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Business Cycles in EU Member States

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Contents:

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Non-technical summary

In the paper we analyze the business cycles within the EU-15, the EU-11 as well as within CU-core countries consisting of Austria, Belgium, Gemany, the Netherlands, and France. The criteria for classifying a country as a core country are its membership in the EMS and stable bilateral exchange rates over a longer period of tim. Although Luxembourg would clearly classify as a core country as well, we exclude it from the core group because of its special status as an international banking place. Our main interest focuses on the question whether there are statistically significant differnces in the per capita growth rates between the EU-states or not. To provide an answer to this question we use One-Way- as well as Two-Way-Anova techniques to decompose the variation in the series into time-specific effects which are common to all countries, country-specific characteristics, and into shocks which are country-specific. A comparison of the size of the different sources of variation gives insights of the importance of the various shocks. These results are used to draw some conclusions about future stabilization policies in EMU.

The main results of the paper are that there are considerable country-specific effects for the EU-15 and the EU-11, but not for the core countries. Within the EU-11 country-specific effects dominate common shocks for Luxembourg, Ireland, Finland, and Portugal. Given that these countries are „small“ in their contribution to the GDP of EU-11, it seems likely that EMU as a whole will not seriously be disturbed by country-specific shocks hitting these countries. But the opposite will of course not be true. Furthermore, for EU-15 we find no significant country characteristics which leads to the conclusion that the European economies are not moving on diverging growth paths in the long run. But over a business cycle divergence may well occur because persistence in the growth rates differs across countries. Considered as a whole, the starting conditions for EMU are quite good and there is no serious indication of an inherent instability in the system with respect to output growth.

Abstract

The paper investigates the business cycle relationships between the EU-15, the EU-11, as well as the EU-core countries for the period 1971 to 1997. Emphasis is put on the question whether there is a synchronization in the national business cycles or not. Using One-way- and Two-way-Anova techniques the results show that country-specific shocks are important to the smaller countries such as Luxembourg, Ireland, Portugal, and Finland. But for most of the EMU-members common shocks are much more important than country-specific shocks. In addition there is no indication of significant differences in the national growth rates, i.e. the European countries do not move along diverging growth paths. Nevertheless, departures over the business cycles are possible because persistence in output growth differs across countries.

Zusammenfassung

In dem Beitrag wird der konjunkturelle Zusammenhang zwischen den EU-15, den EU-11 und den “Kern”-EU-Staaten für den Zeitraum von 1971 bis 1997 dahingehend untersucht, ob zwischen den Staaten ein konjunktureller Gleichlauf besteht oder nicht. Eine One-Way- und eine Two-Way-Anova-Analyse zeigt, daß insbesondere für die kleineren Länder länderspezifische Schocks eine beträchtliche Bedeutung haben. Demgegenüber dominieren bei den Kernländern deutlich die “common shocks”. Da keine länderspezifischen Unterschiede feststellbar waren, kann daraus der Schluß gezogen werden, daß sich die europäischen Staaten entlang eines einheitlichen Wachstumspfades entwickeln. Gleichwohl können kurz- bis mittelfristige Abweichungen eintreten, da die Persistenz im Output für die einzelnen Länder unterschiedlich ist.

I. Introduction

Since the decision of the members of the EU to constitute a monetary union there was much debate in the literature whether Europe is an optimal currency area or not[1]. Despite of the possible advantages of a common currency several authors addressed the question how the necessary adjustment processes will be in EMU when exogenous shocks hit the economy. Contrary to the past several policy instruments are no longer available to the member states, namely the exchange rate as well as the monetary policy instruments. This loss of national instruments which were partly useful in the past to protect one country against foreign shocks, calls for new adjustment mechanisms as shock absorbers[2]. These new adjustment mechanisms are the more in need the more various types of shocks hit the economies differently. It is likely that most of the burden of adjustment in the future will translate into the labor markets[3]. Labor mobility and flexible wages across countries and regions then will have to serve as shock absorbers. But compared with the United States (Blanchard and Katz 1992) European labor market mobility is rather low. An alternative and/or additional adjustment mechanism might use capital mobility to absorb adverse shocks across the nations (Mueller and Heinemann 1999).

But despite of the different origins of the shocks another requirement for a stable EMU is the synchronization of the national business cycles. Whether there is already a European business cycle has, among others, been analyzed by Artis and Zhang (1995) and Karras (1996). Artis and Zhang analyze whether the former ERM countries including Italy moved towards the German business cycle. They conclude that there was a high degree of synchronicity among the countries, using deviations from trend of industrial production as a measure of business cycle fluctuations. Karras (1996) looked at the European OECD countries for the period 1951-90 by decomposing fluctuations in real GDP into common and country-specific shocks. He finds that country-specific

[1] To mention only a few, see e.g.Bayoumi and Eichengreen (1994, 1996), Bayoumi and Prasad (1997), Caporale and Pittis (1998), De Grauwe and Vanhaverbeke (1993), Gros (1996), Ricci (1997) and the survey conducted by Bean (1992).

[2] For a detailed analysis of the impact of the exchange rates as well as the interest rates on bilateral growth differentials as well as on bilateral differentials in unemployment rates, see Mueller and Buscher (1999).

[3] See Puhani (1999) for details on this issue.

shocks were more important than the common shocks in the past. From these findings Karras concludes that a common European currency union will have few stabilization benefits. Using the same methodology Bayoumi and Prasad (1997) and Stockman (1988) compare U.S. and European industries and areas to provide an answer whether Europe will be an optimum currency area. Bayoumi and Prasad draw attention to two criteria, namely the level of industrial diversification and the relative importance of region- and industry-specific shocks on the one hand, and the level of labor market integration in the U.S. and Europe on the other. They find that there are no important differences in the industrial diversification as well as in the nature of shocks for the two regions. But important differences are reported for interregional labor mobility as one future adjustment mechanism for the European countries. From this lack of mobility they conclude that large wage differentials across European countries could remain in the currency union without disturbing the system as a whole. Furthermore, these wage differentials across Europe should be kept flexible to avoid disruptions from country-specific shocks[4].

Analyzing the EMU member states with respect to the question whether they form an optimum currency area or not raises at least three different aspects: the first relates to the question whether shocks will hit EMU symmetrically or asymmetrically[5]. The second point refers to the propagation mechanism of the different shocks and the third issue is concerned with a disaggregated view in the sense that different sectors of the economy will be affected differently when facing exogenous shocks. Closely related to this point is the question whether the member states obey a rather homogenous structure of the economy or if spatial diversification prevails. In the present paper we restrict ourselves to the first question. The second aspect how different shocks are transmitted through the economies relates to the SVAR approach. In this paper we do not follow this line. One reason for using alternative statistical procedures is that most of the SVAR literature on this issue deals with models for single countries, so that there is no direct interrelationship between the different countries analyzed.

[4] Additional results on regional convergence as well as regional specialization are given in Abraham and Van Rompuy (1992) and De Nardis, Goglio and Malgarini (1996). An extensive survey on this issue is provided by Dohse and Krieger-Boden (1998).

The paper is organized as follows. In the next section we start with some summary statistics and analyze the question whether European business cycles are synchronous or not. Section 3 emphasizes the differences in the amplitudes of the European business cycles by performing a One-Way-ANOVA. Decomposing the variations in the growth rates into country-specific effects, country-specific shocks as well as common shocks proceeds in section four by estimating a balanced panel with fixed effects. Conclusions are drawn in the final section. This section also contains some suggestions for future research.

