Regional Convergence and Economic Performance

A Case Study of the West German Laender

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Non-technical Summary

Starting in 1970 the paper analyzes the economic development of the states and city states of West Germany over a 27 years period using annual data, excluding Berlin (West) due to its special status during that time. The main emphasis of the paper deals with the question if the West German Laender converged in their development over the investigation period or not. To proceed in this direction we first ranked the Laender with respect to their real per capita income in 1970 and compared the figures with the 1996 results. In 1970 the Laender could be classified into three groups with the relative „poor" Laender Rhineland-Palatinate, Schleswig-Holstein, Saarland and Lower Saxony. As „rich" we considered the two city states Hamburg and Bremen with the other Laender belonging to the middle group. Compared with 1996 this classification did not change very much. The Laender classified as poor basically remained „poor" and those classified as „rich" remained rich. A remarkable exception is Hesse, a middle group state which connected to the rich group. As a „loser" of the economic development we identify North Rhine-Westfalia.

In a second step we used panel regression techniques to estimate the production functions of the Laender. Under the assumption of a common production technology and identical elasticities we could not detect any significant differences among the Laender. Besides of labor and capital as inputs in the production processes we tried to improve the estimation results by including additional explanatory variables, especially a proxy for human capital and the expenditures on infrastructure of the state governments. Both variables failed to improve the estimation results.

Although the analysis carried out applies only to West Germany, some conclusions with respect to the European Monetary Union as well as to the catching up- process of the new Laender are drawn in the conclusions. With respect to the East German convergence process we are rather sceptical that the new Laender will catch up to West Germany within the next twenty years. The other conclusion relates to the EMU. Some Euro-sceptic claim that nominal convergence is insufficient to guarantee a disturbance-free economic development within the EMU and call for an additional harmonization of the tax and social security systems to improve the conditions for real convergence. The German experience instead shows that unique laws and tax as well as social security systems are by no means a guarantee by itself for real convergence.

Abstract

In the paper we analyze the convergence process of the West German Laender from 1970 to 1995 using descriptive tools as well as panel estimation methods. Although there have been some winners in this process, the main finding is that convergence was insufficient in the sense that no gains have been achieved with respect to a stronger harmonization of the economic performances in the Laender. Some of them proofed to be unable to respond adequately to structural changes, whereas others successfully overcame those challenges.
Panel estimates of production functions of the Laender reveal no significant differences in the production technology across Laender.

Zusammenfassung

Die Arbeit untersucht, ob im Zeitraum von 1970 bis 1996 eine Konvergenz im wirtschaftlichen Wachstum der westlichen Bundesländer stattgefunden hat. Die Ergebnisse zeigen, daß insbesondere die südlichen Bundesländer ihre relative Position verbessern konnten. Jene Bundesländer, die schon 1970 als „strukturschwach" galten, schafften es nicht, den Abstand zu verringern. Der Strukturwandel wurde von den einzelnen Bundesländern mit unterschiedlichem Erfolg bewältigt. Eine Länder vermochten daraus Vorteile für ihre Entwicklung zu ziehen, während andere nur unzureichend auf diese Herausforderung reagierten. Insgesamt kann im Untersuchungszeitraum weder von einer Konvergenz noch von einer Divergenz der wirtschaftlichen Entwicklung in den Ländern gesprochen werden. Dem widerspricht nicht, daß einige Ländern (Hessen und Bayern) insgesamt erfolgreicher in ihrer Entwicklung waren als die übrigen Bundesländer.

I. Introduction

Starting in 1970 the paper analyzes the economic development and performance of the West German Laender, excluding Berlin due to its special status during this time period. The main focus of the paper is concerned with the question if there is a converging process among the Laender or not. To address this issue we look at the β-convergence on one hand, and we estimate a Cobb-Douglas production function for the Laender using a panel approach on the other hand. We use annual data published by the Statistical Offices of the Laender. The period ranges from 1970 to 1996, the latest available data set for all Laender[1].

We think that interest in the topic addressed may result from three sources. First, the federal structure of West Germany allows for competition among the Laender to improve their economic performance by attracting new firms and new jobs. This is an important issue when structural changes occur and the speed of change is rather fast. The second point relates to the economic development in East Germany. Nearly ten years passed by since the fall of the wall and the new Laender are still far away from the West German per capita income level despite of the huge transfer payments from the West to the East during this period. Therefore, it will still take a long time until the East German economy will have catched up to the West German level. The third reason relates to the European Monetary Union, which is a much more heterogeneous area than West Germany but conducts a common monetary policy since the beginning of 1999. Furthermore, the EMU-area is characterized by a number of geographically distinct industrial centers as opposed to the member countries where mostly only a few centers exists.

In this paper we do not contribute to the discussion whether EMU is an optimum currency union but instead focus on the economic development in West Germany. Compared with EMU Germany seems to be an interesting country for a number of reasons: First, due to the federal structure Germany has many industrial centers distributed more or less evenly across the country. Secondly, Germany is a highly homogeneous country with respect to law, education, the social security and the tax system as well as to the wage bargaining process. Furthermore, there are no dramatic differences in the standard of living across the states as for example between the north and the south of Italy. Nevertheless, between the Laender (states) or between regions considerable differences exist in the overall economic performance: unemployment rates are high in the north and low - compared with the average rate - in the south; per capita income is higher in the city-states (Bremen and Hamburg) than in the states; some Laender are net payers in the context of the redistribution of income between the central government and local states as well as between the states for many years, whereas others are net receivers.[2] Another reason for a certain degree of heterogeneity across the Laender stems from the structural change in the course of time[3]. Formerly rich states such as

