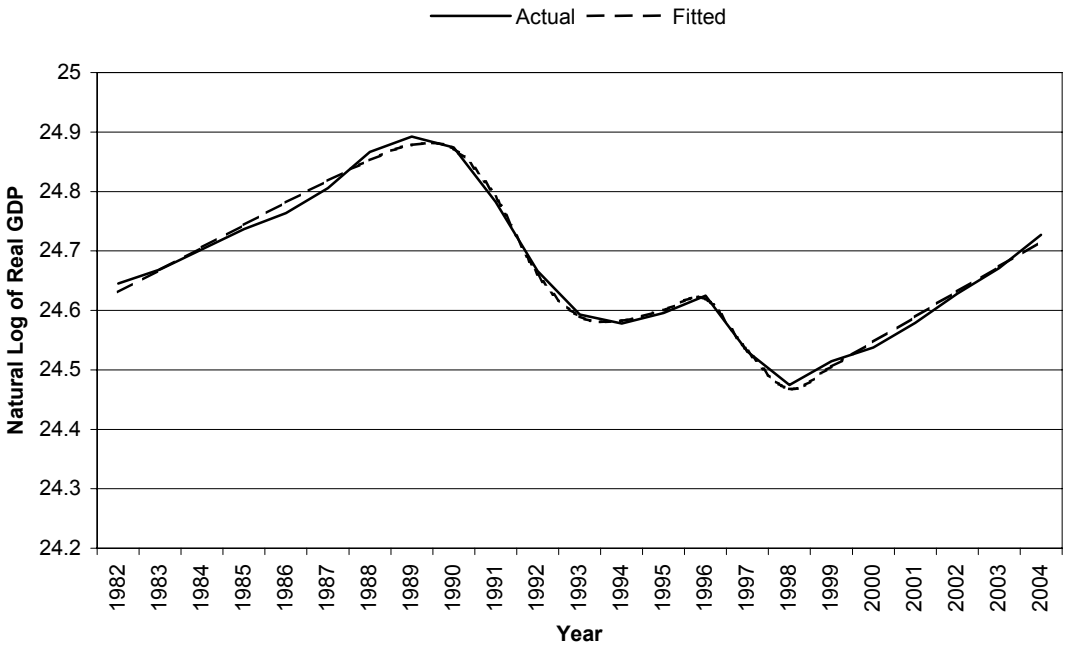


Figure B12a



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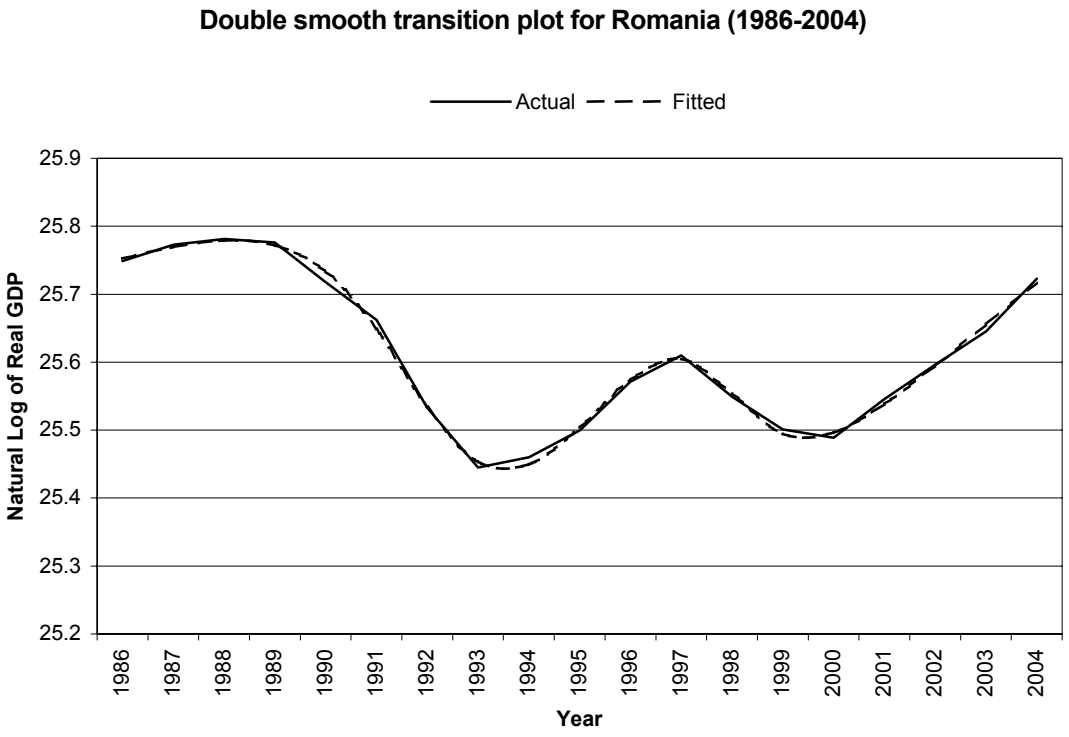

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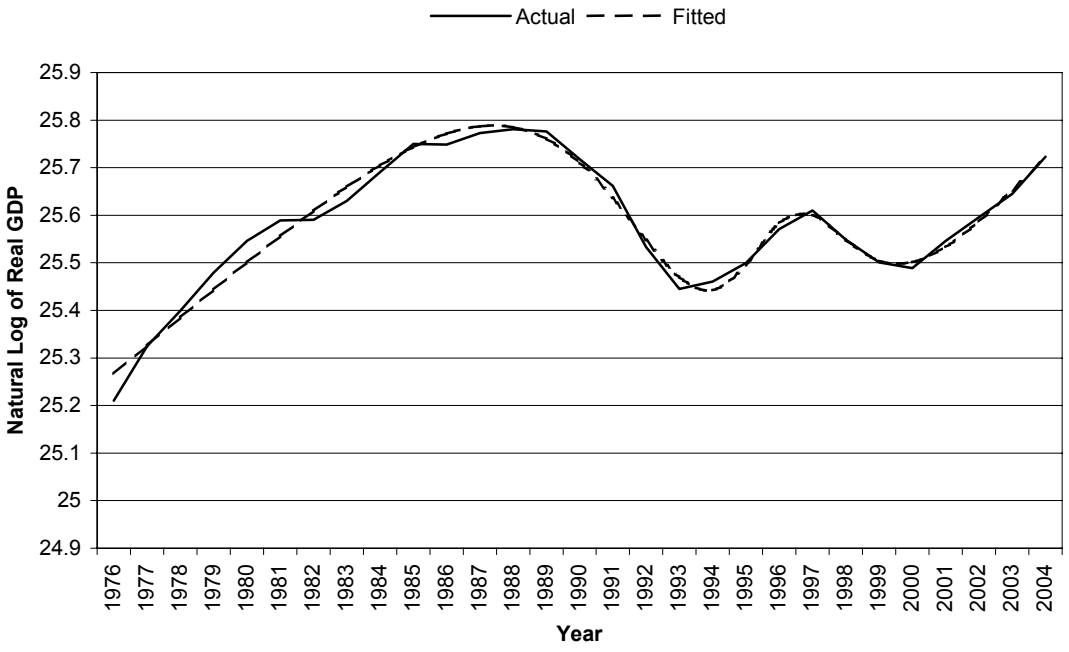

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