II. The Economic Performance of EU-15

Before proceeding to the empirical results we first briefly discuss the data used in the study and some of its characteristics. All data are annual and taken from the appendix of the Annual Report of the German Council of Economic Experts (1998/99). The use of annual data is dictated by the non-availability of quarterly data for the whole period, especially for the small countries such as Luxembourg and Ireland. We start our empirical investigation in the first half of the seventies when the former Bretton Woods system came under serious pressure. Because the data listed in the "International Tables" of the Annual Report are given in national currencies, we transformed them into Ecu, using the annual average Ecu exchange rate in 1991[6]. For national GDP data we deflated the figures by population and then transformed them into growth rates by taking the first differences of the logs.[7] In the case of Germany we only used West German data to avoid problems in the estimations due to the break in the series in 1991

[5] For a recent discussion on asymmetric shocks and their possible implications, see Belke and Gros (1988).
[6] To choose a base year for the conversion into Ecu is to some extend arbitrary. Our choice for the year 1991 results from the fact that all the European data expressed in real terms published in the appendix of the German Council of Economic Advisers use 1991 as the base year.
[7] Using per capita data instead of GDP growth rates for the economy as a whole takes account of several problems. First, per capita growth is highly correlated with GDP-growth. The lowest correlation coefficient applies to West Germany with 0.93 for the period 1971 to 1997 and the coefficient is highest for Finland with 0.999. Second, per capita data account for migration effects which became important during the last years as a consequence of the fall of the iron curtain. Third, using per capita data we can apply the same data set when briefly discussing some convergence properties across the European countries.

when considering German data. Yet another argument to exclude East Germany is the still special situation there and the unusual structure of the economy compared with other industrialized countries.

Figure 1: Real per capita GDP-growth in EU-15

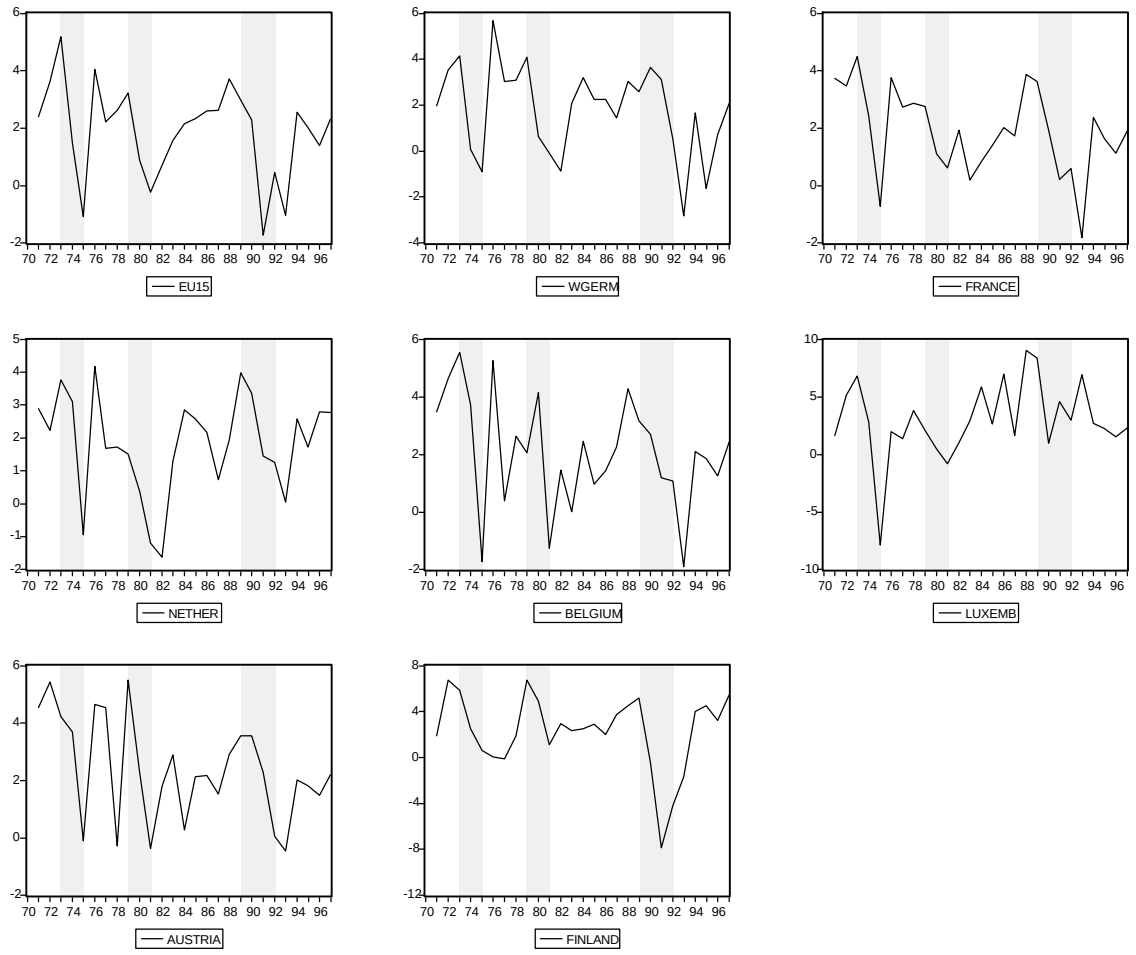
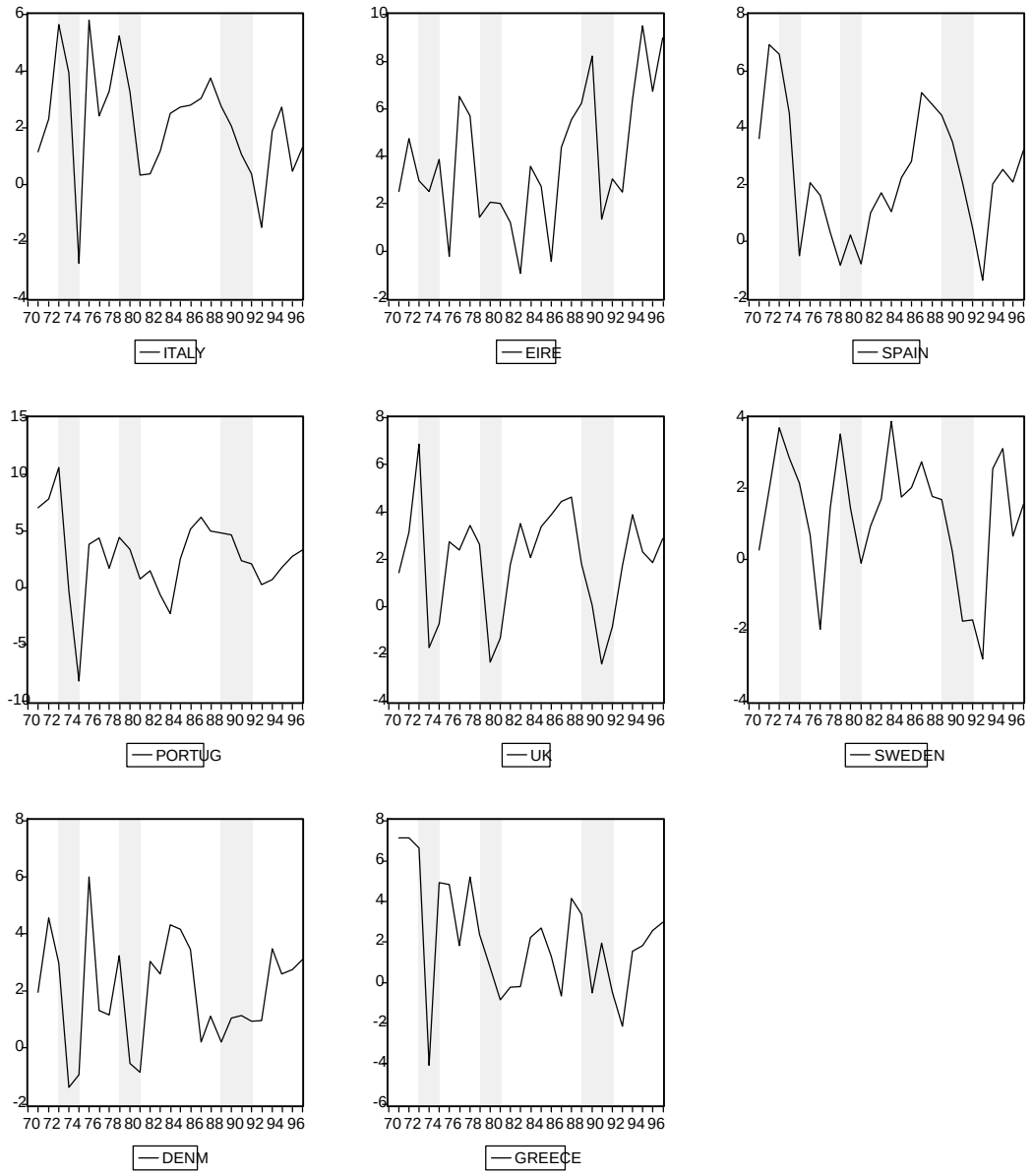


Figure 1 provides an overview of the real per capita GDP growth for EU-15 as a whole as well as for the single countries. The shaded areas represent recessionary phases in

Figure 1 continued: Real per capita GDP-growth in EU-15



the business cycle with EU-15 taken as the reference.[8] Table 1 below presents some summary statistics such as mean, standard deviation, maximum and minimum values, and the Jarque-Bera statistic to test for normality.