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[1] Certain data are available up to 1997 (real GDP and employment), but capital stock data are not yet updated.
[2] This redistribution is an important instrument to prevent continuously diverging economic and social developments across the Laender.
[3] A few examples may clarify this point. Since the seventies coal mining and the steel industry suffered considerably from alternative energy sources as well as from the „steel crises“; shipbuilding lost in importance with

North Rhine-Westfalia turned into an area with a less well-developed infrastructure whereas other states catched up and/or even outperformed the former rich Laender, e.g. Bavaria and Hesse. Finally, shocks hitting the overall economy could not be absorbed by a devaluation of the currency or by a suitably designed monetary policy at the level of the Laender due to the responsibility of the Deutsche Bundesbank or the Federal Ministry of Finance. This situation now also prevails within EMU, depreciation of a currency or an isolated monetary policy are no longer instruments at the level of a single member state.

In recent years many studies have been published which analyze the economic growth and convergence process either across countries or across states or areas. By and large most of these studies report on convergence with a rate of convergence between 2% - 2.5%, which means that convergence takes place only slowly.[4] Nevertheless, these results are by no means unique. Depending on the period, the sample selected as well as the variables entering the regressions the results are rather unstable as Baumol [1986] among others argued.

Dowrick and Nguyen [1989], however, test the catch-up and convergence hypothesis for 24 OECD-countries for the period 1950 - 85. They conclude that there was a strong convergence in per capita income as well as in total factor productivity and, furthermore, that these results are robust against various tests as well as different sample selection criteria. But they also report that after 1973 the strength of the convergence process weakened. In a more recent study, also for 24 OECD-countries but from 1960 to 1990, Andrés, Doménech and Molinas [1996] augment the „convergence equation" by Barro and Sala-i-Martin [1991] and Mankiw et al. [1992] by adding macroeconomic key variables such a money growth, inflation rate, export growth, budget surplus etc. Although the estimated convergence rate of 2 - 2.5% is in line with other studies, the authors report instabilities of the convergence equation when subperiods are considered. Furthermore, the macroeconomic indicators proofed to be important explanatory variables in the equation and, again in certain subperiods, they contribute more to the explanation of growth than the basic variables of the growth equation.

Most of the empirical evidence relates to country studies using different areas such as the OECD or Europe as sample. Only a few studies look at the convergence process within a country by breaking down the data on a state or county level[5]. For West Germany, to the best of our knowledge, regional convergence has been analyzed by Seitz [1995] and Funke and Strulik [1997]. Work related to this topic but with emphasis on the impact of investments in public infrastructure on convergence was undertaken by Licht and Seitz [1993] and Seitz and Licht [1993]. The last mentioned papers conclude that public capital formation encourages private investment which may be one explanation for the observed differences in labor productivity growth and output growth

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serious consequences for the coastal area. On the other hand former poor areas attracted new high-tech industries and services, e.g. Bavaria.

[4] See e.g. Barro [1991], Barro and Sala-i-Martin [1991, 1992], Sala-i-Martin [1996], Quah [1996], Andrés et.al. [1996], Mankiw et.al. [1992], Persson [1997] and Abraham and Van Rompuy [1992].

[5] For example see Persson [1997] for Sweden, Sala-i-Martin [1996], Evans and Karras [1996] and Loewy and Papell [1996] for the U.S.A.

across the Laender. Funke and Strulik [1997] analyze the convergence process for the eleven West German Laender for the period 1970 to 1994 using a panel approach. They conclude that there is conditional convergence, but persistent inequality of regional steady states. Our results suggest that even within a period of twenty six years the economic performance between the states did not change to a large extend,[6] although in 1996 some states are somewhat worse or better off than in 1970. Real convergence will appear only slowly.

The paper is organized as follows: in the next section we present a brief survey of the economic development in the Laender from 1970 - 1996. Convergence is analyzed in section three. Estimates of a Cobb-Douglas production function for the Laender based on panel estimation procedures are given in section four. Conclusions and some suggestions for future research are given in the final section.

2. The Macro Economic Performance of the Laender, 1970 - 1996

Until the mid-seventies business cycle as well as growth problems were by and large considered as second order problems. Periods of downswings were basically characterized by a slowdown of still positive growth rates. And among the different sectors of the economy the manufacturing industry was most important in contributing to gross value added as well as to employment opportunities. Nevertheless, within West Germany several Laender outperformed the others in the degree of industrial concentration. Things changed dramatically after the OPEC crises. Growth rates in the eighties are considerably lower for all Laender than in the seventies. And, in the course of structural change, unemployment or lack of employment became and still is a serious problem. The structural change hit the Laender quite differently. Unemployment is high in the north and relatively low in the south, especially Bavaria. Several Laender pushed programs and strategies to establish new industries and to attract new firms whereas other Laender suffered from the (relative) decline of formerly flourishing sectors like coal mining, steel industry and shipbuilding, to mention the most important ones.

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[6] This statement only applies to the given level of aggregation. Further disaggregation to a county level may reveal different results, especially if industrial regions are located at the borders of different states as is the case with the Rhine-Neckar-triangle, see Egeln et. al. [1996a, b].