[8] We define a recessionary phase as the time periods with negative changes in the real GDP per capita as one criteria. The second criteria relates to the time period before the trough is reached. Clearly, there is some arbitrariness in the definition. But for the purpose at hand it should only serve as a rough guide for the countries under investigation.

Common to all European countries is the recession in 1975 after the first oil crisis. Most of the countries reached the trough in 1975, except for Sweden, Finland, and Ireland. Figure 1 also reveals that the crisis hit the economies quite differently. The decline in per capita growth ranges from roughly zero to about –8 percent (Portugal).

Table 1: Summary Statistics 1971 – 1997 – Per Capita GDP Growth

Country	Mean	Standard Deviation	Max	Min	JB-Stat
EU-15	0.019	0.016	0.052	-0.017	1.133
EU-11	0.019	0.017	0.049	-0.018	2.011
Austria	0.024	0.018	0.055	-0.005	0.968
Belgium	0.021	0.019	0.056	-0.019	0.408
West Germany	0.018	0.020	0.057	-0.028	0.975
France	0.019	0.015	0.045	-0.018	0.720
Finland	0.023	0.033	0.068	-0.018	10.709*
Ireland	0.038	0.028	0.095	-0.010	0.931
Italy	0.022	0.020	0.058	-0.028	0.611
Luxembourg	0.030	0.033	0.091	-0.079	11.077*
Netherlands	0.018	0.015	0.042	-0.016	2.044
Portugal	0.028	0.036	0.106	-0.082	7.709**
Spain	0.023	0.022	0.069	-0.014	0.806
Denmark	0.019	0.019	0.060	-0.014	0.465
Sweden	0.013	0.018	0.039	-0.028	2.334
Great Britain	0.019	0.023	0.069	-0.024	0.568
Greece	0.021	0.028	0.071	-0.041	0.164

Note: JB-Stat = Jarque-Bera Statistic to test for normality. *, (**) indicates that normal distribution is rejected at the 1 (5) % level of significance

The second major recession in the beginning of the eighties is much more alike to the countries, but this time Portugal is as an exception. The final big slowdown in 1991 – 92 hits the Finnish economy most, but leaves Denmark and Luxembourg nearly unaffected. Therefore, Figure 1 suggests that business cycles in Europe are much alike in the timing, but considerable differences exist to the extend single economies are hit by

a recession. The second point to be noted is that for the smaller countries there is some indication that they could isolate their developments at least partly from the major European economies. From 1971 to 1997 the EU-states grew at a rate of 1.9 percent on average, see Table 1.

But four countries deviate significantly from this European average. These are Luxembourg, Ireland and Portugal with average growth rates of roughly three percent or even higher and Sweden with a considerably lower growth rate of only 1.3 percent. Across the other countries there are no remarkable differences in the economic performance. But the variability of growth measured as the standard deviation of the growth rates varies remarkably across countries. Compared with the EU-15 variability, growth is much more volatile in Finland, Luxembourg and Ireland. Two of these three countries were already mentioned with respect to growth rates which are above average. The highest growth rates obtained in the sample period range from nine to ten percent – again for Portugal, Luxembourg and Ireland. But also the sharpest decline in economic growth happened in two of these countries, namely Luxembourg with –7.9 percent and Portugal with –8.2 percent. Testing for normality of the growth rates for later purposes leads to a rejection for Luxembourg, Finland, and Portugal at least at the five percent level of significance, see last column in Table 1. Obviously Luxembourg, Portugal, Ireland, and to a minor extent Finland seem to play a special role within the EU.

Table 2: Contemporaneous Correlation of Per Capita Growth

	A	**B**	**DK**	**G**	**FI**	**F**	**GR**	**IR**	**IT**	**LU**	**NL**	**P**	**SP**	**SW**	**UK**

A	1	.62	.34	.62	.36	.71	.35	-.05	.61	.20	.54	.63	.56	.21	.25
B	***.83***	1	.32	.62	.44	.82	.44	.09	.79	.41	.66	.65	.68	.44	.30
DK	***.28***	***.46***	1	.49	.23	.32	.43	-.10	.34	.28	.42	.28	.17	.24	.58
G	***.78***	***.72***	***.04***	1	.12	.66	.52	-.08	.69	.31	.65	.52	.41	.22	.38
FI	***.22***	***.38***	***.85***	***-.18***	1	.51	.30	.25	.43	.12	.20	.31	.38	.75	.53
F	***.74***	***.96***	***.65***	***.57***	***.58***	1	.55	.16	.75	.36	.61	.71	.66	.39	.50
GR	***.49***	***.62***	***.74***	***.38***	***.44***	***.63***	1	.14	.22	.08	.35	.35	.34	.24	.43
IR	***.55***	***.67***	***.64***	***.10***	***.87***	***.75***	***.45***	1	-.07	-.02	.25	.07	.25	.08	.12
IT	***.79***	***.89***	***.45***	***.46***	***.39***	***.88***	***.55***	***.68***	1	.43	.60	.60	.45	.50	.43
LU	***-.67***	***-.88***	***-.44***	***-.52***	***-.50***	***-.89***	***-.51***	***-.75***	***-.74***	1	.47	.52	.43	.04	.45
NL	***.82***	***.87***	***.51***	***.71***	***.51***	***.87***	***.56***	***.71***	***.67***	***-.90***	1	.47	.59	.27	.35
P	***.71***	***.67***	***-.11***	***.71***	***.02***	***.49***	***.26***	***.43***	***.43***	***-.70***	***.72***	1	.65	.04	.46
SP	***.93***	***.94***	***.45***	***.71***	***.40***	***.87***	***.68***	***.71***	***.86***	***-.83***	***.89***	***.75***	1	.36	.44
SW	***.53***	***.70***	***.85***	***.11***	***.83***	***.84***	***.65***	***.86***	***.81***	***-.68***	***.64***	***.13***	***.68***	1	.43
UK	***-.02***	***.10***	***.81***	***-.35***	***.92***	***.36***	***.24***	***.63***	***.15***	***-.18***	***.26***	***-.32***	***.09***	***.68***	1

Note: figures below the diagonal refer to the sample period 1990-97; figures above the diagonal refer to the sample period 1971-97

At least for Luxembourg this statement is confirmed by looking at the contemporaneous correlation of per capita growth which are displayed in Table 2. This table contains bivariate correlation coefficients first for the whole sample period 1971 to 1997, these figures are given in the upper triangle of Table 2, and second for the period 1990 to 1997, these are the bold figures below the main diagonal. Starting with the lower part of Table 2, the perhaps most striking result is the high negative correlation between Luxembourg and all the other countries since the nineties. This result is even more puzzling when looking at Belgium, keeping in mind that both countries perform a small monetary union for a long time. For Belgium we find a strong positive correlation with the other EU-countries, being somewhat weaker for the Nordic countries and lowest for the UK. There are some additional patterns in the Table. As a tendency per capita growth in the Nordic countries comes up with higher contemporaneous correlations with the UK as well as within the Nordic region than for the continental European countries.