Table 1:	Real GDP-Growth			
	1970-96	1971-79	1980-89	1990-96
Baden-Württemberg	2.49	3.17	2.32	1.85
Bavaria	3.00	3.71	2.53	2.78
Bremen	1.51	2.44	0.32	2.03
Hamburg	1.69	2.09	0.93	2.28
Hesse	3.03	3.62	2.45	3.09
Lower Saxony	2.40	3.00	1.52	2.89
North Rhine-Westfalia	1.75	2.42	1.07	1.86
Rhineland-Palatinate	2.07	3.06	1.54	1.55
Schleswig-Holstein	2.38	3.18	1.77	2.22
Saarland	1.99	2.77	1.57	1.61
West Germany	*2.37*	*2.93*	*1.79*	*2.07*

Arithmetic mean of annual growth rates; GDP in 1991 prices.

At least to a certain degree this structural change led to a shift in economic activities from the north to the south; especially Bavaria and Hesse gained considerably from this shift, which can be seen from the figures in Table 1. Over the whole period only Bavaria and Hesse come up with average GDP-growth rates of 3 percent or slightly more. Contrary to this development, four out of ten Laender show average growth rates below 2 percent with the city states - Hamburg and Bremen - performing worst. Figure 1 shows the development, putting 1970 GDP-values equal to 100. During the last 27 years only Hesse and Bavaria were able to increase their GDPs by more than twice as much as compared with 1970. The poorest performance relates to the city states which were only able to increase their GDPs by around 50 index points. Within the states North Rhine-Westfalia's GDP grew slowest.

Until 1980 all Laender developed closely together with index values ranging from 124 (Lower Saxony and Bremen) to 140 (Bavaria). Only the performance of Hamburg was worse. In the early years of the eighties the Laender started to diverge. At the end of 1996 there are now four groups of Laender: Hesse and Bavaria as the ones with the best performance, the second group consisting of Baden-Württemberg, Lower Saxony, Schleswig-Holstein, the third group consisting of Rhineland-Palatinate and Schleswig-Holstein, and finally, the states with the worst performance North Rhine-Westfalia, Hamburg and Bremen. Figure 1 also shows that GDP-growth was most volatile for Bremen and that all Laender were hit by the 1991 recession, with Lower Saxony being the exception. But it is also visible that the last recession hit the Laender quite differently. Most seriously attacked were Baden-Württemberg, Rhineland-Palatinate, the Saarland and Bremen, whereas Lower Saxony and Hamburg suffered only slightly from this recession.
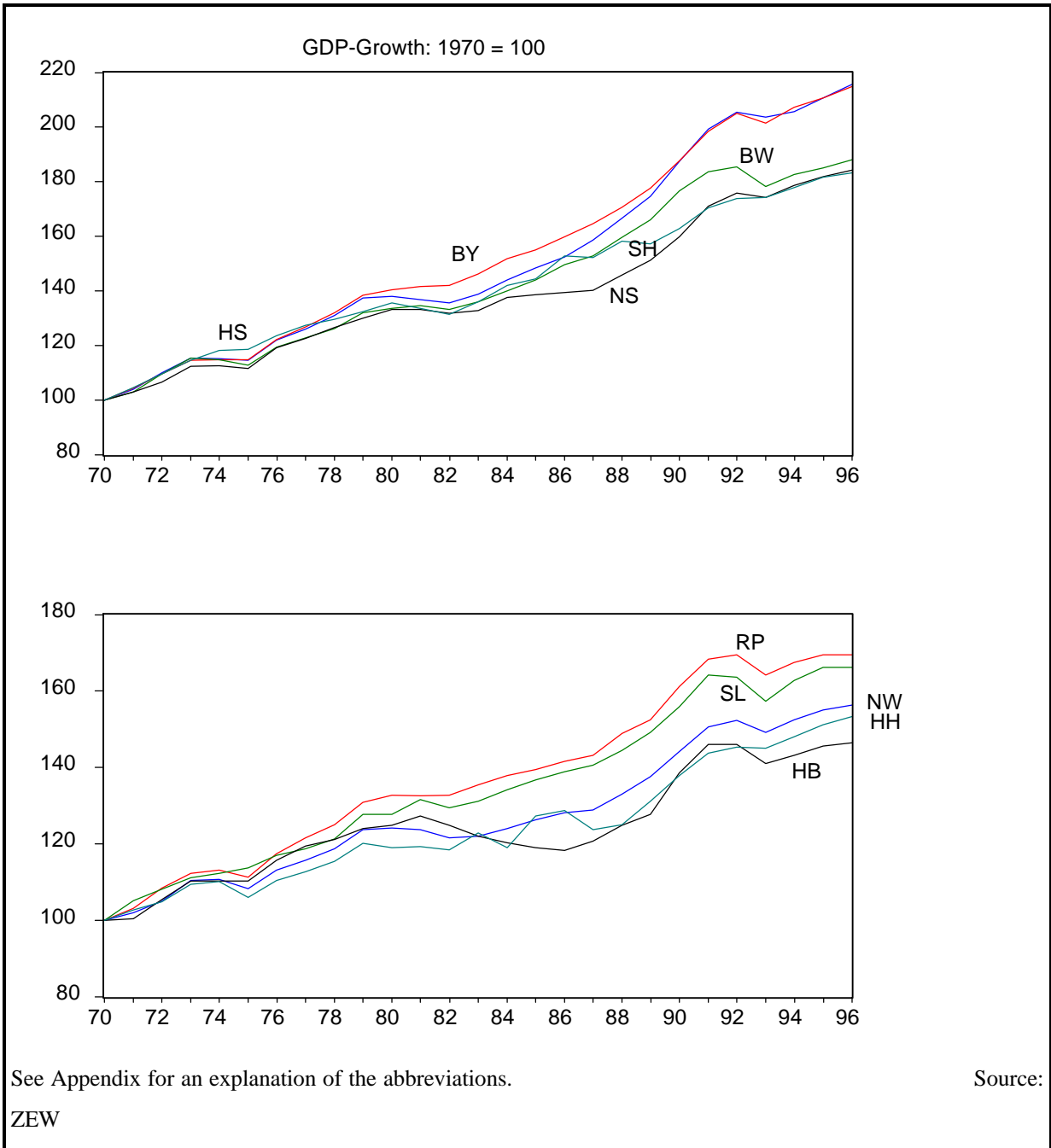
Table 2:	Real GDP per capita employed			
	1970-96	1970-79	1980-89	1990-96
Baden-Württemberg	77.68	65.83	79.13	92.54
Bavaria	73.22	59.86	74.87	89.94
Bremen	82.98	72.92	83.79	96.20
Hamburg	106.53	91.82	109.82	122.86
Hesse	85.15	68.48	85.47	108.51
Lower Saxony	70.50	58.96	72.02	84.80
North Rhine-Westfalia	80.22	71.01	81.15	92.04
Rhineland-Palatinate	74.09	62.50	76.04	87.86
Schleswig-Holstein	74.47	64.80	76.25	85.75
Saarland	72.17	60.97	74.01	85.53
West Germany	*78.22*	*66.30*	*79.38*	*93.60*