Another point to comment on is the rather low correlation of Germany with France and with Italy as well as with the Nordic countries. British and German business cycles are negatively correlated which means that business cycle movements in both countries move in the opposite direction. The German business cycle is highly correlated with Austria, the Netherlands, and Belgium. From this one can conclude that there is no

reason to fear that Germany will dominate in EMU. Comparing the correlation coefficients for the whole as well as for the shorter period and ignoring Luxembourg, the coefficients are by and large higher than those obtained for the whole period. But the picture is by no means unique in the sense that this statement will hold for all of the fifteen countries. A counterexample can be seen in the UK.

Further insights into the European business cycles can be obtained by calculating bivariate cross correlation coefficients. For these figure to have a meaningful interpretation the data should be stationary. Therefore, we first looked at the autocorrelogram of

Table 3: Cross Correlation with EU-11 GDP Growth Rates

Country	**Lag**					**Lead**			
	-4	**-3**	**-2**	**-1**	**0**	**+1**	**+2**	**+3**	**+4**
Austria	-.20	-.13	.05	.22	.75*	.26	-.21	.32	-.08
Belgium	-.10	.05	.02	.15	.82*	.18	-.03	.02	-.07
West Germany	-.15	-.06	-.20	.33	.79*	.07	-.07	.11	-.14
France	-.30	.09	.22	.28	.72*	.12	-.20	-.01	-.10
Finland	.13	.00	.13	.23	.15	-.11	-.28	-.20	-.33
Ireland	-.07	-.28	.05	.26	.05	.21	-.15	-.27	-.00
Italy	-.08	.14	-.08	-.02	.80*	.15	-.17	.01	-.12
Luxembourg	-.13	.09	.04	.01	.47*	.09	-.13	-.21	-.16
Netherlands	-.18	.06	.18	.22	.73*	.14	-.11	-.12	-.17
Portugal	-.18	.02	-.04	.27	.75*	.25	-.09	.02	-.13
Spain	.13	.15	.23	.33	.63*	.25	-.17	-.13	-.12
Denmark	.19	.09	-.09	.23	.39*	-.52*	-.43*	-.07	-.22
Sweden	.28	.14	.02	.18	.31	-.07	-.17	-.19	-.37*
Great Britain	.09	.29	.07	.48*	.36	-.31	-.39*	-.28	-.29
Greece	-.16	.00	-.06	.61*	.49*	-.03	.01	-.07	-.05

Note: * indicates a 5 % significant cross correlation coefficient at the corresponding lead/lag. Lag: c[dlog $y^{EU}(t)$, dlog $y^{Country}(t-i)$]; Lead: c[dlog $y^{EU}(t)$, dlog $y^{Country}(t+i)$]; c = cross correlogram; country = single European country, EU = EU-11, i = 0,..,4. For the EMU-countries their contribution to the EU-11 GDP has been subtracted.

each series. If the Q-statistic calculated for ten lags indicated that growth follows a white noise process, no further tests were applied. This happened to ten countries as well as to the GDP growth rates of EU-11. In five cases, namely Finland, Portugal,

Spain, Sweden, and the UK, the Q-statistic rejected the white noise hypothesis at the five percent level of significance. For these cases we performed the augmented Dickey-Fuller-test afterwards. Except for Spain, for the other four countries nonstationarity has to be rejected at the 1 % level of significance. For Spain stationarity can be accepted at the 5 % level. From these results it follows that the cross correlation coefficients can be interpreted in the usual manner. Table 3 presents the results.

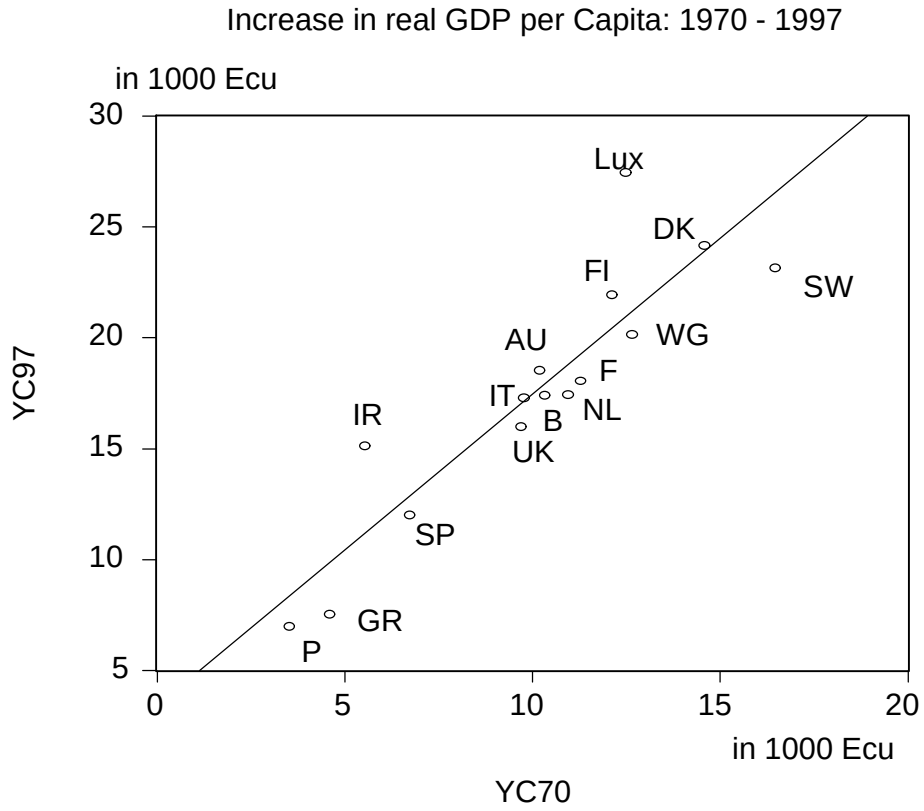
The cross correlation coefficients are calculated for the whole sample period using four leads and lags in each case. We take EU-11 as the reference value. If a coefficient is larger than twice its standard error we consider it as significantly different from zero. These coefficients are marked with an asterix in Table 3. Starting with the EMU-member countries there is no statistically significant lead or lag structure in the growth rates with respect to EU-11 growth. For nine out of eleven countries we find a significant contemporaneous correlation with the European business cycle, being highest for Belgium and lowest for Luxembourg. But it has to be noted that for two countries, Finland and Ireland, there is no statistical link to the European business cycle.

Except for the last mentioned countries the contemporaneous cross correlations are higher or of equal size for the participating countries than for the not participating countries. This may be taken as some evidence of a higher degree of synchronization across the EMU-member states than the EU as a whole. Following the results, the Danish business cycle shows a clear leading pattern up to two years. In addition the Danish business cycle moves in the opposite direction compared with EU-11. The Greek business cycle lags one year behind, although there are also contemporaneous effects with EU-11. No clear-cut pattern can be obtained from the British data; there are statistically significant leads and lags, but no contemporaneous effects. For Sweden there seems to be a four years lead; but this results seems somewhat implausible and may be due to the short data series.

So far we addressed the question of business cycle synchronization among the EU-15. Now we take a brief look at the convergence process across Europe. For this issue we look at the developments of real GDP per capita for the period 1970 to 1997. Figure 2

shows the corresponding scatter plot with the regression line included. On the horizontal axis real per capita GDPs in 1970 and on the vertical axis real per capital GDPs in 1997 are plotted. Additionally we show the estimated slope of the OLS regression of 1997 GDPs on 1970 GDPs. Roughly 80 percent of the variation in per capita income can be attributed to the income variation that already existed in 1970, as the first equation in Table 4 below shows.

Figure 2: Real per capita GDP in 1970 and 1997



Whereas the constant term is statistically not different from zero at the usual significance levels, the slope coefficient is different from zero at the one percent level. The slope coefficient tells us that despite of the constant term per capita income grew of around 40 % compared with the 1970 per capita income level of the countries. The

statistically insignificant intercept suggests that there was no autonomous increase in per capita income during this time period.