in 1000 DMarks

A different picture evolves when real GDP per capita employed is considered. Here we find the typical result that city states have a better performance than most of the states. Large cities serve as shopping and service centers for their surrounding area on one hand, which implies most of an area's turnover takes place there. On the other hand, big cities offer numerous jobs for people living in the vicinity. Both effects lead to a higher per capita GDP than observed in the states. Furthermore, the employment structure in cities differs significantly from the one in the states. Employees in administration and service sectors usually earn a higher income than workers. These rather common arguments explain why real GDP per capital employed is much higher in Hamburg than in the other Laender. Bremen seems to be an exception because real GDP per capita is lower than in Hesse and only slightly above the per capita value of North Rhine-Westfalia. But if one keeps in mind that Bremen is a rather small city state with an unbalanced economic structure on one hand and that Hesse gains to a considerable amount from the concentration of the banking sector in Frankfurt the figures of Table 2 are not very surprising.

With respect to employment growth - see Table 3 - employment declined on average over the whole period in the city states and grew, albeit at low rates - in the states. Surprisingly, employment growth was highest and rather smooth over the decades in Schleswig-Holstein, followed by Bavaria and Baden-Württemberg. Only four out of ten Laender experienced a continuous employment growth on average, namely Baden Württemberg, Bavaria, Hesse and Schleswig Holstein. All the other Laender were confronted with a least one decade of declining employment. Even in the large and long lasting upswing phase from 1983 to 1991 the Saarland as well as the city states were

Figure 1: GDP-Growth of the German Laender, 1970 - 1996

GDP-Growth: 1970 = 100

See Appendix for an explanation of the abbreviations.   Source: ZEW

unable to create more new job opportunities than were destroyed. In the nineties the employment situation improved in nearly all Laender, Bremen being an exception. Nevertheless the temporal picture of the employment development differs markedly across the Laender. For Hesse, Bavaria and Baden-Württemberg we observe considerably lower employment growth in the nineties than in the eighties, whereas in Schleswig-Holstein to opposite is true.

Table 3:	Average Employment Growth			
	1971-96	1971-79	1980-89	1990-96
Baden-Württemberg	0.36	0.08	0.78	0.13
Bavaria	0.46	0.19	0.75	0.40
Bremen	-0.18	0.16	-0.52	-0.14
Hamburg	-0.23	-0.79	-0.13	0.33
Hesse	0.28	0.10	0.50	0.18
Lower Saxony	0.13	-0.22	0.10	0.64
North Rhine-Westfalia	0.14	0.10	0.19	0.11
Rhineland-Palatinate	0.02	-0.20	0.20	0.04
Schleswig-Holstein	0.47	0.51	0.42	0.51
Saarland	0.06	-0.01	-0.16	0.24
West Germany	*0.16*	*0.00*	*0.41*	*0.02*

arithmetic means of annual growth rates

3. Is there Convergence or Divergence Between the Laender?

The next step of the analysis considers how real per capita income developed from 1970 to 1996. Starting in 1970 the Laender can be classified into roughly three groups: the rather „poor" Laender Rhineland-Palatinate, Schleswig-Holstein, Saarland and Lower Saxony; the „middle"group consisting of Baden-Württemberg, Hesse and North-Rhine Westfalia. Between these groups there is Bavaria. The „rich" group in 1970 relates to the city states Hamburg and Bremen. In the second column of Table 4 the Laender are ranked corresponding to their relative position with respect to the Land with the highest per capita income in 1970. Column one informs about the share the Laender had relative to Hamburg. The Laender classified as „poor" in 1970 attained only 50 percent or even less of the per capita income earned in Hamburg. In the middle group the income share amounted to 60 percent or somewhat higher. But even Bremen with the second highest per capita income only obtained 77 percent of the income of the population of Hamburg.