For countries on or close to the regression line in Figure 2 we can conclude that their per capita income growth evolved proportionately to the starting point in 1970. From this it follows that among these countries neither convergence nor divergence took place. The regression line separates those countries which come up with an over- or under-proportionate per capita income growth. Dots above the line indicate over-proportional and dots below the line under-proportional growth. Only in Luxembourg,

Table 4: Least Squares Results of Growth and Convergence Estimates for EU-15

	PER CAPITA GROWTH:	**β-CONVERGENCE**
Endogenous Var.:	**Log (YC97)**	**Average Growth Rates**
Constant	3.422 (1.694)	0.038 (5.485)
Log(YC70)	1.404 (7.407)	-0.00719 (2.321)
R2(adj.)	0.794	0.239
DW-Statistic	2.280	1.575
SER	2.580	3.600
No. of Obs.	15	15

Remarks: Empirical t-values are reported in brackets, R2(adj) is the coefficient of determination adjusted for degrees of freedom, DW-Stat is the Durbin-Watson statistics for first order serial correlation, and SER is the standard error of regression.

Ireland and, to a lesser extent, in Finland per capita income grew faster than the average, whereas Portugal, Greece and Sweden show up with an under-proportionate growth. For the remaining nine countries their relative position within the Community remained more or less unchanged compared with their position in 1970. With respect to EU-11, the countries Luxembourg, Finland, and Portugal show a different growth performance than the other ones.

Further insights into the convergence process can be obtained by looking at the so called unconditional β-convergence. This convergence concept provides information whether countries with a per capita income below average at some starting point catch

Figure 3: σ-Convergence in Europe

up in the course of time to those countries with per capita income above average. Catching up implies that the former poor countries show up with higher growth rates than the former rich countries. Estimating the so called Barro regression for EU-15 for the period 1970 to 1997 leads to the results presented in the last column of Table 4. Both coefficients are statistically significant at the five percent level at least and they show the expected signs. Using the estimated slope coefficient to calculate the speed of convergence one obtains an estimated rate of 0.8 % (see Sala-i-Martin [1996]). This figure means that the relative distance between a poor and a rich country reduces by 0.8 % per annum. Thus we find convergence within the EU-15, but it takes place only very slowly.

Given that β-convergence exists among the European countries, one can look additionally at the σ-convergence which is plotted for the EU-15 and the EU-10 (Luxembourg excluded) in Figure 3. σ-convergence is based on the standard deviations of the log of per capita GDP. σ-convergence prevails if the standard deviations decline in the course of time. As Figure 3 shows this was the case in the early seventies as well as from 1985 onwards. From 1985 on σ-convergence was stronger for the EU-10 countries than for the EU as a whole. For the subgroup the standard deviation declined from 0.42 in 1970 to 0.33 in 1997, whereas for the EU-15 this measure fell from 0.46 to 0.39. Considered as a whole there is convergence among the European countries, but the process differs somewhat for EU-15 and EU-11.

III. Differences in Business Cycle Fluctuations within EU-15

In the previous section we primarily looked at the average growth rates of the EU-member countries. But despite of an equal mean in the national growth rates, there is still another source with could lead to a temporary divergence in the economic developments, namely the dispersion around the mean. Countries with more volatile growth rates in both directions are able to put pressure on the whole system in at least two ways. A nationally overheating economy usually experiences pressure on the price system leading to a new or to an enforced inflationary process. In the past national central banks could prevent this situation by conducting a tight monetary policy. This mechanism is no longer available under EMU. If the overheating economy is large relative to EU-11, the ECB may decide to follow a restrictive monetary policy and thus affecting adversely the development in the other countries. In the opposite case of a deep recession with high unemployment in a country a coordinated policy mix eventually could help to overcome this situation in the past. Again, on a national base a policy like this can no longer be deployed due to the restrictions imposed by EMU. Therefore,

Table 5: ANOVA-Results for Selected EU-Areas – 1971 – 1997

	EU-15:	EU-11	EU-Core
Hypothesis: Means between the series are equal			
F-Statistic	1.71*** (14, 120)	1.65***(10, 286)	0.52 (4, 130)
Between SS	0.0137 (14)	0.0100 (10)	0.0006 (4)
Within SS	0.2234 (390)	0.1723 (286)	0.0399 (130)
Total SS	0.2372 (404)	0.1823 (296)	0.0406 (134)
Hypothesis: Variances between the series are equal			
Bartlett-Test	59.50* (14)	51.01* (10)	3.46 (4)
Levene-Test	2.39* (14, 390)	2.70* (10, 286)	0.83 (4, 130)
Brown-Forsythe-Test	2.19* (14, 390)	2.44* (10, 286)	0.68 (4, 130)

Note: *, (**), (***) indicates rejection of the null at the 1, (5), (10) % level. SS = sum of squares
Core = Austria, Belgium, West-Germany, the Netherlands, and France. Figures in brackets are the degrees of freedom.

it is not only important for the business cycles to move synchronous, but the cycles should also exhibit a similar degree of dispersion around the mean. To test for a common mean as well as a common variance, we perform a simple analysis of variance for the EU-countries. The results of the ANOVA are given in Table 5 for the whole sample period.

In the upper part of Table 5 we test for equality of the means of per capita growth for the EU-15, the EU-11 as well as for the EU-core, consisting of Austria, Belgium, West Germany, the Netherlands, and France. The corresponding F-statistics reveal that differences in the means are important for EU-15 as well as for EU-11, but not for the members of EU-core. Nevertheless, the evidence is rather weak because equality of the means is rejected at the ten percent level only. A closer inspection by dividing the sample period into different sub-periods reveals that differences in the mean were not present for the seventies and the eighties, but are highly significant for the nineties, see Table A2 in the appendix.

More important than differences in the average growth rates are the differences in the variances. The test of equality of variances between the series was performed by using the Barlett-, the Levene- and the Brown-Forsythe-procedure[9]. Basically, these test distinguish with respect to a violation of the assumption of normality. In our case all tests reveal the same information, namely that equality of the variances between the series is strongly rejected at the one percent level of significance for EU-15 and EU-11, but not for the EU-core countries. These results pertain when running the tests for the sub-periods. For all sub-periods the Barlett-test rejects equality of variances for EU-15 and EU-11, but not for EU-core. Differences in the test results occur for the seventies. Here the other tests indicate that the assumption of a common variance cannot be rejected at the usual significance levels. These conflicting results are due to a lack of normality in the seventies, and the Barlett test is sensitive to a violation of this assumption. The more important results in our view relate to the differences in volatility which are still present in the eighties and the nineties. For the EU-core all tests give the same results. Equality of the variances cannot be rejected neither for the whole period nor for the three decades.

Increasing the number of members of EU-core step by step with the omitted countries from EU-11 and eliminating the newly added country when the tests reject equality of variance, it is Luxembourg, Finland and Ireland which caused the tests for EU-11 to fail.

IV. On the Importance of Country-specific and Common Shocks

As a next step in the analysis we decompose the variations in the series into characteristic of a country i, into country specific shocks as well as into shocks which are common to all economies. To proceed along this line, we set up the following formal

[9] The Barlett test of homogeneity of variances is based on the deviations of the data from the mean and crucially depends on the normality assumption. A robust measure of the central location is used instead in the Levene test. Brown and Forsythe modified the Levene test by using an even mor robust measure of the central

model which was also applied by Karras (1996), Stockman (1988) and Bayoumi and Prasad (1997) although in a slightly different context.