Some care should be taken when interpreting these figures. City states are agglomeration centers which offer a wide variety of jobs in all sectors of an economy. The attractiveness of large cities with respect to employment and shopping opportunities leads to biased per capita income. The reason is simply due to the measurement con-

cept. An employee working in a city state but living in another area contributes to the value added of the city state.[7]

Table 4:   **Comparison of the Income Situation: 1970 and 1996**

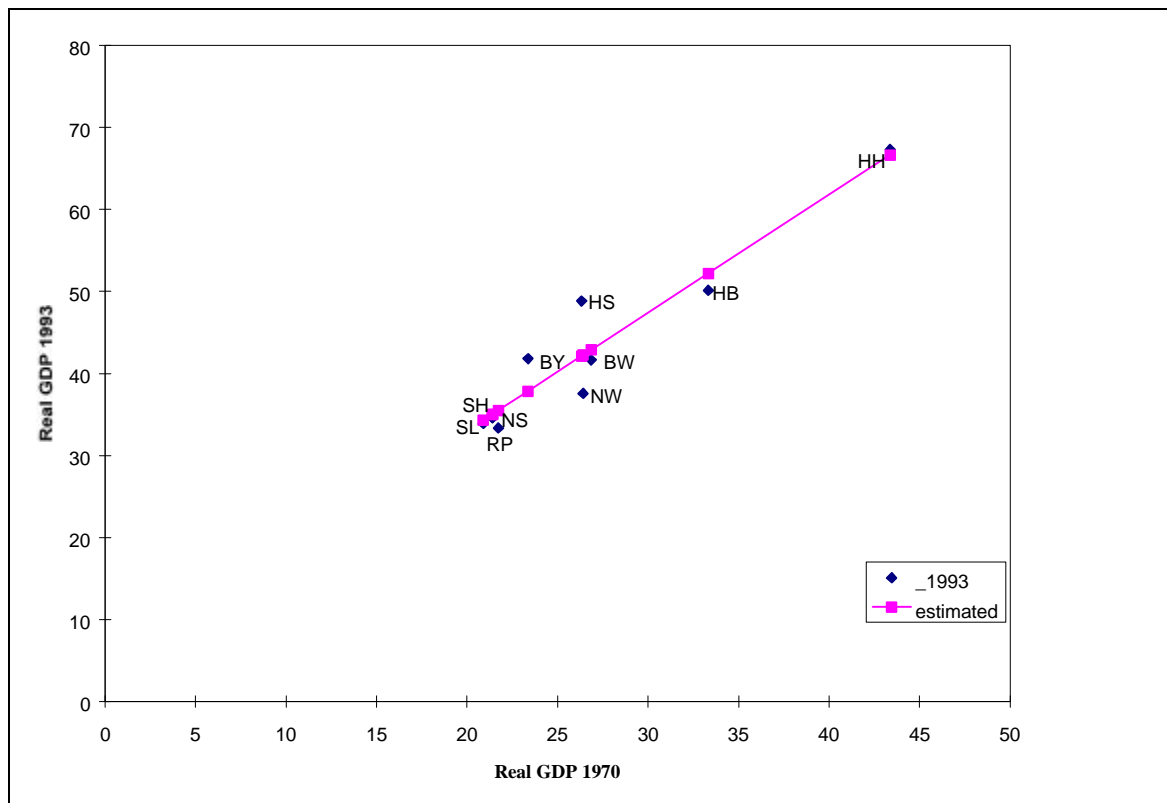| State	GDP per capita in % of state with highest income in 1970	Rank 1970	Rank 1996	GDP per capita in % of state with highest income in 1996	Change in GDP per capita, 1970 - 1996
Hamburg	1.00	1	1	1.00	61.1%
Bremen	0.77	2	2	0.75	56.2%
Baden-Württemberg	0.62	3	5	0.62	61.3%
North Rhine-Westfalia	0.61	4	6	0.56	47.3%
Hesse	0.61	5	3	0.73	92.5%
Bavaria	0.54	6	4	0.63	87.4%
Rhineland-Palatinate	0.50	7	10	0.48	53.9%
Schleswig-Holstein	0.49	8	8	0.51	67.4%
Lower Saxony	0.49	9	9	0.51	66.9%
Saarland	0.48	10	7	0.51	71.8%

Comparing the situation in 1970 with 1996 the dynamics in the relative income changes was rather slow. In column three of Table 4 the new ranking is given. Both city states are leading further on; Baden-Württemberg and North Rhine-Westfalia were passed by Hesse and Bavaria during the 26 years and Rhineland-Palatinate now is the rear light among the German Laender by changing its former position with the Saarland.

Considering the 1993 GDPs in relation to the richest Land Hamburg, then column five informs that the four „poorest" Laender again achieve only 50 percent of the Hamburg per capita income. Compared with the 1970 results we find a more pronounced spread among the middle group in 1996. But on average the middle group could not catch up to a considerable amount to the „rich" group.

Bavaria was successful in catching up to the middle group whereas North Rhine-Westfalia missed its connection at least partly. The „winner" of the growth process is by no means Hesse. In 1996 the per capita income amounts to 73 percent of the income of the leading city state and it is roughly equal to the income one can obtain in Bremen. The final column of Table 4 shows the per capita income growth from 1970 to 1996.

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[7] For the Laender we use GDP data; GNP data are not available. But we cannot exclude that using GNP data the results would look somewhat different.

Figure 2:   Increase in GDP per capita: 1970 - 1993

Although the „poor" Laender outperformed the „rich" city states with respect to average growth, these higher growth rates were nevertheless insufficient to bridge the gap to the richer states, a consequence of the unequal starting points in 1970. Over the investigation period per capita income growth was strongest in Hesse and Bavaria and lowest in North Rhine-Westfalia.