Let Δy_{it} denote real per capita GDP growth in country i at time t, then the regression we run takes the form

$$\Delta y_{it} = c_i + v_t + \varepsilon_{it} \qquad (1)$$

with c_i a country-specific constant, v_t a shock at time t common to all countries, and ε_{it} a country i specific shock at time t. c_i as well as v_t are (0,1). The country-specific constant takes on the value 1 for country i, and 0 elsewhere. Correspondingly, the time dummies are 1 for a certain year and zero elsewhere. The constant for each country i is introduced to allow for country specific issues, captured not elsewhere in the model. The country i specific shock at time t, ε_{it}, is unobservable and is, therefore, captured by the residuals of the regression. In terms of an analysis of variance, c_i are the fixed economy effects and v_t are time-effects. If the fixed-effects assumption is supported by the data, then the implication is that the countries under investigation move along different growth paths, i.e. they are diverging. Furthermore, a comparison of the common shocks v_t with the country-specific shocks ε_{it} provides evidence on the relative importance of both types of shocks an economy is confronted with. Supposed that the country-specific shocks are more important than the common shocks, this will be strong evidence against the expected stability of EMU, because the dominance of country specific shocks will tend to put pressure on the system as a whole. On the contrary, if the common shocks dominate the country- specific shocks in size, then the inherent stability of the monetary union will be sufficient to absorb these shocks without affecting one or a few countries adversely. Although the model contains only (0,1) dummy variables, it can be derived from a structural economic model as Stockman [1988] has shown.

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location which is found to be robust under nonnormality. For details see Conover, Johnson and Johnson [1981], Brown and Forsythe [1974] and Levene [1960].

Several extensions to the above specifications have been made, following the procedure suggested by Karras (1996). First, there is a strong presumption that growth rates are autocorrelated over the business cycle. Therefore, it seems natural to account for this by reformulating the above model to

$$\Delta y_{it} = c_i + v_t + \rho \Delta y_{i,t-1} + \varepsilon_{it} \qquad (2)$$

which assumes that persistence is equal across countries and persistence is measured by ρ, the coefficient on the lagged endogenous variable. If this assumption seems to be too strong, it might be relaxed by assuming that persistence is different in each country. In this case the basic specification modifies to

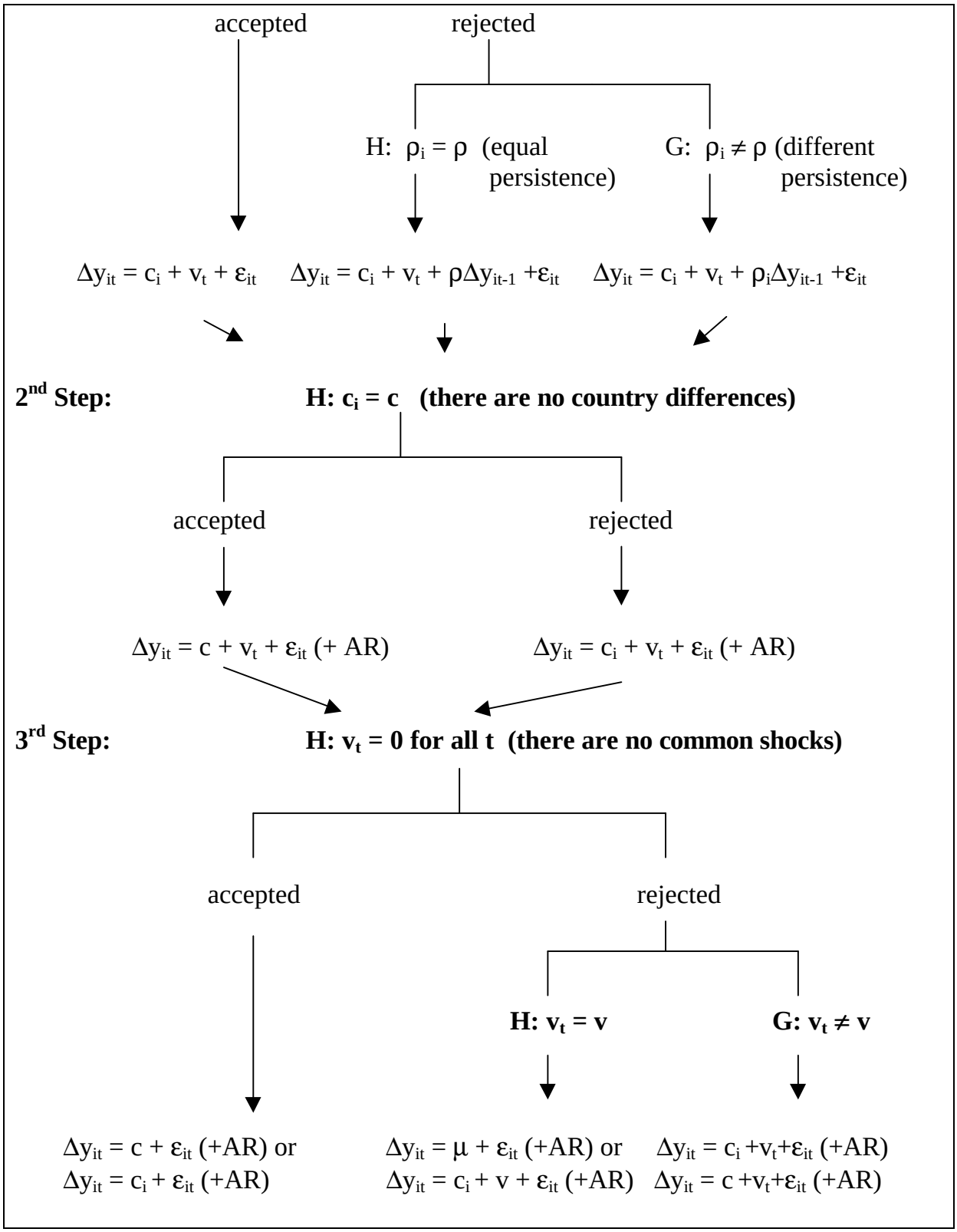
$$\Delta y_{it} = c_i + v_t + \rho_i \Delta y_{i,t-1} + \varepsilon_{it} \qquad (3)$$

In all these cases appropriate tests can be performed; they are reported below. The next point we have to consider relates to the estimation procedure. Given that persistence is not significant in a statistical sense, the basic specification can be estimated by OLS. But if there is considerable correlation among the contemporaneous error terms, this should be taken into account by estimating the equation by SUR (seemingly unrelated regression) instead of OLS. SUR will improve the efficiency of the estimates in the sense that the reported t-values are reliable whereas the t-values obtain by OLS are not, if the contemporaneous variance-covariance matrix is not diagonal.

In cross section regressions heteroskedasticity is a quite common problem. As far as possible we account for this deficiency by calculating the standard errors of the coefficients by White's heteroskedasticity consistent covariance procedure (White1980).

Figure 4: Sequential testing of the hypotheses

1st Step: **H: $\rho_i = 0$ (no persistence)**



As before we split the cross section units into EU-15, EU-11 and EU-core. For each of these (sub-) groups we started with the basic specification, tested for persistence and performed several tests. As it turned out for all country groups significant serial correlation was present. Testing for a common first order autocorrelation coefficient against a country specific one, the decision was always in favor of the latter. Therefore, we

base the presentation upon the results of the third variant of the model. The results of the various tests performed for the three groups of countries are given in Table 6.

For each country group we performed five tests, see Figure 4 for a graphical presentation. First we tested H: $\rho_i = 0$ for all i, with i indexing the countries in the groups. If this hypothesis could not be rejected, we continued by testing whether H: $\rho_i = \rho$ holds for all i. In either case depending on the results, the autocorrelation structure was specified. Next we tested for the joint significance of the country-specific as well as the time-specific effects. With respect to the country-specific effects we checked whether H: $c_i = c$, for all i, holds. In this case the test indicates that there are no significant differences in the country-specific effects and the model is estimated with a common constant term. If H is to be rejected, to opposite conclusion holds. The next tests relate to

Table 6: Results of Wald Tests for Different Country Groups[1)]

	EU-15	EU-11	EU-core
H: $\rho_i = 0$ for all i	F = 3.848 (1 %)	4.400 (1%)	6.808 (1%)
H: $\rho_i = \rho$, for all i	F = 2,358 (1%)	2.972 (1%)	8.491 (1%)
H: $c_i = c$, for all i	F = 1.196	1.427	1.973
H: $v_t = 0$, for all t	F = 12.869 (1%)	10.681 (1%)	23.246 (1%)
H: $v_t = v$, for all t	F = 13.178 (1%)	10.844 (1%)	23.642 (1%)

1) Results are based on joint F-tests; level of significance is given in brackets. All results are based on OLS-regression with White heteroskedasticity-consistent standard errors and covariance.

the time-effects. Again, we first tested if the time-effects are jointly zero, i.e. H: $v_t = 0$, for all t. Given that this hypothesis hold, no further test was conducted. In the opposite case we finally tested if all time-effects are equal, i.e., H: $v_t = v$, for all t.