In Figure 2 we present the growth process in a slightly different manner. On the horizontal axis real per capita GDPs in 1970 and on the vertical axis real per capita GDPs in 1996 are plotted. Additionally we show the estimated slope of the OLS regression of 1996 GDPs on 1970 GDPs (real, per capita). Around 90 percent of the variation in per capita income can be attributed to the income variation existing already in 1970, as the estimate presented below shows.

$$(1) \qquad YC_{1996} = 4.220 + 1.499 YC_{1970}$$
$$\qquad\qquad\quad (0.873) \quad (8.477)$$
$$R2(adj.) = 0.887; \quad DW = 1.950; \quad S.E.R. = 3.739$$

YC is real per capita income in 1991 prices. The empirical t-values are quoted in brackets. R2(adj.) is the coefficient of determination, DW the Durbin Watson statistics and S.E.R. the standard error of regression. The number of observation is ten.

The slope coefficient is estimated as 1.5, i.e. despite of the intercept we estimated a per capita income growth of around 50 percent as compared with the 1970 income for the Laender.[8] For seven states - on one hand the rich and on the other the poor ones - the actual 1996 income figures lie on the regression line or are located close to the line, i.e. that for these states per capita income evolved proprtionately to the 1970 starting point. From this it follows that among these states either convergence nor divergence took place.

The regression line separates nicely those states and city states which come up with an over- or underproportinal real per capita growth in the investigation period. Dots above the line indicate overproportional and dots below the line underproportional growth. Judged from this point of view Bavaria and Hesse show positive deviation from the estimated proportional growth path whereas North Rhine-Westfalia deviates in the other direction. Figue 2 also shows the different development of the states Hesse, Baden-Württemberg and North Rhine-Westfalia which were classified as the middle group due to the comparable income level in 1970. But after 1970 economic growth in these three states developed quite differently: Hesse grew overproportionally, Baden-Württemberg was on average and North Rhine-Westfalia below the average.

The results reflected in Figure 2 - equal income growth of the poor and rich Laender, but strong divergence within the group of the middle states - are hardly compatible with a convergence. In its strong version convergence predicts that different growth paths are primarily the result of differences in income at the starting point. This means that formerly poor states (or countries) will grow faster and that formerly rich states will grow slower than average. For states with an average growth at the starting point we would expect a more or less unchanged growth pattern. From this it then follows that in the future there will be a convergence of income between the Laender. For Germany such a process of convergence among the Laender could not be observed. This view is also supported by the results of the pooled regression given below.

$$(2) \quad y = 2.305 - 0.065 \ln(YC) + 1.259 \, d76 - 0.793 \, d81 + 0.50 \, d86 - 1.88 \, d91$$
$$\quad\quad\quad (1.776) \; (0.169) \quad\quad (4.762) \quad\quad (2.923) \quad\quad (1.744) \quad (6.185)$$

$$R^2(\text{adj.}) = 0.777; \quad DW = 2.646; \quad\quad \text{S.E.R.} = 0.579; \quad N = 50$$

To run this regression we transformed the variables as follows: y contains the average growth rates of the Laender over a five years interval, $\ln(YC)$ is the log of the income level at the beginning of the corresponding intervals, d76, d81, d86 and d91 are (0,1)-dummies with value 1 for the corresponding subperiod and 0 else. The absolute t-values are given in brackets. The important coefficient is the one related to $\ln(YC)$: a negative sign indicates convergence, a positive one divergence. Although the coefficient has a negative sign it is not significantly different from zero at the usual signifi-

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[8] The intercept can be interpreted as a kind of autonomous increase in income which is of equal size for all Laender. But as the t-value indicates the constant is not significantly different from zero at the usual significance level. Thus, autonomous income increases do not seem to play an important role in the German growth process.

cance levels. This again conforms the former result that there was no significant convergence among the West German Laender between 1970 and 1996.

Up to this point the analysis was performed by looking at the per capita income figures in 1970 and 1996. As a next step we take a closer look at the development within the period, Table 5 contains the necessary information. The main message from this table is that the states classified as „poor" stay closely together over the sample period with growth rates which are above average in some periods, but then followed by rates below average. All in all this pattern implies that the poor states do not diverge too much from each other.

Table 5:   Average annual growth rates (geometric mean) in the Laender

State	1971-1975	1976-1980	1981-1985	1986-1990	1991-1996	1971-1996
Hamburg	1,88%	3,17%	2,04%	1,22%	0,62%	1,78%
Bremen	2,02%	3,20%	-0,10%	2,77%	0,17%	1,67%
Baden-Württemb.	1,84%	3,38%	1,50%	3,02%	-0,40%	1,79%
North Rhine-Westfalia	1,30%	2,90%	0,73%	2,08%	0,11%	1,44%
Hesse	2,13%	3,74%	1,72%	3,94%	0,66%	2,46%
Bavaria	2,20%	4,06%	1,97%	2,96%	0,63%	2,35%
Rhineland-Palatinate	1,95%	3,75%	1,05%	2,44%	-0,84%	1,61%
Schleswig-Holstein	2,91%	2,65%	1,33%	2,04%	0,63%	1,93%
Lower Saxony	1,77%	3,65%	0,93%	2,72%	0,16%	1,91%
Saarland	2,89%	2,89%	1,65%	2,49%	0,08%	2,02%
West Germany	1.56%	2.20%	1.12%	2.89%	0.74%	2.04%

For the middle group the result is similar with an exception of Bavaria and Hesse which come up with mean growth rates above the average for all subperiods considered. The Bavarian catching up proceeded rather smoothly over the sample period, as Table 5 shows. A different development applied to Hesse which started up in the middle of the eighties with growth rates which are clearly above the average. From this time on Hesse disconnected its development in the middle group and moved quickly forward to the leading city states.