As already mentioned for all country groups we find significant persistence in per capita real growth which, in addition, turns out to be country-specific[10], see the first two rows of Table 6. Also for all country groups we find time-specific effects which are significantly different from zero on one hand, and which vary from country to country on the other. In terms of shocks this result suggests that common shocks hit the economies quite differently. Only with respect to the country-specific effects, captured by the c_i's, no significant differences between the European countries can be detected. This result indicates "good news" in the sense the EU-countries do not move along diverging growth paths despite of common and country-specific shocks, to which we turn now.

Figure 5: Common Shocks of the Models

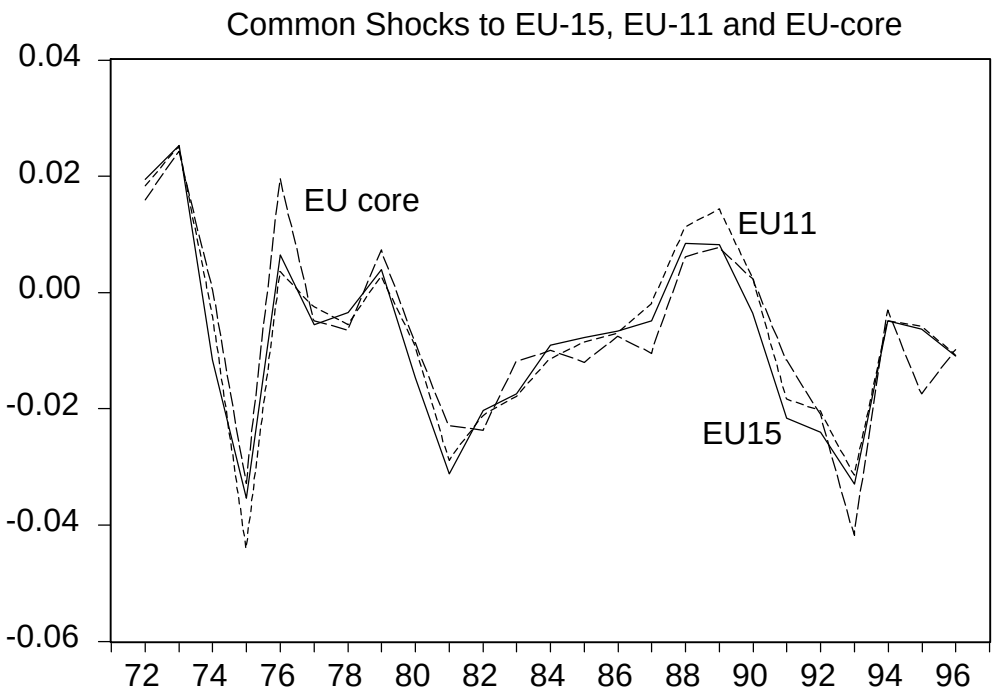


Figure 5 shows the development of the common shocks over time for the three country groups. The plots are obtained by taking the estimated coefficients of the time-effect dummies of the three models.

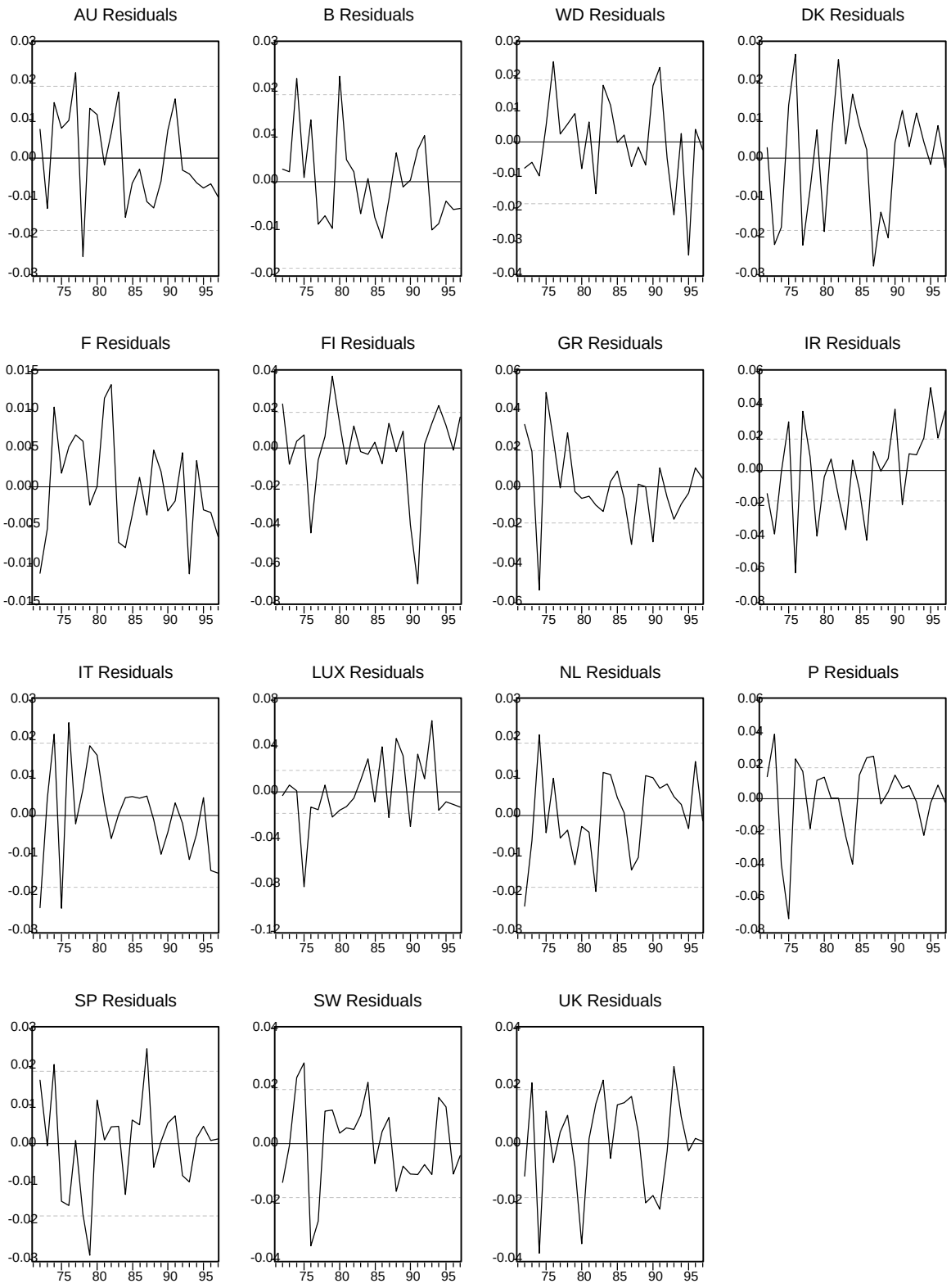
[10] This result is in contrast to Karras' finding who reports a unique serial correlation coefficient when estimating the model for twenty European countries for the period 1950 to 1990.

At a first sight Figure 5 displays a very similar movement of the common shocks for the three country groups over time. Also formal tests of equality of means of the series as well as equal variances do not detect any significant differences. The common shocks range from slightly more than 2 % in 1973 to around –4% in 1975 and 1993, respectively. As the Figure suggests adverse shocks remain in the range of 0 to –4% over the sample period, whereas positive shocks were stronger in the seventies than in the end of the eighties. Note that in nearly all of the nineties the European economies were hit by adverse shocks.[11] It should be noted that the size of the common shocks is quite considerable compared with the average growth rates reported in Table 1. Given these sizable common shocks on the one hand, and the country-specific persistence in growth rates, there is a potential danger in all country groups that a common shock may lead to an asymmetric adjustments in the single countries.