Contrary to this favorable performance North Rhine-Westfalia as the only state of the Federal Republic developed with mean growth rates which were below the averages in all subperiods. This led to the conclusion that North Rhine-Westfalia missed the connection to the middle group.

A final point worth mentioning before we proceed to the panel estimates relates to the differences in the growth rates among the Laender. Whereas in the seventies the distance between the highest and lowest growth rate was roughly 1.6 percentage points, it increased in the eighties, but decreased in the first half of the nineties to the level that prevailed in the seventies.

4. Panel Estimates of the Production Functions

The results of the preceding sections do not offer a unique result to the question whether convergence across the Laender improved or not. Depending on the selected statistics - growth rates of GDP, of GDP per capita employed and GDP per capita - the ranking across the Laender differs. To gain some more insights into the economic development of the Laender we turned over to a production function approach.

As a first step we estimate production functions for the single Laender, assuming an identical technology which can adequately be described by a Cobb Douglas production function[9]. Differences across the Laender may then show up in different elasticities, but not in the functional form. Using labor and capital as inputs as well as a linear time trend to account for technological progress these estimates yield highly implausible results with respect to the coefficient estimates. Using gross value added instead of GDP does not improve the results. Also, inserting the volume of labor instead of dependent employment leads to economically implausible parameter estimates[10]. Therefore, we abandon the single equation approach and turn to panel estimates. One of the advantages of switching to the panel approach is the increase in the number of observations and the more reliable estimates obtained thereof.

Basically, two approaches are estimated: The first approach simply pools the Laender and imposes the restrictions that each state produces along a Cobb-Douglas technology with equal elasticities and technical progress. Relaxing this strong assumption leads to the second approach, the fixed effects model. Still assuming equal production elasticities, differences across the Laender are allowed for in the technological development. Due to the structure of the panel, random effect models cannot be estimated because the observations over time are larger than the number of cross section units.

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[9] Given that we are concerned with long-run developments the assumption of a Cobb-Douglas technology seems justified. More flexible functional forms such as translog functions were not tested due to the small number of observations for a single state.

[10] Taken North Rhine-Westfalia as an example and estimating the Cobb-Douglas production function with GDP, employment and capital (all variables in logs) yields production elasticities for labor of 1.18 and for capital of 0.50. Turning to first differences, the elasticity for labor is still slightly above unit, but capital is no longer significant. Including a time trend in the level regression does not change the results.

Estimation of production functions requires the capital stock as one of the explanatory variables. Unfortunately, these data are only available up to 1992 for the Laender. Therefore, the estimation period had to be shortened from 1971to 1992, using data in first differences of the logs. Thus, 220 observations remain for the panel estimates.

With respect to technological changes we assume two alternative approaches. First, we model technological progress as neutral by simply adding a linear time trend to the regression equations. An alternative to this approach relates to the role of technical progress as either labor oder capital augmenting. To account for this non-neutral technical progress labor and capital were multiplied by the trend variable and entered the regressions as additional explanatory variables. Results for both variants of technical change are reported in Table 6.

Starting with the simple pooling approach with neutral technical progress we obtain production elasticities for labor and capital which are significantly above unit as the F-test indicates. Especially the elasticity of labor is close to unit which is not very convincing. Allowing for labor as well as capital augmented technical progress[11] the estimates indicate that the underlying production technology is linear-homogenous although the coefficients sum up slightly above unity. All the coefficients estimated are statistically significant from zero at the one percent level with the exception of labor augmented technical progress, which is significant only at the ten percent level. The model is able to explain about 38 percent of the variation in output and the Durbin-Watson statistics indicates absence of first order autocorrelation in the residuals. Furthermore, visual inspection of the residuals shows no serious deficiencies in any of the residual series.

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[11] See Steiner [1992] and Steiner and Flaig [1993] for a similar approach.

	Table 6: Panel estimates of the production function: 1971 - 1992			

	simple pooling		fixed effects-models	
	$\Delta \ln y_t$	$\Delta \ln y_t$	$\Delta \ln y_t$	$\Delta \ln y_t$
Const	0.010 (2.64)*	0.018 (3.51)*		
$\Delta \ln e$	0.964 (10.97)*	0.738 (3.71)*	0.954 (10.44)*	0.692 (3.45)*
$\Delta \ln k$	0.365 (3.16)*	0.353 (2.98)*	0.333 (2.57)**	0.151 (1.06)
$t*\Delta \ln e$		0.025 (1.72)***		0.029 (1.96)***
$t*\Delta \ln k$		-0.027 (2.78)*		-0.044 (3.77)*
const-BW			0.0098 (1.60)	0.0322 (3.65)*
const-BY			0.0133 (2.11)**	0.0372 (4.03)*
const-HB			0.0085 (1.74)***	0.0218 (3.55)*
const-HH			0.0960 (1.90)***	0.0227 (3.55)*
const-HS			0.0173 (3.02)*	0.0364 (4.62)*
const-NS			0.0130 (2.36)**	0.0312 (4.10)*
const-NW			0.0058 (1.04)	0.0240 (3.19)*
const-RP			0.0116 (2.02)**	0.0321 (3.95)*
const-SH			0.0079 (1.36)	0.0279 (3.45)*
const-SL			0.0120 (2.37)**	0.0280 (4.16)*
R^2(adj.)	0.358	0.376	0.350	0.387
S.E.R.	0.018	0.018	0.018	0.018
DW-Stat	1.891	1.935	1.946	2.009
Nobs	220	220	220	220
F(a+b=1)	4.60*	0.18	2.74***	0.44