But common shocks are just one side of a coin, the other relates to country-specific shocks which are measured by the residuals of the models. Figure 6 shows these shocks for the EU-15 model. For some countries these shocks are much greater than the common shocks. Negative country shocks affected e.g. France and Finland in the nineties in magnitude which exceeds the size of the common shocks to a considerable extend. But also for Luxembourg as well as Ireland country-specific shocks seem to be much more important than common shocks. In order to get an impression of the importance of both types of shocks, we calculated a relative dispersion measure as has been done by Karras (1996). For this purpose we divided the variance of the countries'

Figure 6: Country-specific Shocks Based on the EU-15 Model

[11] The statistical model used in the paper does not allow to distinguish between the shocks, i.e. whether we are confronted with supply shocks of with demand shocks. To address this issue structural VARs are usually applied.


AU Residuals
B Residuals
WD Residuals
DK Residuals
F Residuals
FI Residuals
GR Residuals
IR Residuals
IT Residuals
LUX Residuals
NL Residuals
P Residuals
SP Residuals
SW Residuals
UK Residuals

residuals by the variance of the common shocks, Table 7 displays the results for the three country groups.

Values of the relative dispersion measure above unity indicate that country-specific shocks are more important that common a shocks to a country. Values between zero and one show that common shocks are more relevant to a country than country-specific ones. The closer the measure is to zero, the less important are country-specific shocks relative to the common shocks.

Table 7: The Relative Importance of Common and Country-Specific Shocks

Country	EU-15	Ranking	EU-11	Ranking	EU-core	Ranking
Austria	0.622	4	0.574	6	0.338	3
Belgium	0.388	2	0.324	2	0.225	2
France	0.191	1	0..191	1	0.206	1
Netherl.	0.511	3	0.426	3	0.345	4
Germany	0.756	7	0.806	7	0.411	5
Finland	***2.167***	12	***2.113***	9		
Ireland	***3.436***	14	***3.158***	11		
Italy	0.650	6	0.527	5		
Luxemb.	***3.644***	15	***3.130***	10		
Portugal	***2.543***	13	***2.084***	8		
Spain	0.641	5	0.472	4		
Denmark	0.983	8				
Sweden	***1.003***	9				
UK	***1.224***	10				
Greece	***1.891***	11				

In Table 7 the corresponding figures are given together with a ranking of the country within the special group. Values of this measure above unity are presented in bold letters. Starting with EU-15, for seven countries country-specific shocks are much more important than common shocks. Out of these seven countries four are members of EMU since 1999. Furthermore, it should be noted that all of the non-participating countries show relative dispersion measures which are clearly below to those of the joining countries. For Sweden both types of shocks are of equal importance, whereas for the United Kingdom, country-shocks are somewhat more important. Ireland and Luxembourg, followed by Portugal are the countries which are most affected by country-specific shocks. On the opposite, France, Belgium, and the Netherlands are countries which are dominated by common shocks. West Germany ranks in the middle of the countries with a ration of 0.756. Things change not much when switching to EU-15. Again, France, Belgium, and the Netherlands rank on places one to three. Only for the EU-core we find ratios for all countries which are clearly below unity. For all core countries common shocks clearly dominate in importance.

V. Conclusion

In the paper we analyzed the business cycles in the EU-15 countries with respect to their common pattern. Furthermore, we looked at two subgroups, namely EU-11 and at five “core” countries. With the start of EMU several instruments such as exchange rate changes or interest changes are no longer at the disposal of a single member country to absorb adverse shocks. The loss of these instruments calls for new adjustment mechanisms if in the past the single countries used these monetary instruments more or less extensively and if asymmetric shocks are still to be expected to the same extent. For EMU to be an optimal currency area, several requirements must be fulfilled. If shocks hitting single countries are dominated to a large extent by common shocks and if business cycles move rather synchronous across the countries, then the requirement of new adjustment instruments such as wages or prices is of minor importance than in the case where shocks are basically dominated by country-specific shocks. In the latter case,

EMU may be plagued by an inherent latent instability due to divergent business cycle movements of its members. In order to be able to smooth such asymmetric shocks, much of the necessary adjustments have to be carried by the labor markets. Our results suggest that the probability of asymmetric shocks seems to be rather high for EU-15 as well as for EU-11. Country-specific shocks turned out to be highly important for the smaller countries such as Luxembourg, Ireland, Finland, and Portugal. This means that although EMU as a whole will be less affected by asymmetric shocks, these small countries will nevertheless be seriously disturbed by country-specific shocks.

But judged as a whole, the starting conditions for EMU are rather good for several reasons. First, our results suggest that there are no important country-specific differences in the per capita output growth. This implies that the EU-15 countries move along the same growth path, at least in the long run. Secondly, the not yet participating countries are much more similar in their business cycle movements as well as in the shocks these countries are confronted with than the already participating countries with the high dependence on country-specific shocks. Therefore, an enlargement of EMU to all EU-15 countries will not add further problems.

In the paper we only analyzed the questions of business cycle synchronization as well as the types of shocks disturbing an economy. For the types of shocks we only looked whether these shocks are common to all economies or if there are some countries for which country-specific shocks are highly important. We did not focus on the nature or the origin of the shocks, i.e. are the shocks supply- or demand-determined. For these additional insights an alternative methodology is required such as structural VARs. Furthermore, we proceeded at a highly aggregated level by looking at per capita output growth. Disaggregating the data on a sectoral basis and testing at this level is left for future research. Finally, besides of growth aspects it seems fruitful to extend the analysis also to the labor markets because for EMU, these markets will be the cornerstones for synchronizing the European business cycles.

Appendix A: Additional Results

Table A1: ANOVA-Results for Selected EU-Areas

	1971-1979	1980-1989	1990-1997
EU-15:			
Equality of Means Between Series			
F-Statistic	0.47 (14, 120)	1.26 (14,135)	3.28* (14, 105)
Between SS	0.0054 (14)	0.0068 (14)	0.0207 (14)
Within SS	0.0977 (120)	0.0519 (135)	0.0473 (105)
Total SS	0.1031 (134)	0.0586 (149)	0.0680 (119)
Equality of Variances Between Series			
Bartlett	29.49* (14)	31.23* (14)	38.66* (14)
Levene	1.37 (14, 120)	3.61* (14, 135)	4.56* (14, 105)
Brown-Forsythe	0.97 (14, 120)	2.68* (14, 135)	3.32* (14, 105)
EU-11:			
Equality of Means Between Series			
F-Statistic	0.24 (10, 88)	1.36 (10, 99)	3.61* (10,77)
Between SS	0.002 (10)	0.005 (10)	0.018 (10)
Within SS	0.075 (88)	0.039 (99)	0.038 (77)
Total SS	0.077 (98)	0.045 (109)	0.056 (87)
Equality of Variances Between Series			
Bartlett	25.26* (10)	25.62* (10)	33.96* (10)
Levene	1.56 (10, 88)	4.15* (10, 99)	5.39* (10, 77)
Brown-Forsythe	1.17 (10, 88)	2.92* (10, 99)	4.16* (10, 77)
EU-Core (A, B, West-G, NL, F):			
Equality of Means Between Series			
F-Statistic	0.53 (4, 40)	0.27 (4, 45)	0.69 (4, 35)
Between SS	0.001 (4)	0.0002 (4)	0.001 (4)
Within SS	0.015 (40)	0.0099 (45)	0.008 (35)
Total SS	0.016 (44)	0.0101 (49)	0.009 (39)
Equality of Variances Between Series			
Bartlett	2.72 (4)	2.62 (4)	4.37 (4)
Levene	0.92 (4,40)	0.83 (4, 45)	1.14 (4, 35)
Brown-Forsythe	0.46 (4, 40)	0.78 (4, 45)	1.04 (4, 35)

Note: *, (**), (***) indicate significance at the 1, (5), (10) % level. SS = sum of squares
Core = Austria, Belgium, West-Germany, the Netherlands, and France. Luxembourg has been excluded due to its special situation as an international banking place. Figures in brackets are the degrees of freedom.

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