Remarks: absolute empirical t-values in brackets; *, **, *** significant at the 1, 5, 10 percent level. S.E.R. = standard error of regression; e = employment, k =physical capital, t = time trend

Turning to the fixed effects-models, columns 3 and 4 in Table 6, the estimated elasticities of production are quite similar to the simple pooling approach when no factor augmented technical progress is taken into account. The empirical F-value to test for linear homogeneity of the production technology rejects the hypothesis of constant

returns to scale at the 10 percent level of significance. Again, the labor elasticity is implausibly high, taken a value of 0.95. With respect to the Laender-specific constants a joint F-test of significance from zero has to be rejected at all usual test levels. Furthermore, equality of the Laender-specific coefficients has to be accepted. The corresponding F-value for this test amounts to 0.71. For these reasons the fixed effects-model without factor augmenting technical progress does not seem to be well suited to explain the data.

Enlarging the regression by accounting for non-neutral technical change leads to results which are more in line with economic theory. The assumption of a linear homogeneous production technology cannot be rejected at the usual significance level, see the last row in Table 6, and the elasticity for labor is of plausible size. But now capital is no longer statistically significant. Furthermore, the estimated coefficient is considerably smaller in magnitude than in the other regressions. Compared with the first estimates of the fixed effects model, all Laender-specific coefficients are significantly different from zero at the 1 percent level. But testing for differences among these constants the empirical F-value of 1.43 indicates equality of the Laender-specific coefficients. These test results suggest that the simple pooling model with non-neutral technical change fits best in the present context.

Several attempts to improve the estimates of the production functions by adding additional explanatory variables remained unsuccessful. First we looked at a possible path-dependence of the growth process (Heckmann [1991]) by adding the endogenous variable lagged one period as an additional regressor. In all specifications the coefficient of the lagged variable is statistically insignificant at the usual levels. Next we looked for possible neighborhood effects among the Laender. This was done by calculating simple correlation coefficients of the GDP growth rates of neighboring Laender. Contrary to the findings of Seitz [1995] we were unable to detect any significant effects. This result may be due to the high level of aggregation. Seitz used county data and reports on considerable neighborhood effects. Whether public investment expenditures improve the economic condition of a Land was tested by adding the corresponding expenditures to the regression. Again, in none of the cases considered we could detect a statistically significant impact on the production function. Here, too, a closer look at a more disaggregated level may yield different results which are more in line with those reported by Seitz and Licht [1993] and Licht and Seitz [1993]. In both papers the authors find that public capital formation encourages private investment.

Finally, we looked at the role human capital plays in the economic growth process. Attempts to account for human capital were done by adding the ratio of students to total population at the Laender level to the production function.[12] Clearly, this variable is only a crude approximation for human capital for various reasons. Therefore, it was not surprising that no statistical impact could be found. Using more informative data by splitting labor into different qualification groups was impossible in the present context due to data limitations. The data on qualification are only available since 1985

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[12] See Grossman and Helpman [1994], Mankiw et al. [1992], Pack [1994] and Romer [1994] for surveys and a discussion of the endogenous growth theories.

which means that the time series are too short to obtain reliable estimates of the impact of human capital. Lack of data is also responsible why we were unable to use R&D expenditures instead of human capital proxies.

5. Summary and Conclusions

In this paper we analyzed the growth process among the West German Laender for the period 1970 to 1996. The basic result of our study is that during the 27-years-period neither convergence nor divergence in the economic performance of the Laender took place. Those Laender which were poor at the starting point remained poor whereas the rich city states remained rich. Noteworthy are the developments of Hesse and Bavaria which performed best in the investigation period. Both states improved their position considerably, Hesse catching up to the leading group and Bavaria became a well-situated member of the middle group. The loser of the growth process is cleary North Rhine-Westfalia with its unfavorable industrial structure, coal mining and steeling.

The second part of the analysis consisted of estimating Cobb-Douglas production functions for the Laender by applying panel estimation procedures. Results for simple pooling, fixed and random effects are presented. The most convincing results were obtained for the random effects model. This implies that all Laender apply the same technology and produce with identical elasticities of production. Differences may occur due to technical progress, but they are randomly. Estimation results with neutral technical progress were less convincing than those for labor- and capital-augmented technical progress.

Jugded from an economic point of view the results are somewhat disappointing. West Germany is a rather homogeneous country and many fiscal transfer mechanism are installed to guarantee a rather smooth and equal development among the Laender. Perhaps without these mechanism the Laender would have diverged to a considerable amount. But the problem with the lack of convergence is to a less extend the West German development but more the development in East Germany. For the East German Laender to catch up with the West German ones it will take much more time than politicians suggest.

But it is not only Germany; the low rate of convergence might come up as a future problem in Western Europe as well. Although there was nominal convergence among eleven European countries - the necessary pre-requiste for the Monetary Union - real convergence seems still far away. A unique monetary policy is surely an important step towards a unified Europe, but there are still many fields in which more harmonization is required.

Appendix

Variables

Population in the German Laender, annual averages	pop
Gross Domestic Product in 1991 prices	y

GDP per capita employed in 1991 prices	pr
Employment (in 1000)	e
Gross fixed assets in 1991 prices	k
time trend	t

Abbreviations of the German Laender

Baden-Württemberg	BW
Bavaria	BY
Bremen	HB
Hamburg	HH
Hesse	HS
Lower Saxony	NS
North Rhine-Westfalia	NW
Rhineland-Palatinate	RP
Schleswig-Holstein	SH
Saarland	SL

Data Sources:

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